

Universitat Politècnica de Catalunya
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Doctoral Thesis:

Livelihood strategies and risk behavior of cacao
producers in Ecuador: Effects of national policies to
support cacao farmers and specialty cacao landraces

By

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PhD Program: Sustainability

Barcelona, May 2019

Acknowledgments

This thesis would not have been possible without the support of many people and institutions.

I am highly indebted to the Universidad Estatal de Milagro (UNEMI) for invaluable support and for providing financial aid during my doctoral studies.

I specially wish to express my sincere thanks and gratitude to my Director Prof. José María Gil, for his valuable support, friendly and closely treatment and also for all materials and infrastructure that have been made available to carry out this thesis.

I also express my thanks and gratitude to my Co-Director, Dra. Elsa Varela for having been with me always and at all the times. She has been my "Guardian Angel" that has given me the technical, spiritual and motivational support in important circumstances of my doctoral studies.

I am thankful to my colleagues at the CREDA center (Centre de Recerca en Economia i Desenvolupament Agroalimentari), for providing a friendly working atmosphere and always being ready to lend a hand when I need them.

Last but not least, I wish to thank my family. My mother Julieta, my father Héctor, my brother Héctor, my sister Patricia, my wife Carmen and my children Elian and Jeremy. His presence has represented the necessary impulse to complete this important step in my life.

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Summary

This thesis addresses the Ecuadorian cacao value chain through three interrelated chapters. Small producers linked to this chain face significant trade-offs between the two main available varieties for planting: the fine flavor variety (known as national cacao-CN) and the hybrid bulk variety (known as CCN-51), that is more productive and profitable but of lower quality than the former.

In the first chapter, the behavior and characteristics of cacao production are analyzed both at worldwide and Ecuadorian level. Ecuador is the sixth producer of cacao in the world and the first of the CN variety. The global cacao value chain is generally characterized by asymmetric power relationships with increasing control by a few leading companies that have the ability to decide how and where value is created and distributed throughout the global chain. The Ecuadorian cacao value chain is fairly fractionated at the producer level, where approximately 79% of the producers develop their activity in plots of less than 5 hectares, while the production of CCN-51 is growing in comparison with the CN. In fact, in 2017 72% of the cacao produced in Ecuador corresponds to CCN-51, a variety that is sown by 54% of the producers.

The second chapter identifies the livelihood strategies of small cacao producers located in the coastal region of the province of Guayas, Ecuador, where the two varieties of cacao are grown. For this purpose, theoretical frameworks for sustainable rural livelihood strategies and household livelihoods were adopted, and a detailed survey was conducted with a sample of 188 households. Based on activity variables, four latent profiles of livelihood strategies were identified, which were related to the endowment of capital assets and income share variables. The results showed that there was no clear gap between the cultivation of CN and CCN-51, since 60% of the sampled households simultaneously cultivated both varieties. Furthermore, the lack of appropriate incentives could threaten the future cultivation of CN, since the National policy for CN rehabilitation has had little impact on the profiles most driven by cacao cultivation and that also have a lower endowment of assets.

Finally, the third study analyzes risk attitude, risk perceptions and risk management strategies of Ecuadorian cacao producers, as well as the relationships between these risk components. Adopting the same sample of respondents as in the previous chapter, experimental lotteries were applied to measure risk attitudes, while perceptions and

strategies were measured by means of Likert scales. The theoretical model to determine the relationships among risk components was tested using variance-based structural equation modelling (SEM) with the partial least squares (PLS) algorithm. The results show that risk perceptions are more important than risk attitudes when deciding risk mitigation strategies. In addition, perceptions play a mediating role between farmers' risk attitudes and the risk management strategies adopted by them. These results advocate for policy measures oriented towards targeting farmers' perceptions of risk in order to implement successful risk management strategies.

Resumen

En la presente tesis, se desarrollan tres estudios relacionados con la cadena de valor del cacao en Ecuador y su participación en ella de pequeños productores, quienes se ven enfrentados a la disyuntiva entre sembrar cacao fino de aroma o cacao híbrido, que presenta algunas ventajas sobre aquel, especialmente relacionadas con su mayor productividad.

En el primero estudio, se analiza el comportamiento y las características de la producción de cacao a nivel mundial y de Ecuador en particular, país que es el sexto productor de cacao en el mundo y el primero de la variedad conocida como cacao fino de aroma. La cadena de valor del cacao a nivel global se caracteriza en general por una relación de poder asimétrica con un creciente control de unas pocas empresas líderes que son las que tienen capacidad de decisión sobre cómo y dónde se crea y distribuye el valor a lo largo de la cadena. La cadena de valor del cacao en Ecuador se encuentra bastante fraccionada en su eslabón de producción, donde alrededor del 79% de los productores desarrollan su actividad en parcelas de no más de 5 hectáreas y en la que la participación de la variedad híbrida, conocida como CCN-51, es cada vez mayor en comparación con la variedad nacional fino de aroma (CN). De hecho, en 2017 el 72% del cacao producido en Ecuador, corresponde a CCN-51, variedad que es sembrada por el 54% de los productores.

El segundo estudio identifica las estrategias de subsistencia de los pequeños productores de cacao en la región costera de Guayas en Ecuador, donde se cultivan las dos variedades de cacao. Para ello se adopta el marco metodológico de estrategias de medios de vida y capitales, realizándose una encuesta detallada de 188 hogares. A través de un análisis de clases latentes realizado en tres pasos que permite incorporar de forma robusta y optimizada variables externas, se identifican cuatro perfiles de estrategias de medios de vida. Estos perfiles se relacionaron con la dotación de activos de capital y variables de ingresos. Los resultados mostraron que no existe una brecha clara entre el cultivo de CN y CCN-51, ya que el 60% de los hogares muestreados cultivaron simultáneamente ambas variedades. Los hogares con una baja proporción de la tierra asignada a CCN-51 mostraron estrategias de diversificación de ingresos más altas y viceversa. Este estudio también muestra que la falta de incentivos apropiados puede amenazar el futuro del cultivo de CN ya que la política nacional para la rehabilitación de CN ha tenido poco impacto en los perfiles que más dependen del cultivo de cacao y que tienen una menor dotación de activos.

Finalmente, en el tercer estudio se analizan la actitud, percepciones y estrategias de gestión de riesgos de los agricultores de cacao ecuatorianos, así como las relaciones existentes entre estos componentes del riesgo. Con la misma muestra de agricultores del segundo estudio se aplican loterías experimentales para medir actitudes de riesgo, mientras que percepciones y estrategias se miden a través de escalas Likert. Toda la información se integra en un modelo de ecuaciones estructurales y se analiza con a través de modelos PLS-SEM. Los resultados muestran que las percepciones de riesgo son más importantes que las actitudes ante el riesgo para decidir las estrategias de mitigación de riesgo. Además, las percepciones juegan un papel mediador entre las actitudes de riesgo de los agricultores y las estrategias de gestión de riesgo que aplican. Las consecuencias que de aquí se derivan para los diseñadores de política, se relacionan fundamentalmente con incidir en las percepciones de riesgo de los agricultores a fin que implementen las estrategias que resulten más adecuadas.

Chapter 1: Introduction

1.1 Introduction

About two-thirds of the 3 billion rural people in the developing world live in around 475 million small farm households and their farming activity takes place on land plots smaller than 2 hectares. Roughly, two thirds of the 767 million extreme poor people live in rural areas (FAO, 2018; World Bank Group, 2016) and their livelihoods have not improved in the last 30 years (Ravallion, 2016). While inequality among countries has reduced, within-country inequality has increased between rural and urban areas and between genders, demonstrating that economic growth in the last decades has not been inclusive enough (FAO, 2018).

Besides farming, small farmers are engaged in multiple economic activities, often in the informal economy, to contribute towards their incomes (Rapsomanikis, 2015). Smallholders raise capital from multiple sources and invest in productive assets. They make decisions and take both risks and profits such as what to plant, which inputs to use and how, when to plow, seed or harvest. Decisions also relate to the balance between either keeping a share of the harvest for self-consumption or selling it to raise cash. These decisions are often made in a context of poor information on the market and subject to many risks -e.g. adverse weather, price surges-. These factors have significant impacts on their livelihoods, also affecting their investment options and capacity to attain social, financial, physical, natural and human capital objectives (Rapsomanikis, 2015).

World trade markets have niches of specialized products that pay an additional value or premium, either due to their quality, meeting certain standards, or because they offer intangible values through certified production practices, favoring biodiversity and environment (Sheck et al, 2013). Governments in different countries provide support to value chains of these products as a development policy, especially when small producers are linked to their production in an attempt to alleviate the poverty that afflicts rural areas (USAID, 2010). However, these interventions by governments often tend to overlook the complexity of the livelihood strategies of small farmers, whose success and diversity significantly depends on the performance of the policies implemented (Donovan & Poole, 2013; Neilson & Shonk, 2014). Importantly, it may be the case that the priorities of the producer families are not always in line with the investment in human capital and labor needed to improve their participation in a given value chain (Sheck et al., 2013).

The agricultural sector in Ecuador is key to the national economy, accounting for ~8% of GDP or US\$5,593 million (BCE, 2019). The National statistics do not allow to visualize the individual role played by cacao production. However, the available data where banana, coffee and cacao-the three main crops in the country- are grouped showed a

production value of US \$ 1,407 million in 2017, which represents a contribution of 2.0% to country GDP and 25.2% of the agricultural sector GDP. Cacao is therefore a key agricultural product in Ecuador with great political, economic and environmental influence.

Two cacao varieties are cultivated in Ecuador that show relevant differences in terms of quality, productivity, income and environmental impact amongst other factors. On the one hand, the fine flavour variety, known locally as cacao Nacional (CN herein after) produces superior quality beans that can obtain premium prices in international markets. Typically, this variety shows a lower productivity and is grown in traditional agroforestry fashion, with shading trees and other crops (MAGAP, 2018). On the other hand, the hybrid variety CCN-51 shows higher productivity and robustness to be cultivated in full-sun conditions, being grown as monoculture that needs pesticide and fertilizer inputs to arrive to its maximum production potential. This variety has been grown in the country since mid-1980s as a strategy to both production volumes and attract new investment. This variety is lower in quality regarding national variety (CN), but much higher in yield per hectare and that grow in large mono-culture plantations (T. Blare & Useche, 2013). Commercialization of cacao to exporters is mostly led by intermediaries. The lower productivity of the CN variety together with lack of price differentiation in national markets with respect to the hybrid counterpart, leads to the common practice by those to mix the two varieties what reduces the attribute differentials of flavour and aroma in the CN variety. It caused that the International Cocoa Organization (ICCO) passed a resolution penalizing Ecuador with a 25% reduction in the market price for its fine aroma cacao due to the quality reduction, together with a loss of confidence and prestige for the country (Galarza, 2012; Troya, 2013).

The limited formal organization of small producers - only 10% belong to cooperatives or associations-, reduces their bargaining power with intermediaries (T. Blare & Useche, 2013; Galarza, 2012). Small producers also face problems at the farm level, such as aging of trees or lack of improved varieties and technical assistance, among other aspects. All these situations lead to a cacao value chain with weak horizontal and vertical linkages that are needed to properly link producers, first and second floor cooperatives, stockholders, exporters, etc. (IDB, 2009).

Given the high participation of small producers in the cultivation of cacao, the agroecological features of CN cultivation and its premium prices in international markets, the Ecuadorian government considers the improvement of its production as an economic development strategy to alleviate the poverty of rural communities while simultaneously

accomplishing the national objectives of environmental sustainability (T. Blare & Useche, 2013). Thus, the so-called National Project for the Rehabilitation of Fine Cacao and Aroma (PRCN, hereinafter) attempts to reposition this variety in international markets, encouraging the participation of small producers in its value chain, under the premises that linking them to specialized markets will improve their revenues compared to those obtained in a conventional chain. However, the effective global market share of specialty cacao remains very small, around 6% of the cacao produced in the world, and nearly one-third of its production is still sold in the mainstream commodity markets (Abdulsamad et al., 2015).

Another key objective of this program is to stimulate CN cultivation amongst smallholders. However, some indicators cast doubts on the achievement of this objective. In 2012 before PRCN was enacted, more than 50% of cacao cultivation area corresponded to CN variety while in 2017 this significantly changed with 28% of the area corresponding to CN and 72% to CCN-51 (MAGAP, 2018).

Support to cacao producers provided by PRCN has largely focused on improving production conditions at the root of the chain (Purcell et al., 2018). However, success of the program at farm-level is dubious. Considering CN cacao producers, just one third of them has watering infrastructure, only 17% of them use fertilizers and less than half of them (38%) uses certified seedlings. Most of the CN variety planted area corresponded to aged trees (older than 30 years), when the peak production arrives when cacao trees are aged 2-3 years. Furthermore, the PRCN measures have benefited to 52% of the total cacao producers population. As a result, despite CN productivity as improved, it is still significantly lower than that of its hybrid counterpart, 0.33 t/year vs. 0.65 t/year (MAGAP, 2018).

Regarding other dimensions of the value chain, the PRCN program has allocated much less attention to key problems that affect small producers' livelihoods and performance of CN. Some of them are the lack of a differentiated value chain for CN; the lack of regulations in the relationships between small producers and intermediaries; the low associativity levels of producers; the lack of differentiated premium price incentives for the CN variety producers (MAGAP, 2018).

Despite some rough estimates provided in the previous lines, the implementation of PRCN has not gone hand in hand with ex-ante or ex-post evaluations of the performance. We argue that the priority the government has granted to this program and the importance that the crop has for small producers, call for an evaluation of its accomplishments.

1.2 Brief literature review on previous studies addressing cacao cultivation in Ecuador

Previous studies and literature that have addressed cacao cultivation in Ecuador that were conducted before the approval of the PRCN program were carried out by international institutions such as FAO, ONU division on industrial development (UTEPI & ONUDI, 2007), the Interamerican Bank for Development (CORPEI-BID, 2009), the German cooperation agency (GTZ, 2011), or the Economic Commission for Latin America and the Caribbean (CEPAL)(CEPAL, 2011). The main objective of these studies was to characterize the value chain of cacao in Ecuador, determining - in some cases - its strengths, opportunities, weaknesses and threats.

The study conducted by Jano (2007) explores the constraints for market development for fine flavour cacao in Ecuador, namely focusing on analysing price premium transmission along the value chain and how these incentives may influence cacao producers' decision to invest in fine flavour cacao production. This work already highlights how Ecuadorian cacao producers were not getting any differential price for producing fine flavour cacao (*"demonstrating that Ecuadorian farmers are not responding to international incentives to produce high quality cacao"*), namely due to *"specific market level constraints, such as transaction costs, market power, and institutional constraints (weak institutions)"*.

Since 2012 (when the PRCN was approved) until nowadays, a number of studies were focused on analysing the trade-offs between the two Ecuadorian cacao varieties (CN and CCN-51). (Galarza, 2012) assesses the problems derived from variety mixing and quality manipulation. This is a generalized practice among cacao producers and intermediaries to maximize individual benefits. The author frames the analysis of this practice through social dilemma theory and assess the impact of this practice for CN variety prices both in national and international markets. (Astudillo Paredes, 2014) assesses production, transformation and marketing phases of the cacao value chain in Ecuador, highlighting that the PRCN have focused only on the first stage of production without considering other factors affecting all stakeholders. The author adopts a qualitative approach known as soft systems methodology to produce a series of recommendations such as the implementation of a more integral process of training to the farmers, the preparation of an organoleptic profile to differentiate both varieties as the first step to ensure the quality of beans for export. The author states that this mechanism also might facilitate the sharing of revenues along the value chain and the formalization of intermediaries.

The studies conducted by Blare y Useche (2014; 2013) are namely focused on analysing the trade-offs between these two cacao varieties, developing a shadow wage for Ecuadorian cacao producers that includes nonmarket benefits such as such as nonmarket ecological and social benefits to better understand the production decisions of smallholder farmers. The comparison of shadow wages shows that the traditional production methods for cacao Nacional proved to be the best production decision when the value for biodiversity was included in analysing the smallholder production decision. Their study shows that trade-offs exist between cash and biodiversity conservation incentives. Therefore, the cacao producers that prioritize quick cash revenues and hold low values for potential biodiversity conservation benefits will opt for CCN-51 variety.

Finally, (Purcell et al., 2018), characterize the historical development of value relations in the cacao value chain in Ecuador drawing on a theoretical framework grounded in Marxian rent theory. From this perspective, since the 80s Ecuador witnesses a post-neoliberal intervention into the cacao sector where class alliances and institutional contexts shaped local production and mediated the developmental impact of fine aroma cacao reactivation. The authors state that the PRCN policy paves the way for market-based regulations. The authors claim that despite productivity improvements of CN may significantly increase country exports, this will not necessarily translate into better perceived prices and/or livelihood conditions for small producers, if power relations and asymmetries in the value chain remain the same. This translates into low bargaining power of producers un the cacao market. Finally, the authors state that the PRCN program promotes cacao as a “business of poverty” for smallholders.

Some of these studies have focused on literature reviews (e.g. Astudillo Paredes, 2014; Purcell et al., 2018), while some others have conducted fieldwork and interviews with reduced sample sizes (e.g. 50 smallhodler households (Blare & Useche, 2013; Useche & Blare, 2013). While some of the studies have focused on assessing specific success examples of transnational companies in Ecuador (Blare & Useche, 2014), some other shave assessed central problems in the Ecuadorian cacao production (Galarza, 2012). They all shared the premise that linking smallholders to CN variety cultivation is the more rewarding strategy and what is needed is improving their conditions in accessing the value chain.

Careful assessment of previous literature and studies conducted in other regions (Nicaragua, Honduras, África) (Donovan & Poole, 2013; Ricketts et al., 2014; Sheck et al., 2013) drew the consideration of a number of hypothesis that underpin this thesis. In first place, accounting for the asset pool of smallholders may allow to seizing whether

they are able to join successfully premium/international value chains. Secondly, adopting a livelihood strategy framework may allow understating that their linkage to a given value chain is a subsystem of their capital assets and productive activity both in and off farm and engaged in either agricultural or non-agricultural activities. Thirdly, agricultural production is characterized (differently from other activities) for being exposed to permanent risks that threaten its performance and continuity. Finally, linking small producers into specialized value chains implies higher exposure to different risk from these they are used to manage in traditional value chains, being this issue completely overlooked by previous studies.

This combination of capital assets, livelihood strategies and risk assessment may provide a more holistic view on the welfare of cacao producers while allowing for policy recommendation derived from it that encompass not only value chain but also the broader sector as a whole.

1.3 Objectives

This PhD dissertation explores from three interrelated perspectives the impact of the Ecuadorian policy of support to the national cacao on the small producers of this country. It has been motivated by the absence of studies that make an evaluation of the results of this policy and by the need to determine if it is viable and sustainable over time.

Therefore, the **overall objective** of this thesis is to determine the impact of the Ecuadorian national policy for fine flavor cacao production on small cacao producers in Ecuador.

This overall objective is narrowed down in the following **specific objectives**:

1. To determine the main characteristics of the global and Ecuadorian cacao value chain with a special focus on the role and situation of the small cacao producers.
2. To identify the livelihood strategies pursued by the small Ecuadorian cacao farmers and assess how the different mix of capital assets influences these strategies.
3. To evaluate whether the governmental policy to stimulate fine flavour cacao production has had an impact on the livelihood strategies pursued by these farmers.

4. To disentangle the interlinkage between the main risk management strategies applied by Ecuadorian small cacao producers and their risk attitudes and risk perceptions.

To achieve this objective, the research follows **three main research lines**:

1. The review of secondary data to characterize the global cacao value chain in general and Ecuadorian cacao value chain in particular.
2. The identification of the livelihood strategies of Ecuadorian small cacao producers and the analysis of the role of fine flavour cacao in unveiling these latent profiles.
3. The identification of the main risk management strategies followed by Ecuadorian small cacao producers and how these strategies are determined by their risk attitude and their risk perception.

1.4 Theoretical framework: livelihood strategies and risk behavior

Household income is relatively simple to measure and is often perceived as a clear welfare gauge (Barrett et al., 2012; Walelign et al., 2015). However, a narrow focus on employment and income as proxies for poverty measurement has come under criticism, particularly when the focus is on a given value chain with no attention to other livelihood activities geared toward the market or subsistence (Sheck et al., 2013). In addition, this approach is exposed to the stochastic nature of income, which can potentially introduce considerable variation in apparent income dependencies from year to year (Barrett et al., 2001; Nielsen et al., 2013). Furthermore, income measurement does not reflect other key dimensions, such as the amount of assets households choose to invest in different activities that may have dramatic impacts on welfare status. The livelihoods of smallholders depend on their choices on how to allocate their labor and few assets across farm and non-farm activities and generate the highest income possible given the constraints they face (Rapsomanikis, 2015). Income differences among smallholders reflect differences in capital assets, but also differences in the skills-mix which give rise to diverse sets of opportunities in the rural non-farming sector. Therefore, income may operate as a misleading indicator to categorize household livelihood strategies and household welfare (Jansen et al., 2006; Nielsen et al., 2013).

The livelihood strategies of households are ultimately restricted by access to assets, in addition to the political, historical and institutional context in which they are immersed, and therefore dependent on broader economic structures (de Haan & Zoomers, 2005; I

Scoones, 2009). Thus, when designing and implementing intervention policies in value chains, the structure of livelihood strategies of rural households should be taken into account, which can ultimately end up affecting the dynamics of their linkage to these value chains. Assets refer to the resource base of people and are often represented as a five-dimension pentagon: natural resources (also called 'natural capital'), physical reproducible goods ('physical capital'), monetary resources ('financial capital'), manpower with different skills ('human capital') and social networks of various kinds ('social capital') (FAO & ILO, 2009). In this thesis, the assessment of the performance of the different cacao producing households and the impact that National policies have on them, is analyzed in a multidimensional way, considering livelihood strategies developed by the producers and the pool of capitals they count on to enable their livelihood pathways.

There is a widespread belief that linking small producers to higher-value markets will result in benefits for them that would be more difficult to attain in conventional chains (Sheck et al., 2013). However, agricultural activity is associated with numerous types of vulnerabilities, uncertainties and an increasing range of risks related to production, price, commercialization, and institutional aspects that altogether make of farming a complex process (Ellis & Freeman, 2005; Iqbal et al., 2016). Therefore, linking producers with international markets entails exposing them to new and different risks relative to these they have been accustomed to endure (Kisaka-Lwayo & Obi, 2012). The risks faced by small producers linked to agro-food value chains, have been increasingly studied in agricultural economics research (Alimi & Ayanwale, 2005), although largely focused on assessing the impact of a single factor (e.g. climate, technology, some type of alternative production, the potential threat of a specific pathogen in crops) (Harvey et al., 2014; Ngwira et al., 2013; Regier et al., 2012; Snelder et al., 2008), while the incidence of multiple sources of risk has been more scarcely addressed (Girdžiūtė, 2012).

The principle of risk management recognizes the fact that risks are a potential source of threats that undermines corporate strategy. Therefore, the need for systematic and proactive measures to mitigate them is fundamental and should not be left to chance (Anin et al., 2015). Since the choice of risk management strategies by farmers is of vital importance for the viability and continuity of their productive activities, it is of great interest to understand the process of making decisions regarding the possible risk mitigation tools that can be implemented (Winsen et al., 2014).

Farmers face risks and uncertainty in different ways and commonly known strategies include: i) Avoiding financial problems - too much dependence on credit or implementing

buffer measures for times of economic difficulties-, ii) Obtaining an off-farm income, iii. Use of external risk management strategies -contracts terms or crop insurance, iv. Diversification of sources of production or income, among others (Hardaker et al., 2004; Winsen et al., 2014).

Despite a dearth of studies have addressed risk management mechanisms, most of them focus on a specific risk management tool and adopt restrictive assumptions about the preferences and attitudes of producers towards risk. Furthermore, the treatment of multiple sources of risk, based on which these tools are designed, has been rather limited (Chambers & Quiggin, 2004; Girdžiūtė, 2012; Khan & Burnes, 2007; Wauters, van Winsen, de Mey, & Lauwers, 2014). IN addition, the dependence of the risk management tools tested on contextual characteristics is unclear, what may cast doubt on their scalability/replicability in other settings (Chambers & Quiggin, 2004). Therefore, this thesis acknowledges the multidimensional nature of risk to assess its influence in the implementation of strategies to manage it by smallholders.

1.5 Thesis structure

The thesis is composed by three interrelated chapters. While the former looks at the global and Ecuadorian whole cacao value chain, the two later focus on the Ecuadorian cacao producers, addressing respectively their livelihood strategies and their multidimensional risk management decision-making process.

The first chapter addresses the first specific objective, analyzing the behavior and characteristics of global cacao value chain and the Ecuadorian cacao value chain in particular and identifying the main sections in the chain, actors involved and volume and value distribution across the chain.

The second chapter addresses the second and third specific objectives. More specifically it determines the factors associated with the choice of livelihood strategies of small farmers in Ecuador linked to the cultivation of two varieties of cacao, CN and CCN-51, which have significantly different economic, social and environmental impacts. Furthermore, this chapter investigates the influences of the national policy to promote fine flavor cacao cultivation on the livelihoods of small farmers, including their capital asset endowments, activities, income shares and livelihood strategies. These objectives allow cover a research gap on the trade-offs faced by small cacao farmers in Ecuador in the production of specialty (CN) vs. commodity (CCN-51) cacao and how these impact on their livelihoods. By adopting the sustainable rural livelihoods (Ellis, 2000; Scoones, 1998, 2015) and household livelihood strategy frameworks (Carney, 1999; Jansen et al.,

2006; Nielsen et al., 2013; Scoones, 1998), activity choices are employed as criteria for livelihood strategy identification. A novel variant of latent class analysis known as improved three-step is applied in the analysis, allowing for identification of groups or profiles in a population based on a set of observed variables, implicitly acknowledging that these profiles may relate to external variables (Bakk et al., 2013; Vermunt, 2010). To our knowledge, this approach has not been applied in the assessment of livelihood strategies in developing. For this purpose, a detailed household survey was conducted from December 2015 to April 2016 in nine rural sites in two districts of the Guayas region of Ecuador, Lorenzo de Garaicoa and Yaguachi Viejo, which represent 10% of the Guayas cacao production.

Finally, chapter 3 addresses specific objective 4 by analyzing the dynamic interaction between risk attitude and risk perception on determining the adoption of risk management strategies by Ecuadorian cacao farmers through a structural equation modelling approach. More specifically, this chapter investigates Ecuadorian cacao farmers' attitude towards various kinds of risks exposure, considering their perceptions of the risks they are exposed to in the study area. A model is built with this information to assess the relationships among risk attitude (RA), risk perceptions (RP) and risk management strategies (RMS). The theoretical model was tested by an empirical application, using variance-based structural equation modelling (SEM) with partial least squares (PLS) (Hair et al., 2017; Hair et al., 2011; Lohmöller, 1989; Wold, 1982). In-depth semi-structured interviews were first conducted to collect information on the different risk dimensions. The same sample as that of chapter 2 was interviewed as part of the survey to obtain information on their risk perception and risk management strategies. Experimental lottery designs with differing real payoffs were applied with the sampled respondents to obtain their risk attitude.

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Chapter 2: Characterization of cacao markets and value chain: implications for Ecuadorian smallholders

2.1 Introduction

Cacao is the world's third most important agricultural export commodity and the second most important cash crop in the tropics (Blare & Useche, 2013; Galarza, 2012). It is estimated that more than 80% of cacao is produced by 7–8 million small family-managed cacao farms in over 50 countries worldwide and it is mostly grown by smallholder farmers (Díaz-Montenegro et al., 2018; ECLAC et al., 2015).

At the global level, few firms rule the cacao value chain. The chocolate candy market is dominated by five companies that make up to 56% of the total market share, while three companies concentrate half of the world's supply of cacao. In contrast, the production of cacao beans is highly fragmented and carried out in approximately five million small plantations worldwide (land plots of one to three ha). This situation generates an asymmetric distribution of the value so that producers receive 5% of the price paid by the final consumer, while trade and processing activities capture 25% of it and chocolate processing and retail sales capture a share of 70% of the monetary revenues (Abdulsamad et al., 2015; Fountain & Huetz-Adams, 2018; Squicciarini & Swinnen, 2016).

The growing trend in world consumption of cacao, driven by the consumption of emerging markets (e.g. Brazil and Russia) has produced an increase in the global production of cacao beans, that grew worldwide 2.4% per year since 1995, arriving to 4 million tons (MT) in 2016 (Squicciarini & Swinnen, 2016). Two thirds of world production come from Africa, with the largest producer –Ivory Coast- representing 43% of the global total. (). The cacao industry is also characterized by cyclical processes of scarcity and overproduction with most of the world production (about 90%) generated by small farmers, while bean grinding is mostly done in the importing regions (ICCO, 2016).

Fine flavour cacao, known locally as cacao nacional (CN, hereinafter) is a premium variety that represents between 6% and 8% of the world cacao production. 80% of it is produced in Latin America, with Ecuador being the largest producer achieving 54% of the total production. Ecuador produces the fine flavor (CN) and bulk (CCN-51) cacao varieties in the coastal tropical provinces. Cacao is a traditional product in the export basket of the country; shipments of beans amounted 232 thousand MT in 2015, which represented 85% of total cacao exports. 30% of the cacao exports corresponded to the CCN-51 variety. The lower quality beans of CN variety were namely exported to the US representing 47% of total exports while the remainder 23% were high quality CN beans shipped to Europe and Japan.

Approximately half of the farms in Ecuador are small properties with less than 50 Ha. It is estimated that 90% of CN production is carried out in traditional systems, while the majority of the CCN-51 production is grown in modern farming systems with more inputs and higher degree of mechanization. The CCN-51 variety is more productive than its CN counterpart, as well as a younger bean producer and more resistant to certain diseases. In contrast, the CN variety has a widely acknowledged superior quality, although this is not always reflected in a better price for the farmers compared to CCN-51, due to the market structure and post-harvest treatment of the beans. Altogether, these factors reduce the incentives for producers to invest in the maintenance, improvement or renovation of their CN plantations.

In Ecuador, support for small farmers, especially linked to the cacao value chain, is seen as a national development strategy (Blare & Useche, 2013). Thus, the so-called National Project for the Rehabilitation of Fine Cacao has been implemented, attempting to reposition this variety in international markets and encouraging the participation of small producers in its value chain. The underlying assumption is that linking small farmers to specialized markets will generate a better distribution of benefits and higher revenues for them than they could obtain in a conventional chain. However, whether the implementation of this policy will achieve the desired results is still questionable.

The objective of this chapter is to characterize the cacao market and value chain both at the global and Ecuadorian level, showing the main dynamics and challenges that policy makers may find in trying to implement policies that may reduce asymmetries in value accruing by different actors as a way of poverty alleviation of rural stallholders. In particular, the chapter is structured as follows: section 2 presents the main features of the international cacao market, both for bulk and fine flavor cacao varieties; section 3 is devoted to characterize the international cacao value chain while chapter 4 is focused on the cacao sector in Ecuador, both its cultivation and value chain features. Section 5 and 6 presents discussions and conclusions for this chapter.

2.2 The international cacao market for bulk and fine flavor cacao

2.2.1 Bulk cacao market

Global cacao bean production registered an annual growth of 3% in the period 2007-2017, reaching a worldwide production of 5.2 million tons in 2017 (FAOSTAT, 2019), with a second global boom in cacao and chocolate consumption taking place since 1990 (Squicciarini & Swinnen, 2016).

The annual growth of harvested area in the period 2007-2012 went hand in hand with the annual production growth rate for the same period, i.e. the production growth was mostly due to the increase in harvested area rather than to a significant increase in productivity (Figure 2.2.1). Stable weather conditions in West Africa (after El Niño phenomenon) together with national policies stimulating cacao production (e.g. Ecuador and Peru), significantly contributed to expand the cultivated area (Fountain & Huetz-Adams, 2018). For example, in Africa in the past five years, it has been reported that a large number of new cacao farms have been established in former protected forests and have started to produce significant tonnages of cacao (Fountain & Huetz-Adams, 2018).

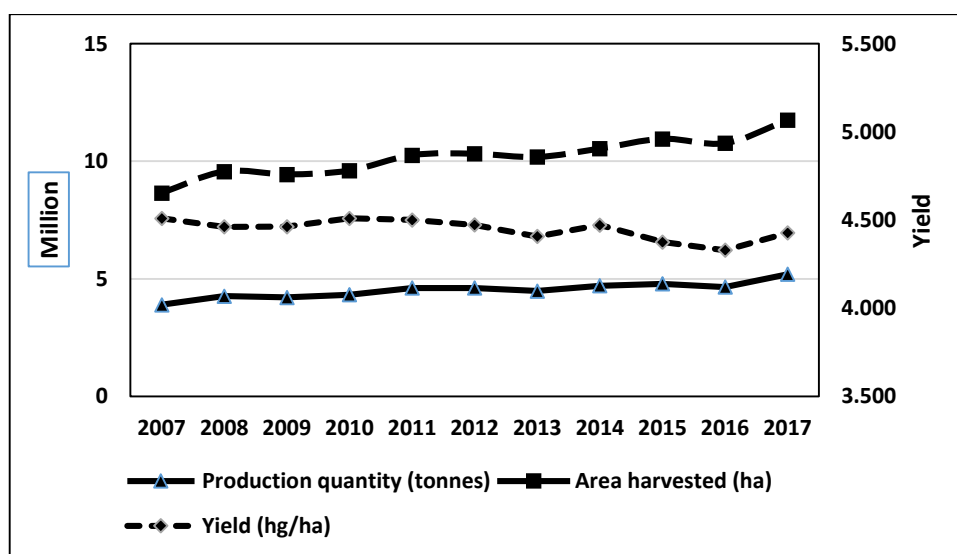


Figure 2.2.1 Cacao beans in the world: Production, Area harvested and Yield
Source: (FAOSTAT, 2019).

Africa dominates global cacao production accounting for 70.4% of global production in 2017 and showing an annual production growth of 3.8% in the last ten years. America's production follows with 15.4% of the production share and shows a yearly increase of 5.3%. Lastly Asia contributes with 13.2% of the global production with 1% yearly decreases in the analyzed decade while Oceania's contribution is marginal (FAOSTAT, 2019).

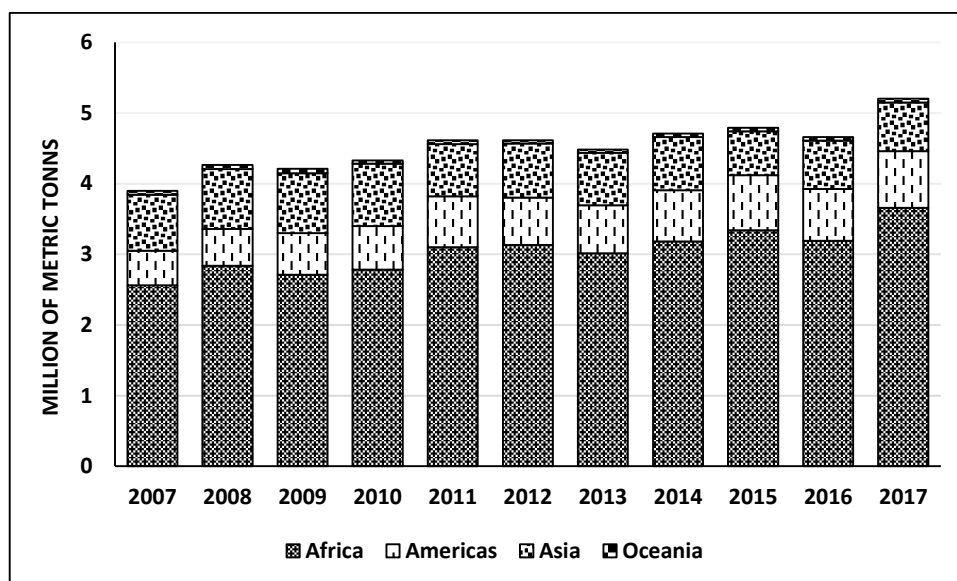


Figure 2.2.2 World production of cacao beans per region
Source: (FAOSTAT, 2019).

Statistics on production per country illustrate a high concentration of production in Africa with the Ivory Coast accounting for almost 40% (FAOSTAT, 2019) (Table 2.2.1).

Table 2.2.1 Regional production of cacao beans

	Production (in million Tons)	%
Africa	3,660	70.4%
Ivory Coast	2,034	39.1%
Ghana	884	17.0%
Nigeria	328	6.3%
Cameroon	295	5.7%
Other	119	2.3%
America	801	15.4%
Brazil	236	4.5%
Ecuador	206	4.0%
Other	359	6.9%
Asia & Oceania	740	14.2%
Indonesia	660	12.7%
Papua New Guinea	45	0.9%
Other	36	0.7%

Source: (FAOSTAT, 2019).

In terms of production per hectare, Africa maintained the leadership until 2016, showing a flat or decrease trend since 2012. America reached the leadership in productivity in 2017 with a yield of 470.9 kg/ha showing an increasing trend since

2012. Finally, Asia and Oceania showed a declining evolution (Figure 2.2.3) (FAOSTAT, 2019).

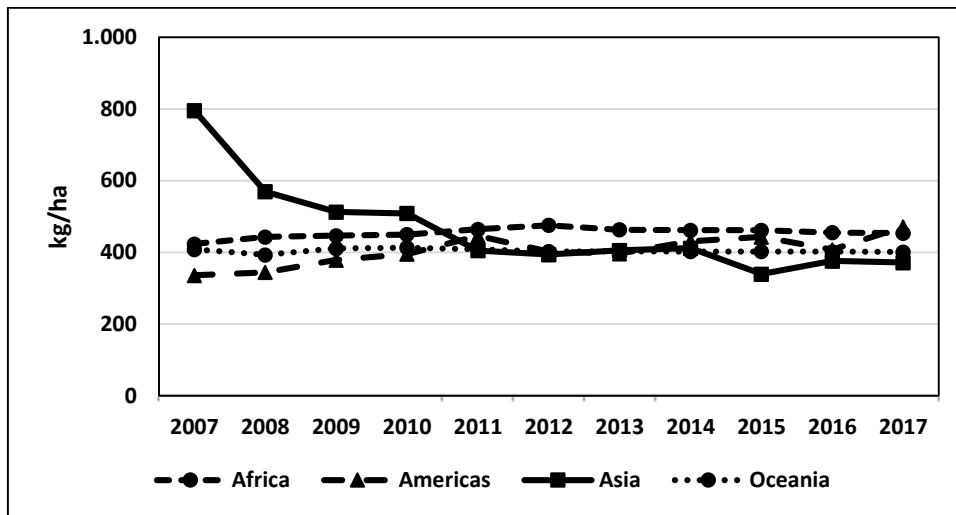


Figure 2.2.3 Regional productivity of cacao beans
Source: (FAOSTAT, 2019).

The price of cacao beans is highly volatile and fluctuates due to several factors derived from their dual condition of commodity and agricultural product (UTEPI & ONUDI, 2007). Therefore, factors such as climate change, weather events or pests as well as productive cycles in large producers, variations in the inventories of cacao processors or changes in consumer markets influence the price. With regards to production cycles, oversupply causes falling prices and stimulates farmers to intensively harvest mature trees that can be substituted by other crops, thereby increasing cacao bean market saturation and hence causing a sharper decline in prices (Fountain & Huetz-Adams, 2018). As a result, future bean shortage occurs bringing price increase. Since the supply in this market reacts slowly to price changes or demand pressures, when demand exceeds supply and prices increase, farmers have incentives to plant new trees, but these take several years to reach their highest productive performance, so that farmers receive very little of the benefits of price increases.

In the last 50 years, both the global supply and demand for cacao have followed a growing trend (2.5% annual on average), although with important differences, since on the one hand the demand had a more stable increase, while on the other, the cacao production showed a greater variability due to climatic factors. However, demand for cacao has been more or less stable between 2012 and 2016. In most European countries, the demand for cacao is currently saturated and might even decrease due to

the ongoing discussion about high sugar and fat contents in many chocolate products (Fountain & Huetz-Adams, 2018; ICCO, 2016).

The international price of cacao as a commodity has shown an instable behavior in the analyzed decade (2007-2017). Figure 2.2.4 shows the upward trend of prices until 2010 and a decrease between 2011 and 2012. As of 2013, an increase is seen while a fall in prices is registered in 2016 (-4.0%) and especially in 2017 (-32.1%) when more than a third of its value was wiped out. This steep price fall in the last two years would be the result of several factors, such as an oversupply of cacao, demand stagnation in emerging economies (e.g. Brazil and Russia) due to economic crisis, and decaying chocolate appetite in the USA, China and India (Fountain & Huetz-Adams, 2018; ICCO, 2016; World Bank, 2019).

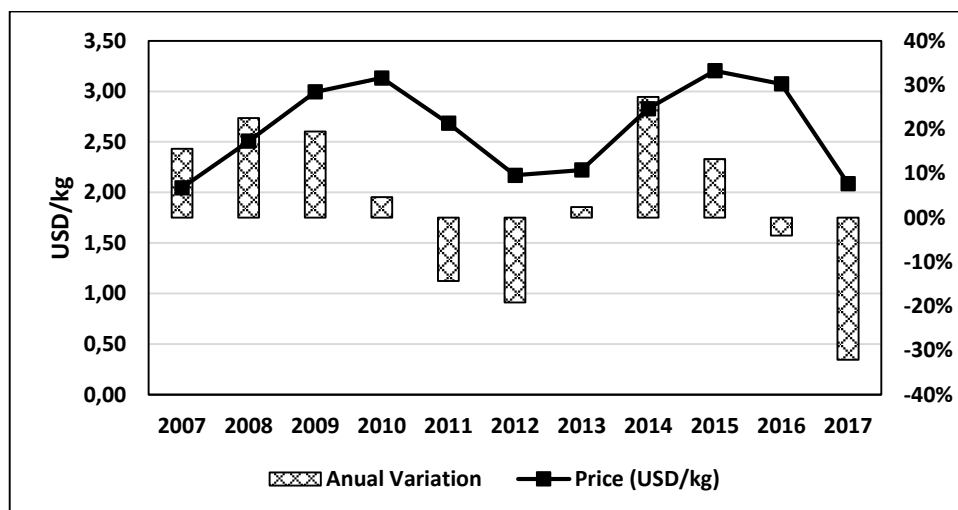


Figure 2.2.4 Real cacao prices (2010 values)
Source: The World Bank (Commodity prices, Pink Sheet).

The demand for chocolate is elastic to price changes, although there are segments of consumers focused on quality and brand image (Squicciarini & Swinnen, 2016). Cacao consumption worldwide has shown a growing trend in recent years, reaching 1,000 tons in the 2015/16 season. If the current fall in international cacao bean prices is sustained, the price of finished cacao and chocolate products is expected to decline, thereby stimulating consumption. However, it may take time for the reduction in the cost of the cacao beans to be passed on to consumer prices (ICCO, 2016).

The world imports of cacao and its processed products reached USD 9.34B in 2017 being the Netherlands (25%), United States (13%), Germany (8.4%) and Belgium-Luxembourg (8.4%) the main importing countries. The products in greatest demand were chocolate and other food preparations containing cacao (representing 57% of imports), cacao beans, raw or partly roasted (20%, and cacao powder without addition of sugar or

another sweetener (8%). In turn, the five main exporters of cacao and processed in 2017 were Cote d'Ivoire (40%), Ghana (19%), Nigeria (7.1%), Ecuador (6.6%) and Cameroon (5.3%) (OEC, 2019).

2.2.2 *The fine flavor cacao market*

The market for fine aroma cacao is relatively small and specialized. According to the International Cocoa Organization (ICCO), there is no internationally accepted criterion to classify cacao as fine flavor. Relevant criteria could include the genetic origin of planting material, morphological characteristics of the plant, and some features of the beans including flavor, chemical components, color of beans and nibs, degree of fermentation, drying, acidity and off-flavors¹ (Van der Kooij, 2013). The International Cocoa Organization (ICCO) offers an estimate of the percentage of exports from those origins composed of 'fine and flavour' by countries. Currently, ICCO estimates fine cacao represents between 6% and 8% of the world cacao production. Latin America and the Caribbean are the most important producing areas, contributing with about 80% of the world production, in contrast with bulk cacao, namely produced in (West -) Africa. Ecuador stands out as the largest producer of fine cacao², with around 60% of the world production (Abbott et al., 2018; Van der Kooij, 2013).

Three market segments can be distinguished for cacao: (1) high-volume low-value bulk chocolate; (2) mainstream quality chocolate; and (3) high-quality 'niche' chocolate, including single origin, fine flavor, Fairtrade, sustainability certified, and organic (Squicciarini & Swinnen, 2016).

International demand for fine flavor cacao seems to outweigh supplies, creating a very attractive niche for cacao chain development (Squicciarini & Swinnen, 2016). However, according to other authors, the market share for premium and super-premium chocolate is extremely small relative to the other segments (Abbott et al., 2018; Dand, 2010).

The price of fine cacao is determined by the balance of supply and demand for a particular type and origin of cacao, being quality and flavor the main factors seized for price setting. Due to the reduce market size, the price obtained for fine cacao beans can be very variable due to the influence of short-term factors in orders and shipments. No information is available on premiums for 'fine and flavor' cacao either on New York or

¹ There are three varieties of cacao, forastero (the most common source of 'bulk' cacao on the global market), criollo and trinitario (varieties from which the ICCO's 'fine and flavor' designation derives). The main exception is the 'Nacional' variety from Ecuador, which is a type of forastero, but produces fine flavour cacao with the right post harvesting techniques. The notion of 'fine and flavor' cacao is essentially defined by the ICCO as cacao from Latin American varieties. (Abbott et al., 2018; S. Van der Kooij, 2013).

² According to the ICCO, Nacional or "arriba" variety of trees in Ecuador are considered as forastero origin, but classified as 'fine and flavor' given their organoleptic attributes (Abbott et al., 2018).

London commodity exchange market. The higher premiums on cacao sales seem to be found on individual transactions between suppliers, specialty exporters and direct trade, and high-end luxury manufactures or processors. There is a wide range of premiums on such transactions, based on anecdotal evidence – since there is no price reporting by cacao quality. In addition, this premium tends to increase when there is a wide availability of standard cacao and decrease when there is a shortage of standard cacao. Any excess of supply is sold into the bulk market (Abbott et al., 2018).

Providing future price estimates for global cacao trade per quality segment remains problematic, since there is no formal market for fine and flavor cacao worldwide. Incentives and policies to expand ‘fine and flavor’ production have been developed all over Latin America (Peru, El Salvador, the Dominican Republic, Ecuador in the others), so the likelihood of supply of exceeding demand in this niche is high (Abbott et al., 2018).

2.3 The cacao-chocolate value chain

The cacao-chocolate value chain worldwide is described in Figure 2.3.1.

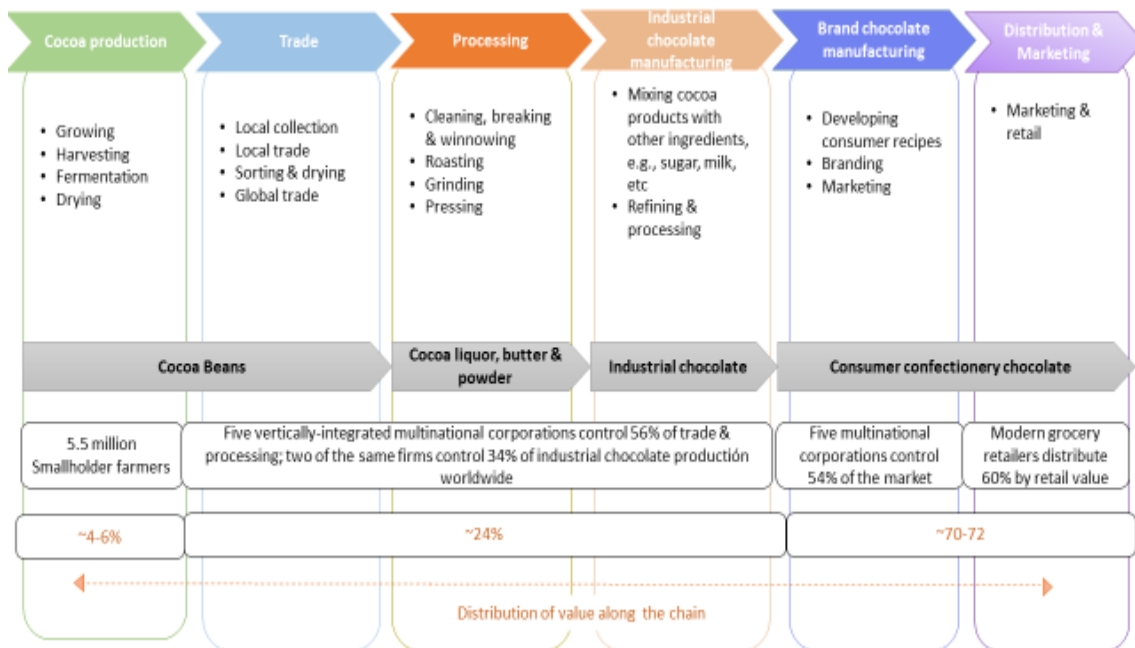


Figure 2.3.1 The Cacao-chocolate Value Chain
Source: Abdulsamad et al., 2015.

The cacao global value chain (GVC) is characterized by a dual governance system where few firms control consumer and processing segments, and hence how and where value is created and distributed along the value chain, while coca bean production occurs

mostly in small landholder farms. Lead firms operate both in the consumer markets, where they control high-value functions in brand manufacturing and marketing, and in the processing segment dominating the global supply chain of cacao ingredients and operating in producer and consumer countries (Abdulsamad et al., 2015).

The leading companies in the consumer markets control high-value functions related to brand manufacturing and marketing, resulting in a global chocolate candy market dominated by five global firms: Mondelez International (15%), Mars Inc. (14%), Nestle (12%), Ferrero (8%), and Hershey Co. (7%). These firms rely on long-established brand recognition and scale economies offered by their worldwide network of manufacturing and market infrastructure. They have remarkable buying power and own several brands that generate each multi-billion dollar annual retail sales in global markets (Abdulsamad et al., 2015).

Three lead firms dominate the vertically integrated global supply chains for cacao ingredients, i.e. from rural areas in the producing countries to the main ports in Europe and North America where advanced processing facilities are located. Barry Callebaut (23%), Cargill (15.3%), and ADM (12.7%) control approximately half of the cacao processed worldwide. vertically integrated supply chains (Abdulsamad et al., 2015).

In contrast, cacao production takes place in approximately five million small farms, where cacao is produced in land plots ranging from one to three ha of land (ICCO, 2016), generating 90% of the global harvest (Purcell et al., 2018). Smallholders are at the lose end of the supply chain since they have low financial capacity to face negative impact and virtually bear all the risks of price volatility (Fountain & Huetz-Adams, 2018). Thereby, the upstream segment of the cacao-chocolate GVC shows a highly fragmented structure. Local cacao trade also involves a large number of local collectors or buying agents, often working on commission for large traders or subsidiaries of multinational corporations, that compete fiercely amongst them and pushing down farm gate prices received by local farmers (Abdulsamad et al., 2015). In addition, the processing (grinding) of cacao beans is carried out mainly in the importing countries where three of them (the Netherlands, Germany and the United States) account for almost one third of the world grindings and therefore appraise the added value of this operation (ICCO, 2016).

The asymmetric relationship in value chain power mirrors price transmission along the chain. Retail prices often rise quickly when the price for cacao goes up but react more slowly when cacao prices go down. Falling prices of cacao beans will immediately impact farmers while the rest of value chain agent are likely to increase their profit margins, even

if only temporarily (Fountain & Huetz-Adams, 2018). Table 2.3.1 shows the acute differences in value distribution along the chain across the production activities realized by cacao-producing countries (6.6%), transport and marketing (6.3%), processing (7.6%), manufacturing (35.2%) and retail sales (44.2%).

Table 2.3.1 Cacao Value Distribution

Value Distribution	Sells (\$)	Buys (\$)	Value Added (\$)	Profit (\$)	Final sale Price (%)
Farmers income weighted	1,874	664	1,210	1,210	6.6
Inland Transport	1,971	1,874	97	?	0.5
Taxes/Marketing Board	2,745	1,971	774	?	4.2
International Transport	2,793	2,745	48	?	0.3
Cost por of arrival	2,993	2,793	201	?	1.1
International Traders	3,038	2,993	45	15	0.2
Processors & Grinders	4,434	3,038	1,395	211	7.6
Manufacturer*	10,858	4,434	6,425	870	35.2
Retail & Taxes	18,917	10,858	8,058	473	44.2

*Per ton of cacao sold

Source: (Fountain & Huetz-Adams, 2018).

The fine cacao value chain is relatively shorter and more transparent compared to the standard cacao value chain. The farmers produce and process the cacao themselves and sell it to traders receiving this way a premium price compared to standard market (Van der Kooij, 2013). However, it is difficult for individual producers to access this market, reason why most producers in this chain sell it through producer cooperatives or associations, able to provide volume and quality required in this market. Typically, producer organizations that are able to access a premium channel, sell a small share of the farmer production to this market while the remainder is sold as bulk cacao on the local market (Abbott et al., 2018). Therefore, premium market is relevant for a small share of producers but it may not be an option for a large number of them (Abbott et al., 2018).

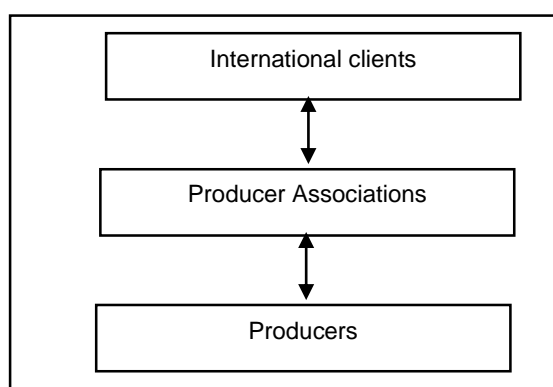


Figure 2.3.2 Specialized cacao value chain

Source: (Galarza, 2012)

2.4 The cacao sector in Ecuador

2.4.1 Cacao cultivation

Ecuador food production capacity surpasses the growing demands of its population. By regions, Latin America, North America and Australia share this condition of high production capacity, in a worldwide context of increasing food demands, especially by emerging economies such as China and India. The Ecuadorian agricultural sector offers important options for food production and for the economy as a whole. However, it is also an area of great productive, social and ecological vulnerability (MAGAP, 2016).

Sixty years after the first agrarian reform (1964) that was impelled by successive laws and decrees in the following years and decades (1970, 1973, 1979, 1994), small farmers ownership structure remains practically unchanged (6.7% in 1954 compared to 6.5 in 2013) and Gini coefficient varied very little (from 0.87 in 1954 to 0.76 in 2013). The Ecuadorian agrarian policy of the last five decades has not adequately confronted the structural problems of Ecuadorian small and medium producers: lack of management, recovery, maintenance and conservation of soils, inequity in access, distribution and management of irrigated land, barriers in access to marketing channels and markets, insufficient research and innovation and technological development, among others. (MAGAP, 2016). Despite the unequal orientation of agricultural policies, the effective volume of agricultural production has increased. The agricultural sector produces 95% of the foodstuffs consumed internally, employs 62% of the active rural population while 46 % of the production is an input source for other productive activities (intermediate consumption). This is a key sector for the monetary liquidity of the country, contributing with 40% of the foreign currency in annual average that entered the country in the present century. Largely, the export performance of products such as bananas, coffee, cacao, fish or shrimp is sustained by low wages and low prices paid to the producer, deepening inequality. Reversing this situation through the implementation of specific policies targeting small and medium producers is essential for the future of the agricultural sector and to guarantee the livelihood improvement of the Ecuadorian population, especially small farmers (MAGAP, 2016, 2018)

Cacao is a key agricultural product in Ecuador with a great political, economic and environmental influence. Cacao is a traditional export product in Ecuador since late eighteenth century, when its successful production and sale abroad allowed significant income increases in the Ecuadorian coastal region until the early twentieth century. During the years 1880-1915, production reached its highest levels so far, making of Ecuador the world leading exporter of cacao (Castillo, 2013). The production and the

export of cacao beans is linked to small farmers. By 2017, 79% of the cacao planted corresponded to plots smaller than five hectares, while only 7% of this area belonged to plots bigger than ten hectares (SINAGAP, 2018). Currently, its production contributes 4.5% to the Economically Active Population and 13.5% to the Agricultural PEA (SINAGAP, 2018). Its cultivation involves some 500,000 farmers representing around 97,000 families (MAGAP, 2015).

Two farming systems exist for cacao cultivation in Ecuador. The agroforestry system grows the traditional cacao variety, locally known as Cacao Nacional (CN) that is sold in specialty markets for a premium because of its fine flavor characteristics. The shade-less monoculture system cultivates a modern, hybrid variety known as CCN-51³ (Useche & Blare, 2013). These two varieties show also differences in their productivity: 0.65 MT/ha for the hybrid variety and 0.33 MT/ha for CN (SINAGAP, 2018). The productive tension between these two varieties shape and define largely the challenges that cacao cultivation faces in Ecuador. The CN variety (fine flavor cacao) is known for its superior quality that enables obtaining premium prices in international markets. However, smallholders rarely retrieve these premium prices, as both varieties are sold at the same price in the local market. For this reason, CCN-51 that shows higher productivity is increasing its cultivation area. The lower productivity of the CN variety, whose commercialization to exporters is predominantly in the hands of the collectors (intermediaries), leads them to the common practice of mixing the two varieties. This significantly reduces the flavor and aroma differentials of CN, and for which Ecuador is usually penalized with up to 25% of price punishment in international markets for fine flavor cacao, with the consequent loss of confidence and prestige for the country with respect to this variety (Galarza, 2012; Troya, 2013).

Both harvested area and yield show a growing annual trend, especially since 2012 (Figure 2.4.1). The yield increase recorded in recent years is due to the expansion of cacao plantations (especially of the CCN51 variety) and, to a lesser extent, to the improvement in CN plantations, supported by the National Cacao Reactivation Project (PRCN) implemented since 2012 by the Ministry of Agriculture of Ecuador (MAGAP) to improve CN cultivation.

The PRCN program aims to stimulate the production of fine flavor cacao, largely focusing on improving production conditions at the root of the value chain by tackling the low productivity of small producers cultivating fine aroma cacao. However, this program has

³ “Colección Castro Naranjal 51” in Spanish.

not been much concerned with ameliorating the bargain power of small producers, especially with intermediaries. In the absence of the institutional support needed to secure standard market prices, fine cacao is regularly mixed with CCN-51 in order to increase produced volume and fulfil contracts struck with intermediaries. The improvements in the productivity of CN has incentivized the speculative activity of intermediaries.

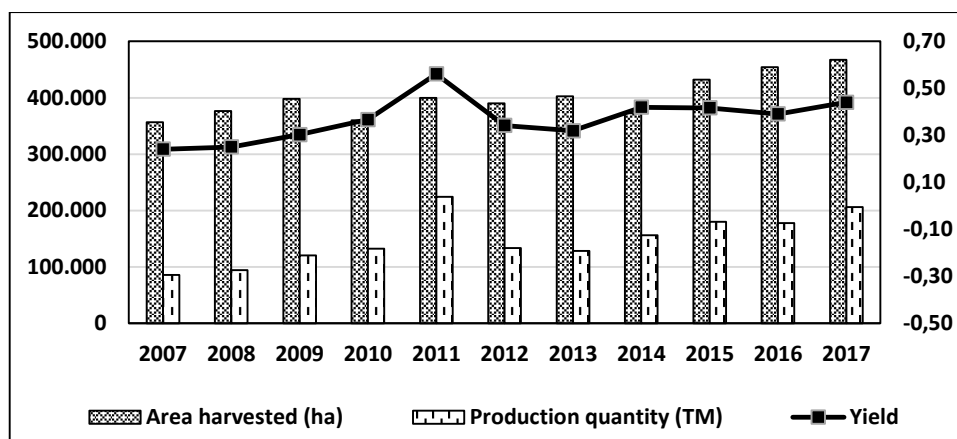


Figure 2.4.1 Cacao beans in Ecuador: Production, Area harvested and Yield
Source: SINAGAP, 2018.

The cacao production increased from 20,000 MT in 2005 to 208,000 thousand MT in 2017. 57% of the harvested area in 2017 corresponded to CCN-51, with this variety accounting for 72% of the total production. Five years before the share of harvested area was 80% - 20% for CN and CCN-51, respectively. A survey conducted with cacao farmers in 2017⁴ revealed that 54% of the respondents had planted CCN-51 (SINAGAP, 2018).

In regional terms, cacao production is namely located in four of the coastal Ecuadorian provinces, which together represent 77% of the national cacao production (Figure 2.4.2). In the eight highest-producing provinces where cacao is grown, the area allocated to CN variety predominates (Figure 2.4.3) (MAGAP, 2018; SINAGAP, 2018).

⁴ Survey carried out by the Ministry of Agriculture Livestock and Fisheries (MAGAP) in 21 cacao producing provinces in Ecuador

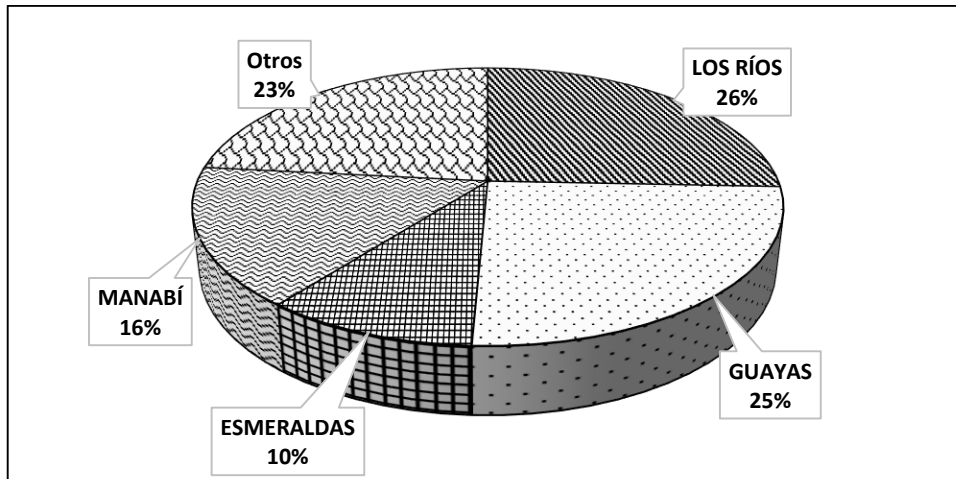


Figure 2.4.2 Share of cacao production per province (2017)
Source: SINAGAP, 2018.

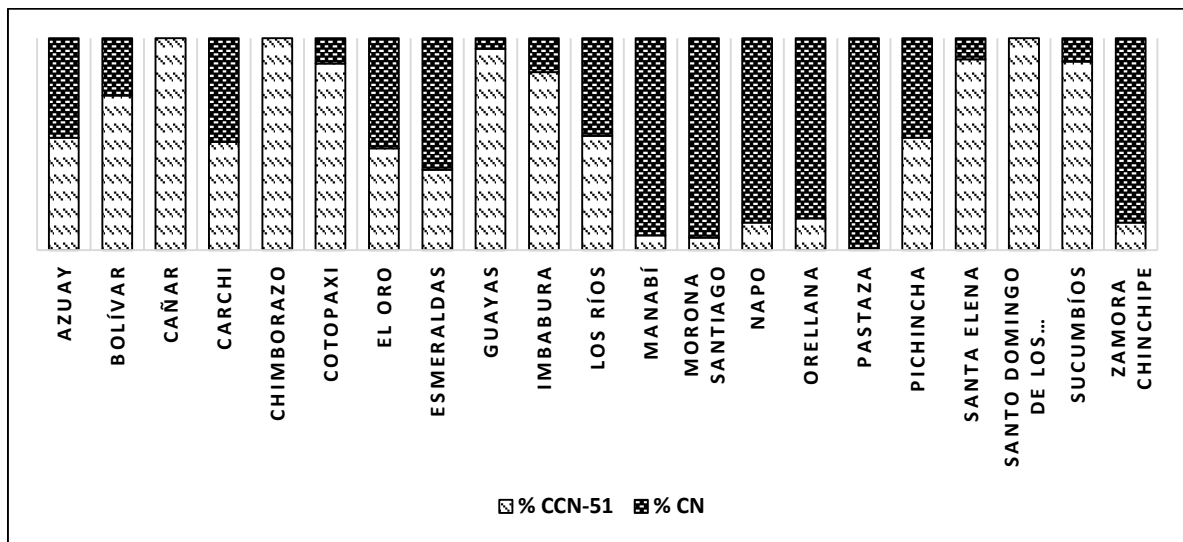


Figure 2.4.3 Share of cultivated cacao varieties per province
Source: MAGAP, 2018.

Figure 2.4.4 shows productivity figures per region for CN cultivation. The PRCN program, focused namely on pruning and seed selection practices, allowed improving productivity (MAGAP, 2018).

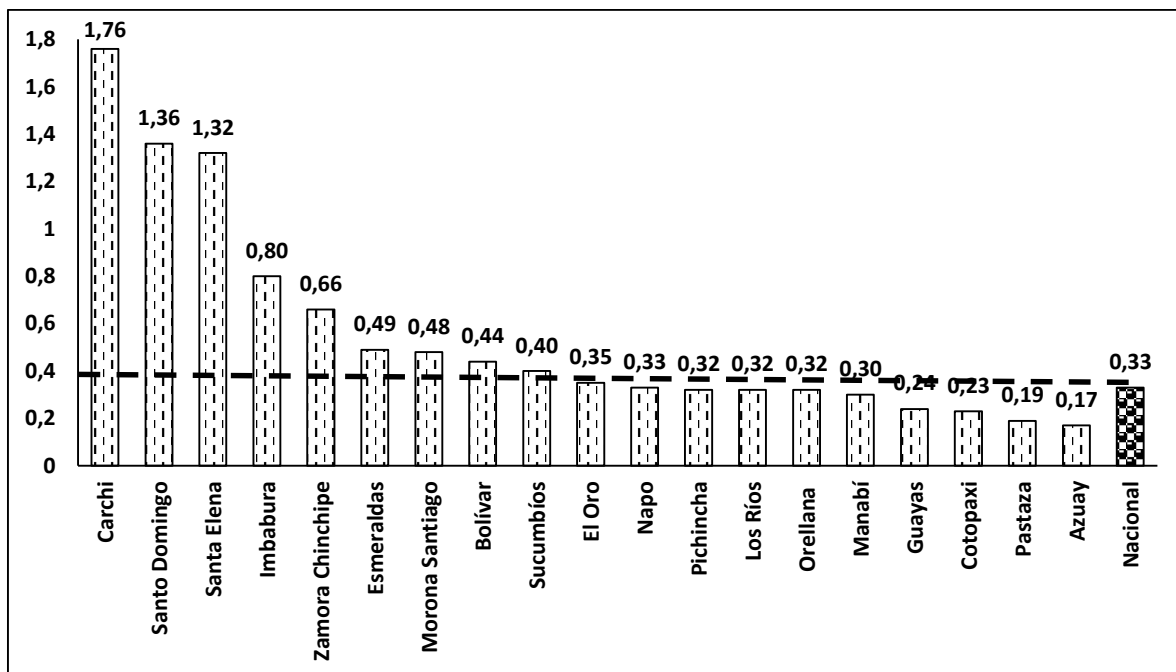


Figure 2.4.4 Yield of CN variety (MT / ha) by province
Source: MAGAP, 2018

Figure 2.4.5 shows productivity of CCN-51. Most of the CCN-51 harvested area (43%) corresponds to young cacao trees aged less than 30 years (between 11 to 30 years), with average yield of 0.69 MT / ha. The peak productivity for CCN-51 variety (0.98 MT/ha) is found on trees over 30 years old, currently representing 28% of the CCN-51 total planted area (MAGAP, 2018). The peak yield for the CN variety, occurs when the plantation is younger, 2 to 4 years (0.51 MT/ha). Only 4% of the CN cultivated area corresponds to peak-production trees while almost in 40% of the CN land mature trees grow. Thereby, renewal of CN plants is a required strategy to maintain their productivity (MAGAP, 2018).

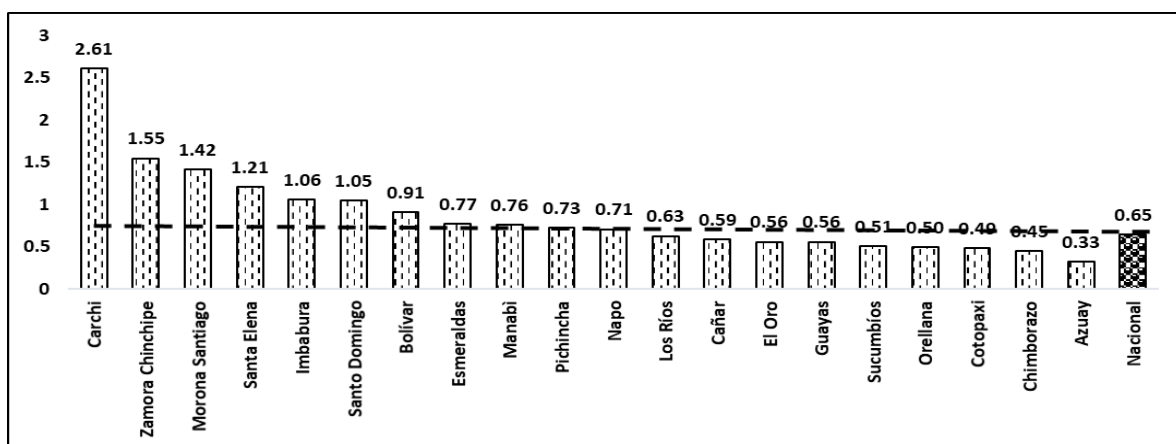


Figure 2.4.5 Yield of CCN-51 variety (MT / ha) by province
Source: MAGAP, 2018

The higher productivity of CCN-51 with respect to CN is due to a number of factors. The higher density of plants per hectare (23% more on average with respect to CN) and the higher rate of healthy fruits per tree in CCN-51 allow reaping a higher harvest per hectare. Furthermore, the cob index is lower for the variety CCN-51, because it needs an average of 17 ears to obtain a kilogram of dried cacao kernel, while CN needs 23 ears of corn. Furthermore, a high share of CN cultivated area corresponds to old trees that tend to be less productive. In addition, CCN-51 farmers tend to adopt practices that are more intensive in terms of fertilizer and pesticide inputs to increase production since cacao tends to be their main source of income. Finally, these two varieties use different farming systems for the production of cacao. The CN variety is cultivated in agroforestry systems that includes a diverse array of crops. This production approach varies greatly compared to the monoculture method used to produce CCN-51 that grow in a shadeless, less diverse and more densely planted plots. Table 2.4.1 summarizes the main differences between these two cacao varieties in Ecuador (MAGAP, 2018).

Table 2.4.1 Summary of main factors differentiating CCN-51 and CN cacao varieties

Item	CCN-51	CN
Planting Material	Private sector	Public and private sector
Farmer Groups	Few, if any	Grouped for certification and/or vertically integrated with exporter or manufacturer
Plantation	Smallholder and large-scale	Smallholder
Yield	High (0.65 MT/ha)	Low (0.33 MT/ha)
Production	Increasing	Stable to Decreasing
Fermentation	On farm	On farm/Collective
Acreage	Increasing	Stable to Decreasing
Flavor	Evolving	Fine and Flavor
Overall Quality	Increasing	Regionalization
Government Support	None	Research, Marketing, Plantation Management
International Community Support	None	Farmer group strengthening
Average density of cacao plants	1.054 plants/ha	857 plants/ha
Average of healthy ears per tree	7	5
Average cob index to obtain a kilogram of dried almonds	17	23
Farmer that apply some type fertilizer	57%	21%

Source: Own elaboration based on MAGAP, 2018; Abbot et al., 2018

A large percentage of buyers either purchase beans in *baba*⁵ or pay a fix price for dried beans, regardless of the variety. Only when beans are sold through a producer association, CN beans receive a higher price than CCN-51 (3% to 5%) when sold dried. However, this small premium does not offset net gains from CCN-51 (even considering equal planting density) (Abbott et al., 2018). During 2017, prices at the national level

⁵ Refers to cacao beans that are sold wet and have not been fermented or dried.

mimicked the international markets, showing a downward trend with respect to 2016. Prices at producer level decreased around 16% for both varieties(SINAGAP, 2018).

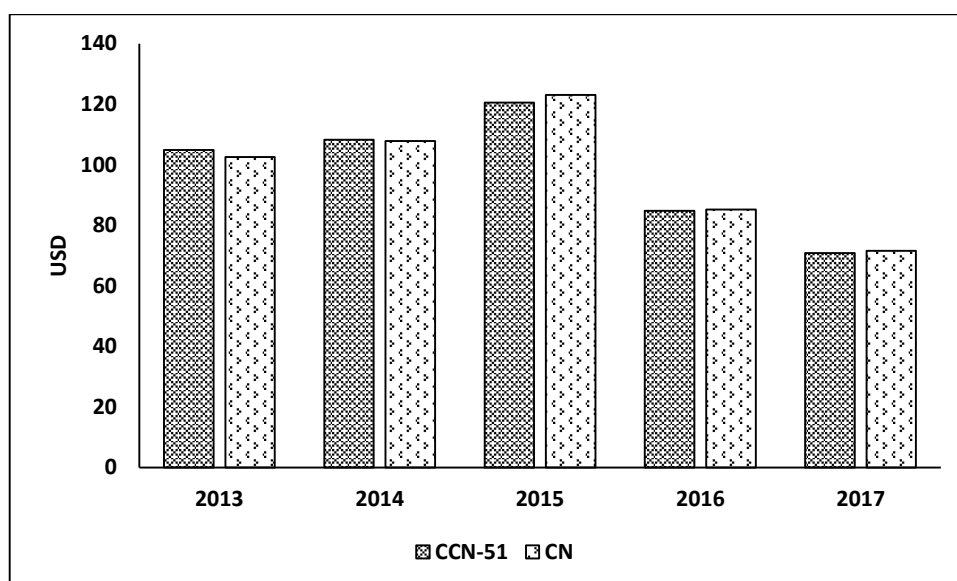


Figure 2.4.6 Prices perceived by cacao producers in Ecuador (USD-2017)
Source: SINAGAP, 2018.

Cultivated area allocated to CCN-51 is expected to increase in Ecuador as a result of CN substitution, conversion of non-cacao farms into CNN-51 farms and, to a lesser extent, through the conversion of forest to agricultural area. CN variety acreage is expected to stabilize or continue its downward trend. Market demand, perceived profitability or the introduction of higher yield CN varieties⁶ will be some of the influencing factors determining the pathways followed by smallholders (Abbott et al., 2018).

Five types of CN cacao beans are distinguished from lowest to superior quality: ASE (Arriba Superior Época), ASN (Arriba Superior Navidad), ASS (Arriba Superior Selecto), ASSS (Arriba Superior Summer Selecto), and ASSPS (Arriba Superior Summer Plantación Selecta) (INEN, 2000). ASE type accounts for 47% of exports followed by the CCN-51 variety (with 30% share), and by the CN types that have the highest quality requirements (ASS and ASSS), which together represented 23% of the export share⁷ (Figure 2.4.7).

⁶ The Government of Ecuador, through the research conducted by INIAP (Instituto Nacional de Investigaciones Agropecuarias), develops clone variety trials on CN varieties seeking to maintain CN distinctive flavour while increasing its productivity.

⁷ These qualifications are quality standards that are based on bean weights that correlate to percentage of fermentation. The higher the grade (A.S.S.S.), the higher the percentage of beans that have fermented (a cut test to determine if there were 75% well fermented) and heavier weight (130-135 grams per 100 beans) (Abbot et al., 2018).

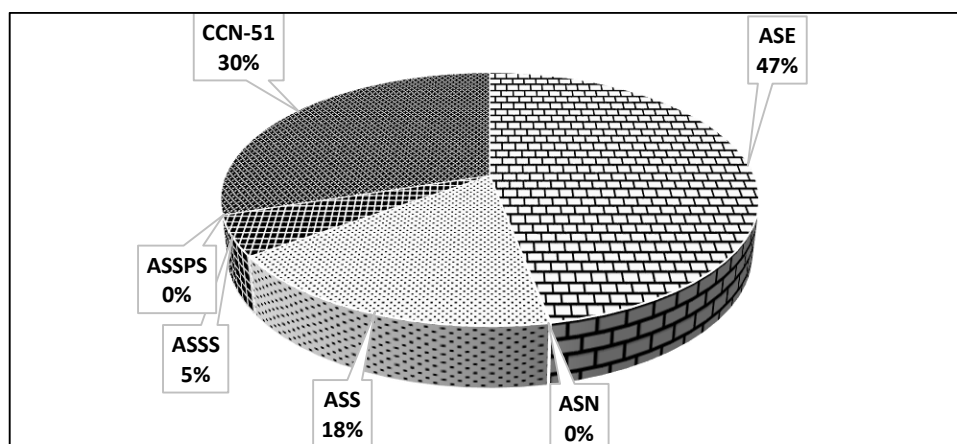


Figure 2.4.7 Cacao Bean Exports by variety and Type (2015)
Source: ANECACAO, 2015.

The statistics compiled by ANECACAO on the evolution of the volume of cacao exported per variety and type for the period 2010 - 2015, show that there has been a 9% increase of the lower quality CN variety (ASE), while the share of CCN-51 increased 11%; the higher quality CN varieties decreased their relative weight by almost 15 points. Actually, the ASE variety is sold as "standard" cacao on the global market, what implies that most Ecuadorian cacao is sold as bulk and the remainder as best quality cacao (ASSS or ASS qualifications). Between 2012 and 2015 the overall difference in the price per ton of beans between conventional and the ASSS/ASS types was approximately \$85 (Abbott et al., 2018; ANECACAO, 2015).

In the period 2010-2017, Ecuador exported most of its cacao production to the United States (29.6%), followed by the Netherlands (9.4%) (Figure 2.4.8). Two large well-defined export markets are distinguished according to bean quality. The best quality CN types (ASS and ASSS) are exported mainly to the markets of Europe (71%) and Japan (67%), respectively, while lower quality CN and CCN-51 are exported mainly to the USA (88%) and the rest of the markets (94%), respectively (Table 2.4.2) (ANECACAO, 2015; SINAGAP, 2018).

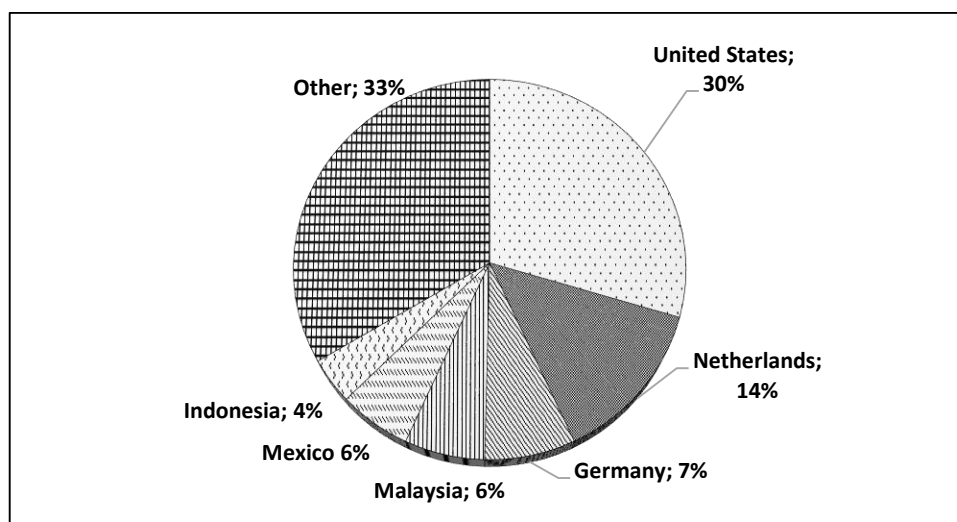


Figure 2.4.8 Main destinations of Ecuadorian cacao exports 2010-2017
Source: Sinagap, 2018.

Table 2.4.2 Cacao Exports in Beans by Type and Destination (2014)

Qualities	Europe	Japan	USA	Other
ASE	17%	33%	53%	32%
ASN	0%	-	0%	0%
ASS	51%	3%	11%	4%
ASSS	20%	64%	0%	1%
CCN-51	11%	-	35%	62%

Source: Anecacao, 2015.

Three different key periods can be distinguished in cacao production in Ecuador (Burbano, 2011; Chiriboga, 2013; Purcell et al., 2018). The first phase covers the period between 1894 and 1924, when Ecuador became the world cacao largest producer. Cacao was produced in large plantations while no uniform world market prices existed. The second period is characterized by the Agrarian Reforms of 1964 and 1973 that promoted cacao cultivation as a small peasant-led colonization strategy, giving rise to a large geographically disaggregated peasant network of “small agrarian capitals”. During this period, the government rolled out a series of policies to stimulate the industrialization of cacao processing, such as fiscal incentives, duties exonerations and subsidized machinery imports. Finally, the current scenario, that started by mid-1980s is characterized by a process of deregulation that has on the one hand increased control of large private exporters over the sector and on the other vulnerability of small producers. The new cloned variety of cacao CCN-51 is introduced in this period as part of a strategy to boost production volumes and attract new investment.

2.4.2 The cacao value chain in Ecuador

During the period 2007-2017 the GDP of Ecuador rose from US\$51,008 million to US\$70,956 million in real terms while the agricultural sector continued to be key in the national economy accounting for ~8% of GDP or US\$5,593 million (BCE, 2019). Despite the National statistics do not allow to visualize the individual performance of cacao production, the available data -where banana, coffee and cacao, the three main crops in the country are grouped- showed a production value of US \$ 1,407 million in 2017, which represents a contribution of 2.0% to country GDP and 25.2% of the agricultural sector GDP.

The set of actors and stages involved in the elaboration of cacao products until reaching the final consumers is shown in Figure 2.4.9. The production stage in Ecuador is highly fragmented, with more than 100,000 farmers involved in the cultivation of cacao, 79% of which develop their activities in plots of less than 5 hectares, 14% in a plot of between 5 to 10 hectares and 7% in plots of more than 10 hectares (MAGAP, 2018). In Table 2.4.9 we can see some of the characteristics of cacao producers.

The limited formal organization of small producers - only 10% belong to organizations and associations - diminishes their ability to negotiate with intermediaries and suppliers of goods and services, and externally makes it difficult for them to market the product directly and benefit from its sale in higher value markets, especially in the case of the CN variety (Blare & Useche, 2013; Galarza, 2012). Small producers also face problems at the farm level, such as: aged plantations, low rate of renewal, a lack of improved varieties and technical assistance, among other aspects. All these factors highlight the need for an integration model in the cacao value chain that encourages the formation of horizontal and vertical links to properly connect producers, first and second level cooperatives, stockholders, exporters, etc. (CORPEI-BID, 2009).

Given the high share of small producers in cacao cultivation, and the agroecological characteristics of the CN variety, the Ecuadorian government considers the improvement of its production as an economic development strategy with a two-fold objective of contributing to alleviate poverty of rural communities while complying with the national objectives of promoting environmentally sustainable production methods (T. Blare & Useche, 2013). Thus, the so-called National Project for the Rehabilitation of Fine Cacao (CN variety) launched by the Ecuadorian government attempts to reposition this variety in international markets and encourage the participation of small producers into its value

chain. The underlying hypothesis is that linking them to specialized international markets will improve benefit distribution compared to that of a conventional chain.

The process of linking small producers to the specialized cacao value chain has occurred without any previous characterization of these farmers' activities and life means. Therefore, it remains unknown as to whether the priorities of the producing families are aligned with the capital and labor investments needed to improve their participation in the value chain (Ree Sheck, Donovan, & Stoian, 2013). Furthermore, strengthening the linkage of small producers to high-value markets may offer them opportunities for improving income and benefits, but it can also expose them to new and higher risks than usually faced in a traditional chain (Ricketts et al., 2014)(Challies, 2008).

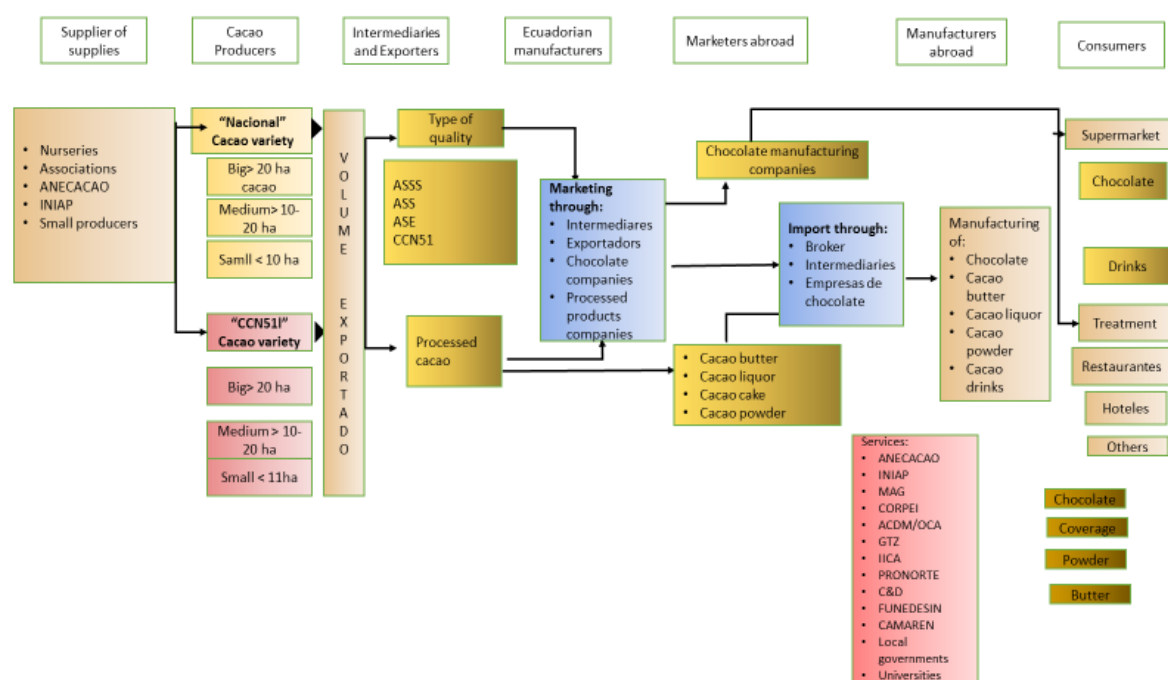


Figure 2.4.9 Cacao value chain in Ecuador

Source: (PROECUADOR, 2013)

Table 2.4.3 Characterization of cacao producers

Item	Description
Producers cultivating CCN-51	54%
Producers cultivating CN	46%
Average age (years)	59
Head of the family farm is male	79%
Completed primary studies only	59%
Producers with irrigation infrastructure	29%
Farmers who fertilize	CCN-51: 54% CN: 17%
Member of a producer association	17%
Producers counting on crop insurance	4%
Producers for whom cacao is the main source of income	52%

Source: MAGAP, 2018.

The value chain is composed of approximately 1,000 commercial intermediaries (local buyers and agents, regional traders and national wholesale traders) who constitute the main nexus among producers, industry, processing centers, brokers and exporters. Those fulfil a number of roles such as credit providers to smallholders, traders of basic goods (rice, corn, sugar) or cash providers. The intermediaries often function on credit from large exporters, therefore being able to lend money to small producers with whom they arrive to pre-harvesting agreements. Intermediaries work based on weekly volume targets and, thus, turnover speed and quota securement are essential requirements they have to accomplish. These intermediaries are known to incur in irregular commercial practices, reporting inaccurate sack weights when negotiating with farmers; this allows them to pay up to 30% less to the producers (Purcell et al., 2018).

The manufacturers cover the transformation of cacao into intermediate products (butter, pasta, liquor, powder) for the external market that is dominated by large companies totally based on foreign capital, such as Nestlé, CAFIESA, INFELERSA, ECUACOCOA and FERRERO (ANECACAO, 2015). In contrast, the production of chocolate and its final products feeds both the internal and external markets and it is dominated by small companies (ANECACAO, 2015).

Twenty-nine companies manage cacao bean exports buying the product from wholesalers. Cacao exporters gathered under ANECACAO (Asociación Nacional de Exportadores de Cacao in Spanish). There are five companies that cover 62% of Ecuadorian exports: Transmar Comodity Group (25%), Blommer Chocolate (13%), Walter Matter SA (10%), ED & F Man Cocoa (8%), Daarnhouwer (7%). (ANECACAO, 2015; Purcell et al., 2018).

Manipulation of fine quality cacao is a practice performed by small farmers and other supply chain actors where fine and bulk cacao beans are mixed in order to maximize their individual profits. In the absence of the institutional infrastructural support necessary to even secure standard market prices, fine aroma cacao is regularly mixed with CCN-51 in order to boost volume and fulfil contracts struck with intermediaries that lead to the penalization of Ecuador's exports in international markets. In 2005, the ICCO downgraded Ecuador's cacao from being rated as 100% fine aroma to 75%, due to the mixing of CCN-51 with CN variety. This sanction was accompanied by a warning to reduce the rating to 50% if the quality is not improved (Abbott et al., 2018; Galarza, 2012; Purcell et al., 2018). The mixing of varieties caused not only a drop in the fine cacao prices but also reduce trust between contractors. Countries like the United States,

Belgium, Switzerland and Germany have expressed their dissatisfaction in this respect (Galarza, 2012)

Only 3% of the national production is consumed locally while the gross of the production goes to the international markets. Ecuador is a global cacao leader with exports consisting of cacao beans (81.5%) and processed products (18.5%) such as chocolates, cacao butter, cacao liquor, cacao powder, cacao paste and fat, and cacao oil. Cacao bean exports grew 18% in value and 22% in volume in the decade 2007-2017 (Abbott et al., 2018; SINAGAP, 2018) (Figure 2.4.10).

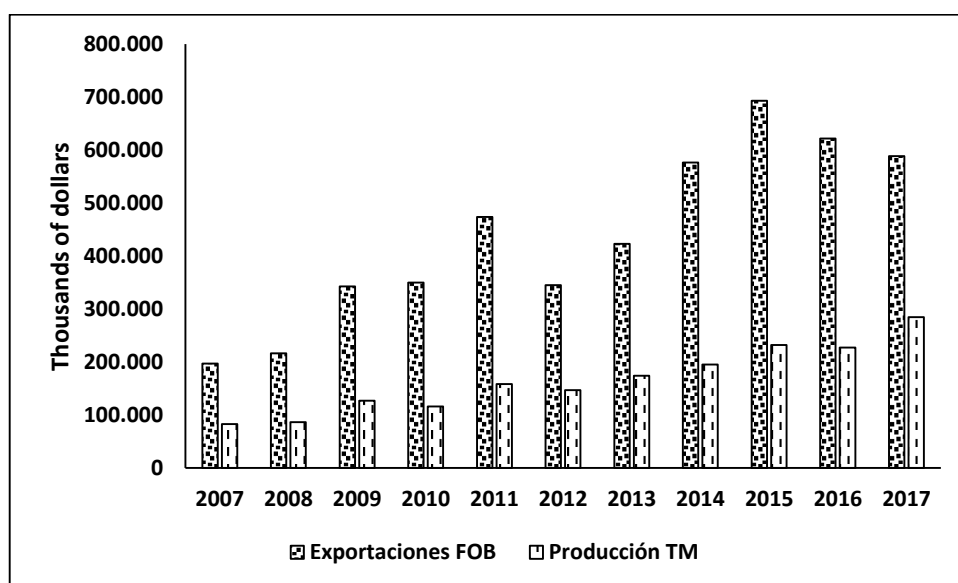


Figure 2.4.10 Exports of cacao beans in Ecuador
Source: Banco Central del Ecuador (BCE), 2018.

2.5 Discussion

The governance of the downstream stages of cacao global value chain, concentrated on few agents, has created a set of asymmetrical power relations that block the value transmission upstream towards small producers. The share of value retained by cacao-producing countries has reduced by more than 50% over the period 1970s-1990s. Thus, producers in these countries (mostly smallholders) have had to bear simultaneously with decreasing market prices while bearing higher costs and increased production risks driven by the dynamics of global markets (Abdulsamad et al., 2015).

The widespread worsening of social and economic conditions in producing countries as a result of those power imbalances have triggered a proliferation of private governance

responses, such as industry behavioral codes, standard and certification schemes or multi-stakeholder initiatives (Bitzer et al., 2012). More recently a renewed emphasis is being placed on public governance mechanisms and re-regulation of the sector in major cacao producing countries (Abdulsamad et al., 2015).

Private governance responses, particularly standards and third-party certification schemes, have focused their efforts in market-based approaches, with development measures linked to cacao brands and their ability to compete in consumer markets. This approach has enabled a dramatic expansion in the supply of certified cacao over the past five years while considerable constraints have appeared in the demand trailed far behind such as: i) demand stagnation in emerging economies due to economic crisis, ii) decaying chocolate appetite in the USA, China and India and iii) increasing concern about high sugar and fat contents in many chocolate products (Abdulsamad et al., 2015; Fountain & Huetz-Adams, 2018; ICCO, 2016; KPMG, 2013; Potts et al., 2014; World Bank, 2019). In the meanwhile, the asymmetric value distribution along the chain remains unaffected by the certification schemes. The share of price paid by the consumer that accrues to certified cacao producers is still not very different from that appraised by conventional cacao farmers (Abdulsamad et al., 2015; von Hagen & Alvarez, 2012).

The challenges constraining market-based solutions have encouraged a renewed emphasis on public governance mechanisms where coordinated initiatives, championed by governments of producing countries offer the potential to concentrate on synergies between growth in the cacao sector and improvement of farmer livelihoods (Abdulsamad et al., 2015). Since 2012 the Government of Ecuador has implemented the National Cacao Reactivation Project (PRCN), focused on small producers cultivating fine flavor cacao (CN), in order to reposition and consolidate “the good name of Ecuador as a producer of the best cacao in the world” and improve the “institutional quality of the of the value chain” (MAGAP, 2013; Purcell et al., 2018).

Currently, the Ecuadorian cacao sector is in transition existing a productive tension between the two cacao varieties. On the one hand, the government promotes CN variety through support provision to the producers. On the other hand, however, the hybrid variety CCN-51 allows obtaining higher yields, it is considered somewhat disease resistant, and can be produced with little to no shade. In the period analyzed (2007-2017), Ecuador experienced an increase in CCN-51 planted area and witnessed the entrance of international exporters interested in trading bulk cacao on the global market (Abbott et al., 2018; Purcell et al., 2018).

Most CN producers who sell their product in the local market do not receive a differentiated price compared to CCN-51 beans. In contrast, these few producers linked to associations that directly market their product abroad, appraise a better price that can improve their livelihoods. However, they must meet strict conditions requiring increased labor time and capital investment to maintain the quality standards required by specialty markets. The cumulative costs of fair trade certificates, organic and biodynamic production techniques mean that for the price to be “fair” for the producers, the cooperatives should double or triple what they pay to the producers. Therefore, the “alternative” to switch to CCN-51 may be regarded as appealing, especially when premiums prices do not come close to making up the difference in revenue (Purcell et al., 2018).

The CN producers face a problem of scale not only because the fine cacao market is small (about 6% of the global cacao production) but also because this variety is almost exclusively grown on smallholder farms, with low planting densities and low yields compared with CCN-51. Therefore, it is not clear whether full land allocation to the national variety -for which they can receive a premium price- may raise farm income and make this option more profitable than land allocation to the more productive CCN-51 variety. This productive tension between both varieties well deserves a careful inspection to assess the impact of the different productive pathways on producers’ livelihoods.

The decision of the farmers to cultivate one or other variety is influenced by external factors, where the productive and market incentives -productive aids, prices - play a decisive role. Also, internal factors such as physical, human or natural capitals with which farmers count influence their decision. The way in which these factors affect the decision of Ecuador's small cacao producers has been scarcely studied in this country. Their analysis would allow evaluating the impact of the PRCN as well as providing insights to improve it.

Support for CCN-51 cultivation is almost exclusively the domain of private sector investments, focused on improving the fermentation process and production systems, including the scaling up to large-scale commercial systems and the increase of market penetration, advocating for this variety amongst the downstream actors. In contrast, support for CN variety is found in both the public and the private sector. While, public support has focused on technical assistance to smallholders (predominantly providing pruning skills to increase yields), private sector support for CN is located in the downstream stages of the value chain, especially processors and chocolate manufacturers (Abbott et al., 2018; Purcell et al., 2018)

Although linking small producers to specialized value chains is seen as an opportunity to alleviate poverty, it also exposes them to new and different risks that do not exist in traditional value chains. The incidence of these risks on the behavior of cacao producers and the risk mitigation strategies that producers apply have not been fully studied in the case of Ecuador.

2.6 Conclusions

The Ecuadorian government has adopted support measures for the CN cacao variety as a development strategy. However, both CN and the hybrid variety CCN-51 can constitute valuable tools for development strategies in the country. Either maintaining a business-as-usual scenario or engaging in debates to adopt either one or the other variety will not improve the value chain unbalances and hence livelihoods of small producers responsible for most of the country production (Abbott et al., 2018).

Therefore, improving cultivation of both varieties through government support may have positive impacts on the livelihoods of smallholders. The productivity of the CCN-51 variety and the fact that it has been cultivated for decades all over the country, makes it the best option for many producers, although technical assistance to improve the fermentation or drying process would be needed to improve product quality. Regarding CN variety, it could be relevant to regionalize and diversify the CN genetic variety countrywide; nursery programs need to be scaled up to meet the demands of the producers.

Despite government efforts aimed to promote the CN variety, its production continues to decline and it is in doubt whether its cultivation is sustainable at farm level. Its lower productivity when compared to its counterpart, together with the lack of premium prices in the domestic market are key factors behind this trend. For those few producers who sell their product through cooperatives in the domestic market and manage to receive premium payments, it is not entirely clear whether this strategy allows for significant improvements in their livelihoods, due to the investments required to meet certification standards and relative low volumes sold through this market channel.

The Ecuadorian government program (PRCN) has focused on technical solutions linked to improving farming practices overlooking aspects such as market-related issues, price transmission and governance in the value chain where the lack of bargaining power farmers have contrasts with market concentration in the hands of few multinationals. Addressing these issues from an integral perspective would also require taking into account livelihood conditions of producers (e.g. local infrastructure, including schools,

health care, access to markets) to seize how cacao farming can contribute to its improvement.

2.7 References

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Chapter 3: Livelihood strategies of cacao producers in Ecuador: Effects of national policies to support cacao farmers and specialty cacao landraces⁸

⁸ This chapter has already been published in a peer reviewed journal: Díaz-Montenegro J, Varela E, Gil J. Journal of Rural Studies, vol. 63 (2018) pp. 141-156 Published by Elsevier Ltd. doi.org/10.1016/j.jrurstud.2018.08.004

3.1 Abstract

This study identifies the livelihood strategies pursued by small cacao farmers in the Guayas coastal region in Ecuador, where two distinct cacao varieties are grown: the fine flavor variety, Cacao Nacional (CN), and a hybrid variety (CCN-51). Enhancing CN production is regarded as an economic development strategy since CN variety beans are characterized by premium prices in international markets. This study aims to assess the trade-offs faced by small cacao producers in the production of specialty (CN) vs. commodity (CCN-51) cacao and how they affect their livelihoods. A detailed household survey sampled 188 households. Based on activity variables, four latent profiles of livelihood strategies were identified, which were related to capital asset endowment and income share variables. The results show that there was not a clear gap between cultivation of CN and CCN-51, as 60% of the sampled households simultaneously grew both varieties. The results indicate that the variable “share of land allocated to CN” does not significantly contribute to discriminating among profiles. Households with a low share of land allocated to CCN-51 showed higher income diversification strategies and vice versa. Our study also shows that the lack of appropriate incentives may threaten the future cultivation of CN since the National policy for CN rehabilitation has had little impact on the more cacao-driven profiles that have a lower asset endowment. The design, structuring and maintenance of a domestic differentiated value chain for the CN variety, together with income diversification measures and prior improvement on the asset endowment of these profiles, seems to be the pathway to improve the livelihoods of small farmers and increase the success of the current policy for fine flavor cacao rehabilitation at the national level.

Keywords: rural livelihoods, three-step approach, latent profile analysis, specialized value chain, asset endowment.

3.2 Introduction

Cacao is the world’s third most important agricultural export commodity and the second most important cash crop in the tropics (Blare & Useche, 2013; Galarza, 2012). It is estimated that more than 80% of cacao is produced by 7 to 8 million small family-managed cacao farms in over 50 countries worldwide (ECLAC et al., 2015).

The world cacao market distinguishes between two broad categories of cacao beans. Fine flavor cacao beans represent 5% to 10% of the total world market and can be sold for a premium because of their outstanding characteristics (Galarza, 2012; Melo & Hollader, 2013; ICCO, 2006). International demand for fine flavor cacao outweighs

supplies, creating a potential attractive niche for its chain development at the national level, if certain additional incentives such as a price premium are appropriately distributed to all actors along the chain (Blare & Useche, 2013; ICCO, 2012).

Ecuador plays a major role in the world cacao market in terms of volume and quality, as it is the largest producer of fine flavor cacao, producing approximately 65% of the global supply (Blare & Useche, 2013; Squiccianni & Swinnen, 2016; WFC, 2013). The fine cacao variety in Ecuador, known locally as cacao Nacional (CN), is grown in polyculture systems with other trees that produce timber and fruits and with other crops such as maize or soybeans. The modern hybrid CCN-51 is a full-sun variety that may double the productivity of its CN counterpart at the expense of being more demanding in the use of inputs (fertilizers or herbicides), among other key differences (Astudillo Paredes, 2014; Blare & Useche, 2013; Franzen & Mulder, 2007; MAGAP, 2013; Ton et al., 2008). In the national Ecuadorian market, small farmers are paid the same price for both varieties. Since the small farmers do not perceive price premiums for CN, it is common that they combine both varieties (MAGAP, 2013).

The Ecuadorian cacao small farmers develop their activities in a general context characterized by low productivity, high concentration of assets and vulnerability of markets⁹ (SENPLADES, 2017). Sectoral constraints include a lack of adequate grades and standards throughout the marketing chain, difficulties in accessing basic and extension services, inefficient articulation among authorities and support organizations with productive actors, aging trees with low productivity and resistance to disease and pests (Astudillo Paredes, 2014; Blare & Useche, 2013; Kooij, 2013; Lehmann & Springer-Heinze, 2014).

Linking small farmers to higher-value markets has been perceived by governments, donors and NGOs as a way to reduce poverty among these vulnerable populations, either directly through increased incomes or employment or indirectly through spillover effects in local economies (Horton et al., 2016; UNIDO, 2011). Enhancing CN production is viewed as an economic development strategy (CORPEI-BID, 2009) that may contribute to alleviating poverty in rural communities, which reached 38.2% in Ecuador (INEC, 2016). Since 2009, the Ecuadorian government, along with local and international development organizations, has implemented the Project on Restoring CN cultivation (PRCN, hereafter). The assumption underpinning the design of this program is that protecting the quality of the CN variety and strengthening the linkages between

⁹ Rural poverty by income is 38.2% whereas the multidimensional poverty rate is 59.9% and the rate of adequate employment is only 27.85% of the population (SENPLADES, 2017).

producers, buyers and processors in local and international higher-value markets will lead to improvement of the living conditions of cacao producers. PRCN can be viewed as value chain development (VCD) to target poor and vulnerable populations upstream in the value chain and reduce poverty (Horton et al., 2016). However, these strategies have been criticized for the underlying assumption that the small holders to whom these policies are addressed do not face substantial trade-offs when using their resources to participate in these chains (Stoian et al., 2012; Ton et al., 2011).

This study intends to cover a research gap on the trade-offs faced by small cacao farmers in Ecuador in the production of specialty (CN) vs. commodity (CCN-51) cacao and how these impact on their livelihoods. This overall aim is focused on two specific objectives. First, to determine the factors associated with the choice of livelihood strategies of small farmers in Ecuador linked to the cultivation of two varieties of cacao, CN and CCN-51, which have significantly different economic, social and environmental impacts. Second, to investigate the influences of the PRCN on the livelihoods of small farmers, including their capital asset endowments, activities, income shares and livelihood strategies. For this purpose, a detailed household survey was applied in nine cacao-producing villages in the Guayas, the largest cacao-producing province in Ecuador.

This study adopts the sustainable rural livelihoods and household livelihood strategy frameworks (Carney, 1999; Scoones, 1998; Jansen et al., 2006, Nielsen et al., 2013). Many studies have adopted these frameworks to determine the livelihood strategies rural farmers engage in to earn a living (outputs) and their relation with external variables such as capitals assets (inputs) or income (outcomes) (e.g., Alemayehu et al., 2018; Alemu, 2012; Browder et al., 2004; Brown et al., 2006; Fang et al., 2014; Hua et al., 2017; Jansen et al., 2006; Pichon, 1997; Walelign et al., 2016 Bebbington, 1999; Bhandari, 2013;).

Most of these studies determine the livelihood strategies of the sampled population (through principal component analysis, latent cluster analysis, or latent Markov cluster analysis). Then, different regression models are adopted (e.g., multinomial logit or ordinary least square models) to determine the relation of these strategies with external variables (Nguyen et al., 2015; Nielsen et al., 2013; Walelign & Jiao, 2017; Walelign et al., 2016). However, to our knowledge, an integrated assessment of strategies and external variables has not been performed.

This study applies a novel variant of latent class analysis (LCA) known as improved three-step that allows for identification of groups or profiles in a population based on a set of observed variables and implicitly acknowledges that these profiles may relate to external variables (Bakk et al., 2013; Vermunt, 2010). LCA uses a probability-based

classification, making it advantageous over traditional clustering techniques (Magidson & Vermunt, 2002). The three-step approach of LCA incorporates a correction procedure that avoids the downward-biased estimates of the strength of the relationships between the profiles and external variables that may arise when these relationships are estimated simultaneously with the model identifying the latent variable (one-step) or separately (three-step method without correction) (Bolck et al., 2004; Vermunt, 2010). This statistical approach also allows for analyzing the relationship between livelihood strategies, capital assets and incomes in a robust manner, more consistently aligned with the household livelihood strategy framework. To our knowledge, this approach has not been applied in the assessment of livelihood strategies.

3.3 Theoretical framework: sustainable rural livelihoods and household livelihood strategy

Drawing on the work of Waleign & Jiao (2017), this study is theoretically grounded in the conceptual frameworks of sustainable rural livelihoods (SRL) (Ellis, 2000; Scoones, 1998; 2015) and household livelihood strategy (HLS) (Jansen et al., 2006; Nielsen et al., 2013). The SRL describes the basis for livelihood analysis and the HLS elaborates upon the SRL and enables examination of the relationships between the different elements of the SRL framework to determine the different livelihood strategies that households undertake to earn a living.

The SRL framework defines a sustainable livelihood as one that comprises the capabilities, assets (including material and social resources) and activities required for a means of living (R Chambers & Conway, 1992). A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets while not undermining the natural resource base (Chambers & Conway, 1992, p. 5; Scoones, 1998, p. 6).

The SRL framework (Carney, 1999; Scoones, 1998) links livelihood resources (designated here by the term capital assets) and outputs (livelihood strategies) to outcomes (e.g., income generated, wellbeing) (Scoones, 2009). Agricultural intensification (more output per unit area through capital investment or increases in labor inputs), agricultural extensification (more land under cultivation), livelihood diversification (diversifying to a range of off-farm income earning activities) and migration (seeking a livelihood elsewhere, either temporarily or permanently) are some of the broad strategies that rural households pursue to make their living (Scoones, 1998).

These input-output-outcome elements identified by the SRL framework are amenable to quantitative analysis of the livelihood strategies of rural households (Scoones, 2009). The HLS framework quantifies livelihood strategies based on the portfolio of main activities that rural households undertake depending on the available assets (Babulo et al., 2008; Jansen et al., 2006; Nielsen et al., 2013; Winters et al., 2009). The strategies are directly and indirectly influenced by capital assets and the relevant contextual factors that generate specific outcomes such as income.

Households in both frameworks constitute the basic unit of analysis (Ellis, 2000; Winters et al., 2009; Nielsen et al., 2013; Walelign & Jiao, 2017) in which three closely connected components are assessed: activity variables, capital assets and outcomes. The latter two largely draw on the SRL framework and the definition of activity variables and the modeling approach adopted in this work align with the HLS framework. The variables are described in more detail below and are depicted in 3.10.1

3.3.1 *Activity variables*

Activities are actions taken by the households to produce outcomes, which involve the use of a single asset or set of assets (Winters et al., 2009). Assessing the proportions of assets allocated by rural households to different income-generating activities is used as a grouping criteria so that households with similar asset allocation choices are grouped together in a livelihood strategy profile (Jansen et al., 2006; Nielsen et al., 2013; Hua et al., 2017; Brown et al., 2006; van den Berg, 2010).

By using activity choices as criteria for livelihood strategy identification, the HLS framework circumvents some drawbacks related to the use of other grouping criteria. Many studies identified livelihood strategy groups based on absolute income or the share of income generated by different livelihood activities (Chilongo, 2014; Tesfaye et al., 2011; Walelign & Jiao, 2017; Zenteno et al., 2103). However, this approach neglects that income per se is stochastic and does not reflect the amount of assets households have invested in different activities (van den Berg, 2010; Walelign & Jiao, 2017). For example, income shares from a particular year reflect a household's short-term coping mechanisms rather than a long-term livelihood strategy (Jansen et al., 2006). Occupation-grouping criteria has a key downside, since it generally overlooks the fact that rural households, especially in developing countries, engage in a diverse range of activities (Davis et al., 2010; Walelign, 2016). Finally, the asset grouping-criteria may neglect that households combine assets to generate income from a portfolio of activities (Brown et al., 2006; van den Berg, 2010).

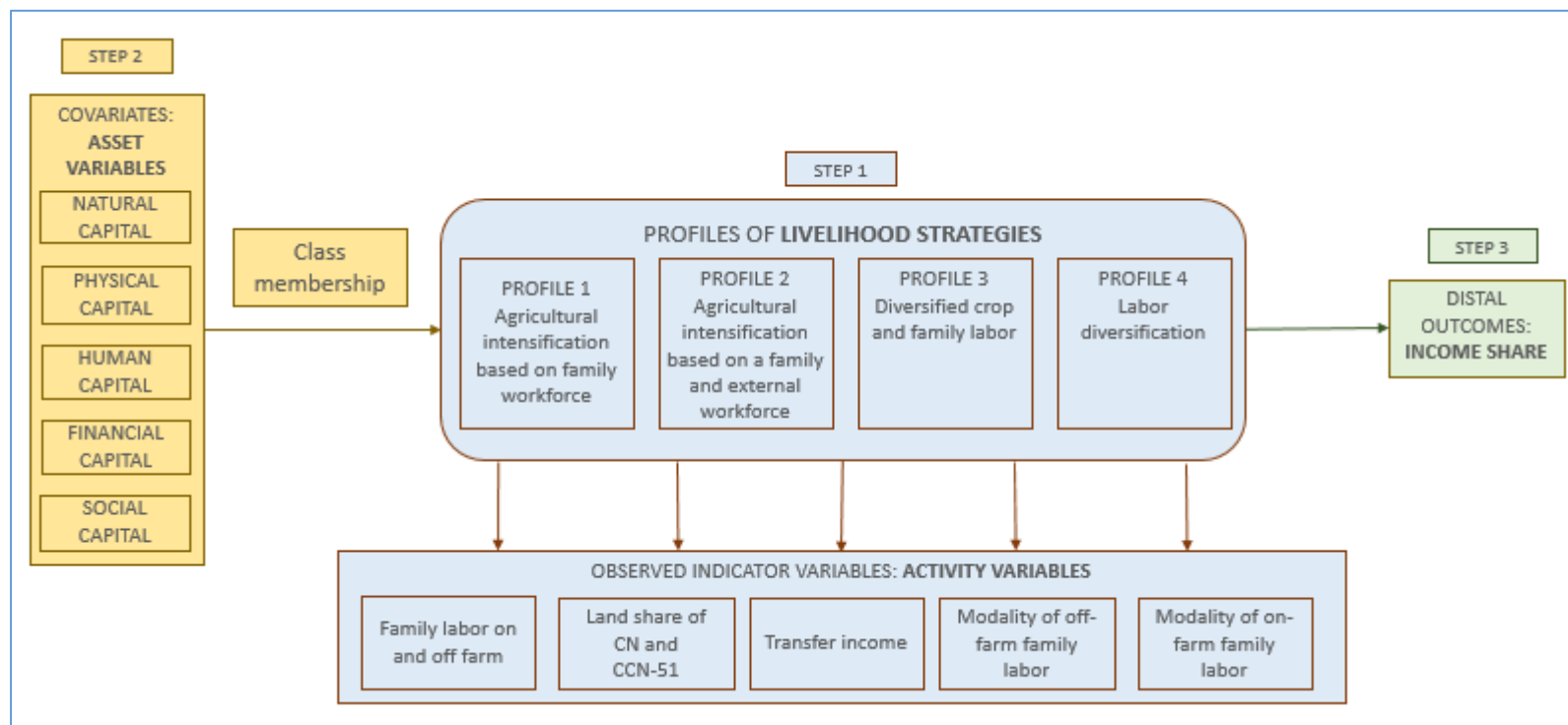


Figure 3.3.1 The three-step approach methodology adapted to the household livelihood strategy framework.

Source: own elaboration on Magidson Vermunt (2015) and Nielsen et al. (2013). First step: Activity variables (land and labor) measure the livelihood strategies. Second step: Capital asset variables are covariates that predict profile membership of the households to the latent profiles. Third step: The latent profiles identified act as predictors income share variables.

The activity choice criteria applied in this study considers the household's use of its main assets, i.e., land and labor (Jansen et al., 2006). We also included remittances to acknowledge one of the main criticisms of activity choice as a grouping criterion, since activities from nonproductive assets often play a key role in livelihood strategy selection in developing countries (Nielsen et al., 2013; Walelign et al., 2016).

3.3.2 *Capital assets*

Capital assets may be seen as the building blocks for a household to choose its livelihood strategy (Ellis, 2000; Brown et al., 2006; Nguyen et al., 2015) and from which different productive streams are derived. These assets are tangible (resources and stores) or intangible (claims and access) and are commonly considered as composed of five types of capital: natural, human, social, financial, and physical.

Natural capital includes all natural resource stocks and environmental services from which livelihoods are derived, including the central variables of access to farmland and its ownership. Physical capital includes the basic infrastructure and producer goods that are essential to support livelihoods (Bebbington, 1999; Bhandari, 2013; DFID, 1999). Infrastructural assets, such as roads, or production assets, such as vehicles or equipment that foster diversification of rural livelihoods (Amekawa, 2011; Ellis, 2000; Rakodi, 1999) are physical capital. Human capital comprises the amount and quality of labor available, skills, knowledge and health that enable individuals or households to pursue different livelihood strategies (DFID, 1999). Financial capital includes the stock of money available for households in the form of savings, credit, remittances, and pensions (Amekawa, 2011; Carney, 1998). Social capital arises from social relationships and describes the stock of reciprocity and trust embedded in the relations of individuals and households with other actors and entities such as family, relatives, friends, organizations, and networks (Amekawa, 2011). It plays an important role in mediating people's access to and utilization of other assets (Bebbington, 1999) and has recently been recognized as a significant component in understanding agricultural value chains (Abbey et al., 2016).

In our study, these assets are mainly used to determine how varying capital assets influence livelihood strategies and evaluate the impact of PRCN policy on structuring the smaller producers' asset endowment and enabling their decisions toward adoption of the CN cacao variety.

3.3.3 *Outcome variables (income shares)*

The livelihood strategies pursued by households intend to achieve outcomes such as income, increased well-being, improved food security or social claims (Amekawa, 2011). Among these, income is the most commonly assessed outcome variable, partly because it is relatively straightforward to measure in absolute and relative terms (Jansen et al., 2006). Income is often perceived as a welfare gauge (Barrett et al., 2001), although some authors are reluctant to consider it as an outcome given the multidimensional nature of wellbeing (Alkire & Foster, 2011; Chambers, 1995; Ellis & Freeman, 2005). Household income analysis should include the values per income source (Walelign, 2016) for example, distinguishing between on-farm and off-farm income is crucial since the latter generally eases capital constraints and may contribute to higher farm production and income (Babatunde & Qaim, 2010; Chang & Mishra, 2008).

In this study, the share of different income sources was assessed to determine the income mix of each livelihood strategy. It allowed for analysis of the degree of income source diversification of the livelihood strategies linked to varying cultivation intensities of the two cacao varieties. The relationship between the capital asset endowments that characterize less diversified strategies is also considered to suggest appropriate targets of intervention.

3.3.4 *Relationship between concepts*

Livelihood activities link the capital assets to the ex post flow of income (Fig 3.10.1) and are subject to the endowment of livelihood capitals because they determine the possibilities for rural households to achieve goals related to revenue, safety, and welfare (Fang et al., 2014; van den Berg, 2010). Depending on their contexts, households harness the assets at their disposal in pursuit of livelihood strategies with a goal of maximizing livelihood outcomes (Amekawa, 2011; Nicol, 2000; Scoones, 1998) (Brown et al., 2006; Fang et al., 2014). Livelihood activities geared toward market or subsistence and a particular asset mix allow for smallholder households to take advantage of new market opportunities and institutional constellations to respond to shocks, adverse trends and seasonality (Scoones, 2009; Sheck et al., 2013).

Identifying what combination of livelihood assets is required for different livelihood strategy combinations is a key step in the analysis process. For example, successful agricultural intensification may combine access to natural capital (e.g., land, water) with economic capital (e.g., technology, credit) whereas, in other situations, social capital (e.g., labor sharing arrangements) may be more significant (Scoones, 1998).

Operationalization of these concepts in the HLS framework is based on identification of groups of livelihood strategies based on activity variables; these strategies are first described based on the capital assets of the households (e.g., Jansen et al., 2006; Nielsen et al., 2013; van den Berg, 2010) and act as predictors of income shares. The three-step approach adopted in this study allows for addressing the relationship of the livelihood strategy profiles with external variables (capital assets and income shares) in a robust manner.

3.4 Case study description

Ecuador's cacao is produced almost exclusively by small farmers, for whom it represents a key source of income (Astudillo Paredes, 2014; Blare & Useche, 2014).

Fine cacao is the source of high-end chocolate manufacturing. Its production is scarce (5% of the world's cacao production) and it may obtain premiums of 30% (and even 60%) over ordinary cacao beans in international markets (Blare and Useche, 2013; ICCO, 2012). Ecuador accounts for almost half of the world's production of this variety (ICCO, 2006).

Fine cacao is exclusively harvested from cacao Nacional (CN) trees (Melo & Hollander, 2013). The CN variety is considered part of the Ecuadorian identity (Susan van der Kooij, 2013). It is typically produced in a shade-cultivation system (Bentley et al., 2004; Melo & Hollander, 2013) together with other tree crops that provide shade and, more importantly, products such as wood (e.g., laurel tree) or fruits such as mango, guayaba, citrus, plantain, or papaya (Coq-Huelva et al., 2018; Ofori-Bah & Asafu-Adjaye, 2011). This complex of trees provides habitat for diverse fauna, contributing to meeting the consumption needs of small rural farmers.

The shade production of cacao has been progressively substituted by the full-sun variety CCN-51 accounted for 48% of plantings during early 2000s (Bentley et al., 2004; Ruf, 2011). CCN-51 is said to be the most productive variety of cacao worldwide, with a production potential of approximately 77 kg/ha. The production approach for CCN-51 is based on monoculture with high plantation densities. Its yields may reach almost four times those of CN (Galarza, 2012) and it is resistant to fungal diseases (Espinosa et al., 2006). However, this usually comes at the expense of increased use of fertilizers and herbicides (Clay, 2004), without which, productivity may decrease to 12-15 kg/ha with respect to the potential production (MAGAP, 2013). The productivity of both varieties can oscillate greatly depending on crop management. The survey conducted by Jano (2007) showed that farmers cultivating CCN-51 spent on average 77% more on pesticide

applications and labor than farmers cultivating CN¹⁰. The CN production potential in the study region may reach 33 kg/ha and, with adequate management productivity, may reach an estimated 40 kg/ha (MAGAP, 2013). Accordingly, management costs per hectare also greatly differ from \$660/ha for CN to \$820/ha for CCN-51. Even if CCN-51 allows for obtaining more cash income than CN, in a season with low cacao harvest, households may face difficulty meeting their subsistence needs.

The distinctively lower quality of the hybrid CCN-51 does not qualify its beans for fine cacao production and hence it cannot be sold at premium prices in the international markets like CN, whose unique flavor and aroma make it the base of the finest chocolates worldwide (PROEcuador, 2013). Therefore, each variety has been commercialized through different value chains in the international markets and have their own regulations and prices.

However, in the Ecuadorian national market, such differentiation is nonexistent and both varieties are sold in the same value chain. As a result, farmers receive the same remuneration for the two varieties, either at the farm gate or the local market. The national cacao value chain in Ecuador is rather long and exporters and intermediaries are the dominant actors that qualify quality, determine prices and establish market rules (Galarza, 2012; Jano, 2007; MAGAP, 2013; Useche & Blare, 2013).

The average price of cacao beans in the Ecuadorian national market, where both varieties are sold at the same price, was \$107 in 2016 and \$77.02 in 2017 (SINAGAP, 2018). This is one of reason small farmers shifted from CN to CCN-51, since they are not rewarded for their effort to produce quality cacao (Blare & Useche, 2014; Collinson & León, 2000). The production decisions of small farmers linked to specialty markets such as the CN market significantly depend on incentives (economic and noneconomic) that are transmitted along the value chain (Jano, 2007). Since these benefits are not being transmitted, partly due to the absence of a specialty value chain at the national level, only the farmer associations that have circumvented intermediaries and sold directly to exporters or exported directly have achieved better prices (Astudillo Paredes, 2014; Jano, 2007). However, this constitutes a minority of cases in the sector.

This lack of a price difference also represents an obstacle to avoiding the mixing of varieties that is currently a regular practice (MAGAP, 2013). Until 2004, intermediaries and exporters did not separate National from CCN-51 (Melo & Hollander, 2013). The lack of a monitoring system that enforced the homogenization of cacao quality or the

¹⁰ However, in a more recent study conducted in northern Ecuador, Blare & Useche, 2013, estimated a difference of 19% in cultivation costs between both varieties, similar to the 24% estimate provided by MAGAP (2013)

segregation of different qualities (Jano & Mainville, 2007) allowed for fine quality cacao manipulation. Thereby, some supply chain actors mixed bulk cacao beans with fine ones. The mixture was sold by intermediaries in the international markets as fine cacao to maximize their individual profits (Galarza, 2012). This mixing produced a reduction in quality and led to a downgrading of the Ecuadorian fine flavor cacao rating by the International Cacao Organization (ICCO) from 100% to 75% since 1994. In 2005, possible future grading reductions were announced, motivating the involvement of the Ecuadorian state in the industry (see Melo and Hollander (2013) for a critique and description of the Ecuadorian cacao market). There is obviously a gap between the lack of differentiation in the local market and the efforts the country is making to overcome sanctions and promote fine cacao from Ecuador in international markets (Jano, 2007). Furthermore, the increased cultivation of CCN-51 reduces the opportunities of Ecuador as a big international player in the fine cacao market, since the quality of CCN-51 is not suitable for high-end chocolate manufacturing.

The Ecuadorian government, along with local and international development organizations, initiated a project for CN restoration in 2011, which includes links with other organizations advocating for CN as an economic development strategy to alleviate poverty in rural communities (CORPEI-BID, 2009). The PRCN policy aims to revitalize its production through the improvement of current CN plantations and establishment of new ones. The project actions initially tackled the production and the value chain at large, aiming to develop a specific value chain for CN that would establish the incentive of a premium price at the farm-gate level (Jano, 2007). The project implemented the creation of a germplasm bank, facilitated small farmers, provided technical and training assistance and strengthened farmers' associations. However, the full display of PRCN has been jeopardized by a lack of financing and governmental changes; in recent years, the focus has been on providing technical assistance while value chain development for CN has not been implemented.

Cacao production in Ecuador is primarily concentrated in the coastal-plain region, with 85% of the country's total production. The Guayas account for 26% of the national production and is the largest cacao producing region (INEC, 2015). This study was conducted in nine rural sites in two districts of the Guayas, Lorenzo de Garaicoa and Yaguachi Viejo, which represent 10% of the Guayas cacao production. Table 1 summarizes the principal statistics of the two districts.

The study area belongs to the dry west woodland ecosystem, characterized by a tropical mega thermal climate with mild temperatures (25°C – 30°C) and abundant rainfall (2000

mm). CN and CCN-51 varieties at different cultivation intensities constitute the agricultural basis of these villages, complemented by other crops such as banana, sugar cane, soy, corn, tobacco and rice (GAD-Garaicoa, 2015; GAD-Yaguachi Viejo, 2015; INEC, 2015). In the Table 3.10.1 we show some characteristics of the sample used in the investigation.

The government has implemented the PRCN program in these nine rural sites since 2012 to stimulate farmers to switch from the CCN-51 variety to the CN variety. The CN variety is now cultivated at different intensities without full withdrawal of the hybrid variety.

Table 3.4.1 Summary statistics of surveyed respondents

VARIABLES	Lorenzo de Garaicoa		Yaguachi Viejo		Full sample			
	M	SD	M	SD	M	SD	Min.	Max.
Age (years)	48.47	13.94	54.19	15.36	50.23	14.59	18	86
Gender (% female)	22.00	-	20.70	-	21.80	-	-	-
Education (years)	8.03	4.52	8.38	3.89	5.33	4.01	0	15
Household size	2.50	1.23	3.31	1.74	2.75	1.46	1	7
Land size (ha)	4.99	6.46	4.49	3.48	4.96	5.79	0.38	47.5
Married or live together (%)	70,00	-	74.10	-	71.30	-	-	-
Nacional Cacao variety (ha)	1.23	2.45	2.56	2.26	1.64	2.46	0.20	12.00
CCN-51 Cacao variety (ha)	1.23	2.30	0.17	0.74	0,9	2.02	0.45	13.50
Permanent crops (ha)	0.71	1.66	0.76	2.06	0.73	1.79	0	13.50
Other crops (ha)	1.81	4.98	0.84	1.61	1.51	4.25	0	44.50

3.5 Material and Methods

3.5.1 Modelling approach: the improved three-step approach

Latent Class Analysis (LCA) was introduced by Lazarsfeld & Henry (1968) to derive latent attitude variables from responses to dichotomous survey items and was originally designed to be used with dichotomous observed variables or indicators. LCA allows for building typologies based on observed variables. The technique is helpful for researchers who seek to identify subgroups (i.e., latent classes) within large, heterogeneous populations (Tein et al., 2013). A review of the method and its evolution can be found in (Magidson & Vermunt, 2004).

Different from cluster analysis techniques, LCA is a model-based approach. This means that a statistical model is postulated for the population from which the data sample is obtained. An advantage of using a statistical model is that the choice of the cluster

criterion is less arbitrary and the approach includes rigorous statistical tests for the selection of a model with optimal (likelihood) classes (Magidson & Vermunt, 2002).

LCA involving continuous variables is also termed a latent profile model (Gibson, 1959; Lazarsfeld & Henry, 1968), which is the focus of this study. Latent profile analysis (LPA) is a person-oriented analytic technique that identifies discrete profiles of individuals who share similar response patterns across a set of indicator variables using probability-based classification (Collins & Lanza, 2010). Conceptually, it is similar to cluster analysis, but group membership is treated as latent rather than known and measurement error is allowed (Magidson & Vermunt, 2002).

Applications of LCA also investigate how the latent classes are related to external variables (Bakk et al, 2013). This is usually done in three steps: i) building a latent profile (LP) model for a set of response variables; ii) assigning individuals (households, in this study) to latent classes based on their likelihood profile membership probabilities and iii) investigating the association between the profile membership and external variables.

The improved three-step approach (Bakk et al., 2013; Bakk & Oberski, 2014; Bakk et al., 2016; Vermunt, 2010) adopted in this study allows for examining the association between latent profile groups and external variables, acknowledging the uncertainty of group membership (Lanza et al., 2013).

First step: Estimating a Latent Profile (LP) Model

Following Bakk & Oberski (2014), an LP model is estimated employing K observed indicator variables. Given a sample of n units, the vector of observations Y_i is modeled as arising from T unobserved (latent) profiles X_i ,

$$P(Y_i) = \sum_{t=1}^T P(X_i = t)P(Y_i|X_i = t) \quad (1)$$

$P(X_i = t)$ represents the probability of belonging to profile t and $P(Y_i|X_i = t)$ the probability of having a response pattern y conditional on belonging to profile t .

The conditional probability of the i^{th} response given the latent profile can then be written as a product of conditional item responses, where R_k denotes the categories of responses to variable k ,

$$P(Y_i|X_i = t) = \prod_{k=1}^K P(Y_{ik}|X_i = t) = \prod_{k=1}^K \prod_{r=1}^{R_k} \pi_{ktr}^{I(Y_{ik}=r)} \quad (2)$$

The first-step log-likelihood of the sample data L_1 follows by assuming the independence of observations:

$$L_1(\theta_1) = \sum_{i=1}^N \log P(Y_i) = \sum_{i=1}^N \log \left[\sum_{t=1}^T \rho_t \prod_{k=1}^K \prod_{r=1}^{R_k} \pi_{ktr}^{I(Y_{ik}=r)} \right] \quad (3)$$

Second step: calculating the profile membership of each unit

Following Bakk et al. (2016), after estimating the latent profile model in the first step, a new variable W is created, assigning each unit (household, in our study) to an estimated profile. Following Bayes rule, each unit's posterior probability of belonging to profile t is

$$P(X_i = t|Y_i) = \frac{P(X_i = t)P(Y_i|X = t)}{P(Y_i)} \quad (4)$$

The true (X) and assigned (W) profile membership scores will differ. The classification errors must be calculated and the correction methods¹¹ for the assignment variable W are applied in the third step. The posterior profile membership conditional on the true value can be expressed as:

$$P(W = s|X = t) = \frac{\frac{1}{N} \sum_{i=1}^N P(X_i = t|Y_i)P(W_i = s|Y_i)}{P(X = t)} \quad (5)$$

Third Step: Relating Estimated Profile Membership to External Variables (Covariates and Distal Outcomes)

The third step of the approach relates the latent profiles to external variables. These act as predictors of the individual membership to the latent profiles, i.e., covariates. Alternatively, latent profiles can act as predictors of external variables, i.e., distal outcomes.

Following Bakk et al. (2016), the assigned classification W is related to a vector of covariates, Z , while also correcting for the classification error in W . $P(X=t|Z_i)$ and $P(W=s|Z_i)$ are related to each other, thus $P(W=s|Z_i)$ can be written as a weighted sum of the latent profiles given the covariates, with the classification error probabilities as the weights:

$$P(W = s|Z_i) = \sum_{t=1}^T P(X = t|Z_i) P(W = s|X = t) \quad (6)$$

¹¹ For more details of correction methods applied, see Appendix A.

Z_{iq} denotes the value of subject i on one of the Q covariates and the structural part of the model can be parametrized by means of a multinomial logistic regression model,

$$P(X = t|Zi) = \frac{\exp(\beta_{0t} + \sum_{q=1}^Q \beta_{qt}Z_{iq})}{\sum_{s=1}^T \exp(\beta_{0s} + \sum_{q=1}^Q \beta_{qs}Z_{iq})} \quad (7)$$

Below, we present the three-step model with external variables that are predictors of latent profile membership (Bakk et al., 2013). The parameters of interest are the logistic regression coefficients β_{qt} , gathered in the vector θ_3 . Consistent estimates $\hat{\theta}_3$ can be obtained by maximizing the third-step log-likelihood (Vermunt, 2010),

$$L_3(\theta_3|\theta_2 = \hat{\theta}_2) = \sum_{n=1}^N \sum_{s=1}^T P(W = s|Yi) \log \sum_{t=1}^T P(X = t|Zi) P(W = s|X = t) \quad (8)$$

3.5.2 Variables employed and their connection with the improved three-step approach

In this study, we identified three sets of variables: i) activity variables that measure the latent profiles, ii) capital asset variables (covariates) that predict household membership to the latent profiles of livelihood strategies and iii) income share variables (distal outcomes) that are predicted by the latent profiles. Once the entire sample is grouped into livelihood strategy groups based on activity variables, the membership of each of the sampled households to these groups or profiles can be explained based on a set of predetermined capital asset-based variables (Jansen et al., 2006) that encompass the five main types of capital. Finally, the income share of each profile is assessed, considering it as a distal outcome (i.e., predicted by the livelihood profiles).

Activity variables to identify the livelihood strategy profiles

Drawing on the SRL and HLS approaches, identification of livelihood strategies was based on eight activity variables. Five correspond to labor allocation and two variables refer to land allocation, which are the main productive assets that small farmers typically allocate into income-generating activities (Jansen et al., 2006; van den Berg, 2010). The transfer income variable accounts for income generated from nonproductive assets. The activity variables are shown in Table 3.10.2.

In relation to labor, we considered the proportion of family labor allocation to on-farm and off-farm activities (agriculture and non-agriculture related), and the proportion of external workforce hired. Disentangling on-farm and off-farm work is highly relevant, since

strategies that combine both tend to earn higher incomes (Jansen et al., 2006). We also identified temporary and permanent modalities of on-farm and off-farm employment.

Table 3.5.1 Activity, income and asset variables

Variables	Description
<i>Activity variables</i>	
On-farm family labor	Household adults working on-farm/Total household adults
Off-farm family labor	Household adults working off-farm/Total household adults
On-farm non family labor	External workers/Total on-farm workers
Cacao Nacional CN	Ha of CN/Total ha
Hybrid cacao CCN-51	Ha of CCN-51/Total ha
Transfer income ^a	This measures the participation of transfer income in total income. Transfer income/Total income
Modality of off-farm family employment ^b	1= permanent employment, 2= temporary employment, 3= other forms of employment, 4= does not apply
Modality of on-farm non family employment ^c	1= permanent employment, 2= temporary employment, 3= other forms of employment, 4= does not correspond
<i>Income share variables</i>	
On-farm agricultural activities	Income share of on-farm agricultural activities over total income
Off-farm agricultural activities	Income share of off-farm agricultural activities over total income
Off-farm no-agricultural activities	Income share of off-farm non-agricultural activities over total income
Non-agricultural self-employment activities	Income share of non-agricultural self-employment activities over total income
<i>Natural capital</i>	
Land	1= < 3 ha, 2 = 3-6 ha, 3 = > 6 ha
Own land	The total amount of arable land owned by the household.
<i>Physical Capital</i>	
Production implement index ^d	Measures the household possession of production implements. The larger the index greater the asset holding
Basic services index ^e	Measures the access of households to basic services. The larger the index greater the access
<i>Human Capital</i>	
Family size	Adult income household members
Education	1=No education, 2=Primary education, 3=Secondary education and higher.
<i>Financial Capital</i>	
Savings	Dummy variable indicating possession or absence of saving
Debt	Dummy variable indicating possession or absence of debt
<i>Social Capital</i>	
Farmer association	Dummy variable indicating membership to rural cooperatives

^a Includes retirement pensions, remittances from family member resident abroad and Bono de Desarrollo Humano (a government cash transfer program)

^b Other forms of employment include: job as payment for lends, mix between permanent and temporary. Option 4 is selected when the households does not have adult members labor outside of farm

^{c,d} Access to productive assets: plow, installations for drying of products, transport of products, and installations for storage of products.

^e Access to basic services: drinking water, passenger transport, landline, mobile phone, internet, health and education.

We identified the share of land allocated to CN and CCN-51 varieties that form the agricultural basis of the farmers in the study to assess the influence of these crops in shaping livelihood strategies and determine whether the PRCN has influenced the livelihood of these households.

Capital asset variables as covariates to predict household membership to the livelihood strategy profiles

After identifying the livelihood profiles, we examine the association between capital asset variables and livelihood profile membership.

The five types of capital assets were measured considering a wide range of variables and some built-in indexes (Table 3.10.2). Natural capital was measured considering both access to and ownership of land (Jansen et al., 2006). Two built-in indexes were considered to address the physical capital dimension, in which higher values represent higher access and therefore more physical capital. The production index measured access to machinery, storing installations and transportation and the basic services index measured access to drinking water, health and education. Family size and the educational level of the head of the household were proxies employed to measure the human capital dimension. Financial capital was assessed through the households' savings and debts. Finally, social capital was measured considering membership in rural cooperatives.

The five types of capital variables are entered in the model as predictors (covariates) of household membership to each profile, allowing for determining the asset mixes that characterize the different livelihood strategies. This procedure is equivalent to using a multinomial logistic regression model, except that the three-step approach estimates classification errors when assigning profile membership and then corrects them by maximum-likelihood adjustment before the regression is applied (Bakk et al., 2013; Bakk et al., 2016; Vermunt, 2010).

Income share variables as distal outcomes of livelihood profiles

A pilot questionnaire served to establish the household's main income sources over the past two years. In the final survey, farmers were requested to indicate the proportion of income from the following sources: on-farm activities, off-farm agricultural activities, off-farm non-agricultural activities and non-agricultural self-employment activities (Table 3.10.2).

We examined the association between income shares and livelihood profiles by employing the profiles as predictors of income shares (distal outcomes), acknowledging

that income sources are outcomes rather than determinants of livelihood strategies (van den Berg, 2010).

3.6 Data collection

A detailed household survey was conducted from December 2015 to April 2016. Data collection and handling followed the Poverty Environment Network (PEN) survey guidelines that were designed to measure income and livelihood patterns (Angelsen et al, 2011; PEN, 2015). The PEN prototype questionnaires were translated into Spanish and thoroughly field tested at nine rural sites before operationalization.

Meetings were initially held with presidents of the cooperatives and communities in each area to explain the goals and methodology of the study. A survey schedule was prepared so that heads of the households were randomly selected across the nine villages and summoned on the agreed upon date to complete the questionnaire. Each interview lasted approximately 45 minutes. 188 heads of randomly sampled households were interviewed.

The final questionnaire was divided into three sections. The first recorded household activity variables, the second section collected data about household income shares and the third section compiled information about capital assets.

3.7 Results

Using the three-step approach adopted in this study, an LPA model was estimated to identify typologies of rural households that exhibited similar patterns of livelihood strategy. Capital asset variables are entered in the model as predictors of household membership to each livelihood strategy profile, describing the capital mix in each of the profiles that enables the choice of that livelihood strategy. Finally, the profiles are employed as predictors of income shares¹².

3.7.1 Profiles of livelihood strategies

A four-profile model performed the best, according to Bayesian Information Criteria (BIC), Consistent Akaike Information Criterion (CAIC) and conditional bootstrap tests (see Table 3.10.3 and for more details of the application of these criteria see Appendix A). Table 3.10.4 shows mean values, standard deviations and the overall Wald test for each profile activity variable and the size and name of each profile. All activity variables

¹² These analyses were estimated with Latent Gold 5.1 software (Vermunt & Magidson, 2015).

contributed significantly to discriminating among the profiles ($p < 0.05$), except for transfer income and the CN variable, meaning that the land share devoted to CN cultivation does not contribute to discriminating between profiles.

Table 3.7.1 Fit statistics for models comprising 1 to 5 latent profiles

VARIABLES	PROFILE MODELS				
	1	2	3	4	5
Log-likelihood	-2184.49	-2092.56	-2057.25	-2009.68	-1991.5
Global measures-fit (1)					
BIC	4992.12	4855.38	4831.90	4783.89	4794.66
AIC	4606.98	4441.11	4388.51	4311.37	4293.01
CAIC	5111.12	4983.38	4968.90	4929.89	4949.66
Local measures-fit					
max (BVR)	97.794	82.856	42.927	41.893	41.431
Entropy-R2	1	0.9907	0.9541	0.9798	0.9348
Class.Err. (CE)	0	0.0013	0.0166	0.0059	0.0395

BIC: Bayesian Information Criterion

AIC: Akaike's Information Criterion

CAIC: Consistent Akaike's Information Criterion.

BVR: Bivariate Residual.

Profile 1 (P1) accounts for 37% of the sample, followed by profile 2 (P2), with 31% of the observations, and profiles 3 (P3) and 4 (P4) comprised approximately 15% of the sample each.

P1 farms allocate approximately half of their land to cacao cultivation with a similar share of land allocated to CCN-51 ($M=0.32$) and CN ($M=0.28$), and were the group with the largest share of land devoted to the former. Labor on the farm mostly relies on family members ($M=0.67$) and off-farm family labor ($M=0.04$) and on-farm nonfamily labor ($M=0.03$) were irrelevant. This pattern indicates that, despite the government support given to the CN variety, CCN-51 is still important for certain farmers. Households in P1 can be framed within a strategy of agricultural intensification based on cacao, in which the intensification pattern relies on family workforce resources. We hypothesize that the lower labor requirements to cultivate CCN-51 allow for this profile to manage both varieties exclusively with the family workforce. We named this group *agricultural intensification based on family workforce*.

P2 is the most cacao-oriented profile, with two thirds of the farm land devoted to this crop. Despite having a similar share of land devoted to cacao as P1, the land allocated to CN is double the land share of CCN-51 ($M=0.41$ versus $M=0.24$). They make the most intensive use of family labor among the four profiles ($M=0.79$) and rely on hired workforce ($M=0.56$) and off-farm family labor ($M=0.08$) is irrelevant. This pattern is typical in small

Table 3.7.2 Profiles of livelihood strategies

	PROFILE 1		PROFILE 2		PROFILE 3		PROFILE 4		p-value ^a	R2
	<i>Agricultural intensification based on family workforce</i>		<i>Agricultural intensification based on family and external workforce</i>		<i>Diversified crop and family labor</i>		<i>Labor diversification</i>			
Profile Size (%)	37%		31%		17%		15%			
	M	SD	M	SD	M	SD	M	SD		
On-farm family labor	0.67 ²	0.03	0.79 ^{1,3,4}	0.00	0.58 ²	0.00	0.65 ²	0.04	0.015	0.060
Off-farm family labor	0.04 ^{3,4}	0.00	0.02 ^{3,4}	0.00	0.55 ^{1,2}	0.00	0.65 ^{1,2}	0.00	0.000	0.630
On-farm non-family labor	0.03 ^{2,4}	0.00	0.56 ^{1,3}	0.00	0.03 ^{2,4}	0.00	0.52 ^{1,3}	0.00	0.000	0.717
CN	0.28	0.16	0.41	0.16	0.44	0.42	0.41	0.55	0.580	0.026
CCN-51	0.32 ³	0.01	0.24 ³	0.02	0.08 ^{1,2}	0.01	0.16	0.16	0.058	0.059
Transfer income	0.12	0.38	0.08	0.38	0.12	0.41	0.08	0.39	0.690	0.008
Modality of off-farm family employment	3.04 ^{3,4}	0.03	1.43 ^{3,4}	0.04	1.43 ^{1,2}	0.09	1.66 ^{1,2}	0.10	0.000	0.810
1. Permanent employment	0.00	0.00	0.00	0.00	0.57	0.09	0.36	0.09		
2. Temporary employment	0.01	0.01	0.01	0.02	0.42	0.08	0.63	0.09		
3. Other forms employment	0.05	0.03	0.03	0.02	0.00	0.00	0.00	0.00		
4. Does not apply	0.94	0.03	0.96	0.02	0.00	0.02	0.02	0.02		
Modality of on-farm non-family employment	3.05 ^{2,4}	0.03	1.85 ^{1,3}	0.05	3.03 ^{2,4}	0.04	1.83 ^{1,3}	0.07	0.000	0.795
1. Permanent employment	0.00	0.00	0.16	0.05	0.00	0.00	0.18	0.07		
2. Temporary employment	0.00	0.07	0.84	0.05	0.01	0.01	0.82	0.07		
3. Other forms employment	0.06	0.03	0.00	0.00	0.96	0.03	0.00	0.00		
4. Does not correspond	0.94	0.03	0.00	0.01	0.03	0.03	0.00	0.01		

^a From overall Wald test. Super indexes correspond to the profiles from which data is significantly different from at 5% level.

farms with intensive production of cacao and in which there is a high use of labor and minimal linkage to other agricultural and non-agricultural activities. Households in P2 can easily be identified with a strategy of agricultural intensification based on CN cultivation. We named this group *agricultural intensification based on family and external workforce*.

P3 is the most CN-specialized profile (M=0.44), with marginal participation of CCN-51 (M=0.08) and higher productive diversification than the other groups, dedicating almost 50% of its land to other permanent and temporary crops. This is linked to the standard cultivation procedure for CN, which intermixes other tree crops in polyculture agroforestry. On-farm family labor (M= 0.58) is as important as off-farm family labor (M=0.55), with permanent employment (M= 0.57) as the main modality for the latter case. Households in P3 follow a strategy of diversification in both crop production and family labor. We named this group *diversified crop and family labor*.

P4 also shows specialization in the CN variety (M=0.41) but, in contrast to previous groups, it shows a high proportion of labor in all researched alternatives: family labor on- and off-farm (M=0.65) (as the group with the highest share of the latter), and external workforce (M=0.52). This high percentage of external workforce may indicate more business-oriented activity in this group. Temporary employment is the main modality of labor off-farm (M=0.63) and on-farm (M=0.82). Households in P4 show a distinctive strategy of labor diversification that led us to name it *labor diversification*.

The land allocation to CN and CCN-51 and, more importantly, labor allocation to its different modalities led to identification of four clear patterns of livelihood strategies. The first two are based on agricultural intensification strategies that rely on family resources or hiring an external workforce to achieve their production objectives. In contrast, profiles 3 and 4 adopt a distinctive diversification strategy; P3 includes bidimensional crop and family labor diversification and P4 is based on labor diversification, with family members working on- and off-farm and reliance on external workers.

Although there is no data available on the labor per hectare needed to manage each cacao variety, our results show that increases in land cultivation of 1% for each variety imply increases in family and total labor of 2% for CN cultivation and 1.75% for CCN-51.

Considering the influence of the PRCN policy in promoting CN cultivation, especially among small farmers, cultivation of CN does not significantly contribute to shaping the membership of households to any of the profiles. Furthermore, among P1 and P2, which comprise two-thirds of the sampled households and who are the more agriculture-oriented households, the CCN-51 variety continues to be highly preferred. These results show that the policy intervention focused on crop management assistance (e.g., pruning,

seed selection, technical assistance) is not obtaining the intended results of increasing CN cultivation. This evidences the mismatch between the main theoretical beneficiaries of the PRCN (the small farmers in profiles 1 and 2) and their practices. P3 and P4, which are the profiles favoring CN, show a diversification livelihood strategy. Supporting farmer diversification (either in terms of crops or labor), may be considered by the PRCN as an indirect but effective way of achieving an increase in CN cultivation. However, these results also indicate that CN cultivation may be a residue in a slow process of tree replacement, with a slower pace in P3 and P4, since household strategies in these profiles are oriented toward obtaining non-agricultural income and have lower investments in improving cacao production¹³. In addition, the results highlight the need for creating a value chain for the CN variety in which external incentives such as premium prices are also distributed among small producers.

3.7.2 Capital asset variables as predictors of membership to the livelihood strategy profiles

All capital asset mix variables were significant predictors of livelihood strategy profile memberships (overall Wald test with $p < 0.05$). At this stage and, similar to other works (Nielsen et al., 2013), a baseline group is defined against which the other strategies are compared to assess the role of capital assets in defining the profiles (see Table 3.10.5). First, the profile with the highest share of CC-N51 (P1) was taken as a baseline to pivot P2, P3 and P4. In a second phase, P2 (with more intensive on-farm family labor and cacao land share) was taken as a baseline to compare P3 and P4. See Appendix A for more information.

In the first pivotal comparison, households belonging to farmer associations are more likely to belong to P2 whereas those with larger family size and a primary education are more likely to be in P3. P4 shows significantly different capital assets than P1; medium and large farms are more likely to belong to P4 and being the owner of the land reduces the probability of being in this group. Furthermore, having a positive and relatively high capital production index increases a household's likelihood of being in P4 and a low basic service index decreases the likelihood. Finally, having savings and low debt also increases the probabilities of being in P4.

The second pivotal comparison shows that the probability of belonging to P3 or P4 with respect to P2 increases with land size and decreases with land ownership. In addition, the larger the family size, the more likely the household belongs to the P3 or P4 profiles.

¹³ We are indebted to one of the reviewers of this manuscript for noting this.

Table 3.7.3 Capital asset variables prediction of household profile membership

Capital Asset variables	a) P1 vs P2, P3 and P4 profiles						b) P2 vs P3 and P4 profiles				Wald	p-value
	P2 <i>Agricultural intensification based on family and external workforce</i>		P3 <i>Diversified crop and family labor</i>		P4 <i>Labor diversification</i>		P3 <i>Diversified crop and family labor</i>		P4 <i>Labor diversification</i>			
	β	z-value	β	z-value	β	z-value	β	z-value	β	z-value		
Land											13.71	0.030
Less than 3 ha.	0.00	.	0.00	.	0.00	.	0.00	.	0.00	.		
Between 3 and 6 ha.	-0.09	-0.17	-0.29	-0.48	1.65	2.24	-0.21	-0.32	1.74	2.21		
More than 6 ha	-0.31	-0.34	1.57	1.66	3.38	2.64	1.88	2.31	3.69	2.95		
Land ownership	0.11	1.25	-0.08	-0.83	-0.38	-2.33	-0.19	-2.73	-0.49	-3.13	13.50	0.000
Production implement index	0.46	1.67	-0.02	-0.06	0.85	2.37	-0.48	-1.62	0.39	1.07	8.18	0.040
Basic services index	-0.36	-1.77	-0.24	-0.99	-0.60	-2.77	0.11	0.41	-0.25	-0.99	8.69	0.030
Family size	-0.29	-1.47	0.36	2.36	0.29	1.54	0.65	2.97	0.57	2.12	10.35	0.020
Education											27054.68	0.000
No education	0.00	.	0.00	.	0.00	.	0.00	.	0.00	.		
Primary education	1.47	1.58	54.80	95.32	0.87	0.65	56.73	96.16	-0.60	-0.48		
Secondary education	0.39	0.43	53.48	0.00	-0.32	-0.24	56.49	0.00	-0.72	-0.56		
Savings											9.79	0.020
No	0.00	.	0.00	.	0.00	.	0.00	.	0.00	.		
Yes	0.15	0.25	-0.21	-0.32	1.91	2.90	-0.36	-0.49	1.76	2.16		
Debt											10.05	0.020
No	0.00	.	0.00	.	0.00	.	0	.	0	.		
Yes	0.80	1.75	0.48	0.81	-1.42	-2.02	-0.32	-0.54	-2.22	-2.94		
Farmer association											12.23	0.007
No	0	.	0	.	0	.	0	.	0	.		
Yes	1.57	2.98	-0.22	-0.43	1.12	1.52	-1.78	-2.98	-0.46	-0.57		

Households with primary education are more likely to belong to P3. Finally, having savings and low debt also increases the probability of being in P4.

Examining the role played by different capital assets in defining the profiles, we observe that natural capital, specifically, the area of cultivated land, and human capital (family size) play determinant roles in enabling diversification strategies (either P3 or P4). Households with agricultural intensification strategies (P1 and P2) are small families that own and cultivate small properties whereas the diversification strategies (P3 and P4) are characterized by larger family sizes and hiring strategies to cultivate larger size plots.

Households in P2 appear to be the most vulnerable, with low natural capital and financial indicators (i.e., small land area and financial debts). Social capital through membership in farmers' cooperatives is significant in defining membership to this profile. This may be a strategy to balance and reduce natural and financial vulnerability. In contrast, households in P4 have distinctively high physical capital (i.e., good access to production implements and basic services) and financial capital (savings and low debt).

The low endowment of key assets that characterizes profiles 1 and 2 may explain why these farmers do not prioritize CN in their farms and continue to maintain relatively high levels of CCN-51, contrary to the farmers with better asset endowments in profiles 3 and 4. As some studies show, both endowment and the wise use of such assets permit responding to the shocks, adverse trends and seasonality that characterize rural activities and better addressing risk decisions, especially for small farmers (Scoones, 2009; Sheck et al., 2013). With a low endowment of assets and without major incentives, the higher productivity of CCN-51 continues to be an important factor in the production decisions of these farmers.

The national policy to stimulate the production of CN has a two-fold objective to improve the competitiveness of Ecuadorian cacao in global markets and to reduce the poverty of small farmers through premium prices obtained for CN beans (MAGAP, 2013). However, the former objective has not been achieved since premium prices for farmers are not in place in the national markets, as the PRCN policy focused on improving cultivation procedures. Although we do not have ex ante data to measure the impacts of PRCN policy on the asset endowment of profiles 3 and 4, it is relevant to signal that the small farmers in the study area on whom many PRCN policies are focused, profiles 1 and 2, are currently the least endowed with assets. This adds to evidence of the mismatch between the main theoretical beneficiaries of the PRCN policy (small farmers in profiles 1 and 2) and their current situation in terms of asset endowment.

3.7.3 Income share predictions by livelihood strategy profiles

We computed the profile-specific means for income share variables related to four labor types (see Table 3.10.6). The overall Wald test was significant for three of them: on-farm agricultural activities, off-farm non-agricultural activities and off-farm agricultural activities (see Appendix A for additional information on the statistical tests).

Table 3.7.4 Income share prediction by livelihood strategy profiles

Income shares	PROFILES								Wald	p-value
	P1		P2		P3		P4			
	<i>Agricultural intensification based on family workforce</i>		<i>Agricultural intensification based on family and external workforce</i>		<i>Diversified crop and family labor</i>		<i>Labor diversification</i>			
	M	SD	M	SD	M	SD	M	SD		
On-farm agricultural activities	0.72 ^{3,4}	0.04	0.79 ^{3,4}	0.03	0.50 ^{1,2}	0.06	0.55 ^{1,2}	0.05	24.771	0.000
Off-farm agricultural activities	0.10 ³	0.02	0.06 ³	0.02	0.21 ^{1,2,4}	0.05	0.09 ³	0.02	8.745	0.033
Off-farm non-agricultural activities	0.04 ⁴	0.02	0.03 ^{3,4}	0.01	0.14 ²	0.04	0.23 ^{1,2}	0.05	12.429	0.006
Non-agricultural self-employment activities	0.01 ⁴	0.01	0.04	0.01	0.03	0.02	0.06 ¹	0.03	3.073	0.380

^{1,2,3,4}Super indexes correspond to profiles significantly different at 5% level.

The income share results align with the findings of the livelihood strategy identification in which P1 and P2 clearly differentiate from P3 and P4. The income share from on-farm agricultural activities represents the largest proportion for all groups. However, it differs among them; P1 and P2's own-farm income source represents more than 70% of their total income whereas its importance is somewhat less (approximately 50%) for P3 and P4, showing a more diversified income structure. Differences were also observed between these two groups regarding the second-most important source of income. For farmers in P3, it is off-farm agricultural activities (21%) whereas for farmers in P4, it is off-farm non-agricultural activities (23%).

These differences between the two groups of profiles reflect the vulnerable condition of the cacao producers in profiles 1 and 2 whose household income is highly dependent on the behavior of the cacao market.

These profiles appear to be in a setup in which the intensive labor dedication to cacao cultivation and a low endowment of assets may jeopardize their access to less vulnerable livelihood strategies. Increasing their asset endowment and share of CN cultivation (and

hence dependency), as intended by the PRCN policy, may not necessarily result in improvement of their income status, especially while lacking a differentiated value chain for CN at the national level that rewards farmers with higher prices. This result adds to previous evidence signaling the existing gap between the objectives of the PRCN policy to improve the situation of small farmers and the actual results.

3.8 Discussion

Small farmers face some opposing goals and trade-offs when cultivating cacao. CN may accrue premium prices in international specialty markets, and full-sun, high-yield CCN-51 benefits from less labor but relies more on external inputs and obtains lower prices (Franzen & Mulder, 2007). Most studies assessing the role of these two varieties and their distinctive implications in terms of ecosystem service provision, cultivation or market access suggest that farmers would opt for one or the other variety (Andres et al., 2016; Jano & Mainville, 2007; Ton et al., 2008; Vaast & Somarriba, 2014). In contrast, our survey shows that more than two thirds of the sampled households (P1 and P2), specifically those showing livelihood strategies focused on agricultural intensification, solve this “dilemma” by allocating a substantial share of their land to concurrent cultivation of CN and CCN-51. Furthermore, the variable “share of land allocated to CN” does not significantly contribute to the adoption of a particular household livelihood strategy.

Our results show how the asset endowment of small farmers affects their livelihood strategies; two broad patterns can be disentangled. Profiles P1 and P2 are highly dependent on their agricultural production whereas P3 and P4 show a more diversified farm economy. Diversification toward off-farm activities is a key strategy in rural livelihoods (Hua & Zhang, 2017; Nielsen et al., 2013; Walelign, 2016) since it may reduce vulnerabilities to prevailing agricultural risk (Davis, 2006; Kandulu et al., 2012) and is generally a viable strategy for improving living standards in rural areas (Nielsen et al., 2013; Walelign et al., 2016). Profiles that were less diversified toward off-farm activities also had the highest share of land devoted to CCN-51 production and vice versa. However, high welfare strategies tend to be associated with high levels of capital (van den Berg, 2010), as our study also supports.

Labor is a building block in acquiring livelihood objectives and sustaining livelihood outcomes (Bhandari, 2013) and its analysis shows how P2 farmers rely on external workers to support their farm activities. The P2 group allocated more land to cacao production and a substantial share to CN. CN cultivation requires more labor whereas

households that produce CCN-51 substitute labor with other inputs, especially herbicides (Bentley et al., 2004; Franzen & Mulder, 2007; Blare & Useche, 2013). Therefore, for less diversified livelihood strategies, cultivation of CCN-51 may be viewed as a way to obtain benefits in the short-term and reduce the need to hire an external workforce.

Similar to other studies, cultivated land resource endowment was a key factor influencing the differentiation of livelihood strategies (Hua et al., 2017; Jansen et al., 2006; Winters et al., 2009). A high allocation of land resource endowments to CN production (approximately 40%) and marginal land allocated to CCN-51 indicates a pathway of off-farm income diversification. Large farmers tend to have better access to economic/financial capital and can afford to purchase modern farm inputs that allow for them to strengthen their livelihood (Bhandari, 2013). Households in P4 can easily be identified with this pattern, showing positive and significant values for medium and large property sizes, a positive and significant production implements index compared to P1 and a diversified economy with off-farm income based on non-agricultural activities. In addition, our results show that access to the land, not land ownership, is the key factor contributing to engaging in higher income opportunities (Jansen et al., 2006; van den Berg, 2010).

Human assets enable households to pursue different livelihood strategies to achieve their livelihood objectives (Bhandari, 2013). Family size plays a crucial role in this respect since larger families are able to pursue non-agricultural livelihood strategies due to their higher labor capacity (Hua et al., 2017). P3 and P4 show distinctively larger family sizes than P2, translating into increased labor capacity and greater ability to diversify income sources. Some studies also suggest that family size positively impacts the adoption of innovations in crop management and restoring CN cultivation (Tiwari et al., 2008).

The importance of cacao as a major global commodity makes the establishment of effective cacao policy a high priority (Franzen & Mulder, 2007); our findings may contribute to shaping current implementation of PRCN policy as well as future policies in Ecuador. Through PRCN policy, the Ecuadorian government has focused on developing measures related to agronomic issues in CN production and disregarded other factors that shape cacao production and commercialization (Astudillo Paredes, 2014). The lack of a differentiated value chain for CN at the national level impedes farmers from receiving differentiated prices for CN beans. Some farmer associations in Ecuador have achieved better prices for CN by circumventing the intermediaries and selling directly to exporters or exporting directly (Astudillo Paredes, 2014; Jano & Mainville, 2007). Thus, strengthening the role and capacity of farm cooperatives may be a successful approach

to reinforcing the ability of CN farmers to obtain premium prices in international markets. However, strategies that intend to link small farmers to markets tend to implicitly assume that these farmers have sufficient assets to participate in high-value markets and can assume higher risks for their investments, overlooking the trade-offs they incur (Donovan et al., 2015; Horton et al., 2016).

Without such asset endowments, cacao farmers are constrained by entry barriers (Amekawa, 2011) and income diversification measures may be detrimental for these families if their household asset stocks and feasible activity options are neglected (Amekawa, 2011; Barrett et al., 2001). Development interventions that would allow for them to effectively participate in value chains would support poor households in building a minimum stock of productive assets, without which the poorest may experience asset depletion and increased vulnerability (Donovan & Poole, 2013; Sheck, et al., 2013).

Since asset thresholds are key to improving poverty transitions (Mutenje et al., 2010; Scoones, 2015; Walelign, 2016), national policies oriented toward reducing the poverty of cacao small holders should consider increasing cacao productivity and investments in infrastructure and social safety nets to develop sustainable livelihoods (Bhandari, 2013; Davis & Lopez-Carr, 2014; Mahdi et al., 2016; Mbaiwa, 2011; Park et al., 2012; Reenberg et al., 2013; Timmer, 2012)

However, the measures implemented through PRCN have not provided the small farmers who are focus of this policy with key asset endowments to support them in the case of allocating more land to the less productive CN variety, which results in the same prices as CCN-51 in the national markets they have access to.

For CN cultivation, to create a real impact on the small farmers, it is necessary to establish a differentiated value chain for the CN variety at the national level in which external incentives such as premium prices are distributed among small producers. The lack of this value chain may limit the future viability of CN cultivation in Ecuador.

Since our study analyzed household livelihood strategies at a given moment in time, several hypotheses can be considered to understand the dynamic allocation of land to the two cacao varieties. Farmers who are more dependent on on-farm income are the largest producers of CCN-51; probably because shifting completely to CN may be seen as a risk when they receive the same price for both varieties. The short-term benefits of cultivating CCN-51 allowed for its spread (Franzen & Mulder, 2007; MAGAP, 2013; Melo & Hollander, 2013), but it appears that many farmers acknowledge the benefits of combining CN cultivation with other tree crops that are key for family subsistence and the lower maintenance costs of this variety. In addition, cultivation of both varieties by

agricultural intensification profiles may be a resilience strategy in case of plant diseases, pests or plagues. Finally, the higher share of CN observed in the more diversified profiles may indicate a higher capacity to adopt innovations in CN cultivation or CN may be a residue in the process of replacing trees, which occurs a slower pace in these profiles due to their prioritization of non-agricultural incomes. Further adoption of CN or halting its substitution process could be enhanced by creation of a value chain and improvement of the asset endowment of small farmers.

The nonsignificant role played by the CN land cultivation in differentiating livelihood strategies and the lower asset endowment income diversification of the theoretical target beneficiaries of the PRCN highlight the gap between the postulates of this policy and the actual results.

This work builds on previous studies assessing Ecuadorian cacao production (e.g., Galarza, 2012; Melo & Hollander, 2013; Useche & Blare, 2013) and adopts a robust statistical approach aligned with the theoretical frameworks adopted to investigate livelihood strategy profiles. Different from traditional cluster analysis (Babulo et al., 2008; Nielsen et al., 2013; Walelign, 2016), the improved three-step approach allows for more statistically robust and less arbitrary final grouping and profile assignment (Collins & Lanza, 2010; Magidson & Vermunt, 2002; Bolck et al., 2004).

3.9 Conclusions

Establishment of effective policies to improve cacao cultivation is viewed as a way to enhance the livelihood of small producers. Ecuador, as the largest global producer of fine flavor cacao (CN), has developed a national policy (PRCN) to rehabilitate and stimulate production of the CN variety over its hybrid counterpart (CCN-51) to preserve the former and adopt its cultivation as a rural development strategy for cacao small farmers.

The production decisions of small farmers occur in a context of diversified livelihood strategies in which they make decisions related to their linkage to markets for specialized or bulk cacao varieties. This study shows that fine flavor cacao does not insure the living conditions of small farmers that would enable them to opt for a specific livelihood strategy. In contrast, the capital assets significantly determine the livelihood strategies of small farmers. Low capital asset endowments hinder transitioning toward more rewarding livelihood strategies. Accordingly, policy interventions should be oriented to enhancing access to quality asset endowments and providing asset protection for small farmers.

In the context of diversified livelihood strategies, policy interventions should also focus on measures to facilitate income diversification and improved opportunities for off-farm employment, as they may encourage adoption of CN by small producers

The mismatch identified by this study between the PRCN policy and its theoretical beneficiaries, small cacao farmers, also calls for policies that design, structure and maintain a differentiated national value chain for the fine flavor variety. Ensuring that small farmers receive the incentives that accompany this variety, such as the premium prices obtained in international markets, would contribute to securing the mid-term viability of CN and the potential of this crop to enable access of small farmers to more rewarding livelihood strategies.

This study advocates for a multidimensional policy strategy to promote fine flavor cacao cultivation, in which improved asset endowment, income diversification measures and development of a specific national value chain should accompany the improved CN breeding and management.

Finally, in the framework of policy interventions, longitudinal data collection and analysis could improve assessment of the pathways that the livelihood strategies of small cacao farmers follow over time under the application of specific sectorial policies.

Conflict of interest

The authors declare that they have no conflicts of interest.

Acknowledgements

This manuscript is part of the PhD dissertation of the first author of this manuscript. He acknowledges the funding received by the Universidad Estatal de Milagro (Ecuador) to conduct this study. The authors are thankful to two anonymous reviewers for their insightful comments that significantly contributed to improving this manuscript.

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Chapter 4: The role of risk attitudes and risk perceptions on the adoption of risk management strategies among Ecuadorian cacao producers

4.1 Introduction

Agricultural activity is associated with numerous types of vulnerabilities, uncertainties and an increasing range of risks related to production, price, commercialization, and institutional aspects that altogether make of farming a complex process (Ellis, 2000; Iqbal et al., 2016). Accordingly, farmers acknowledge and manage risks at farm level (Drollette, 2009; Iqbal et al., 2016) in the context of their endowments, risk preferences and risk perceptions (OECD, 2009), implementing a variety of risk management strategies (Wauters et al., 2014).

Despite it is widely recognized that the perception of risks of the decision-maker influences the decision-making process (Slovic et al., 1982; van Raaij, 1981), little is known about the decision-making process that farmers follow when choosing optimal risk management strategies (Meraner & Finger, 2017). In this respect, the interplay between perceived risk and attitudes towards risk seem to play a key role in farmers' decision-making in risky and uncertain settings (Fahad et al., 2018; Meraner & Finger, 2017). Risk perception (RP) is determined by both the perceived probability and perceived impact of the individual (Dunegan, 1992; Sjöberg, 2000; Wauters et al., 2014). Therefore, in their decision-making process, farmers assess both the probability of the occurrence of an uncertain event and the consequential negative impact (Slovic et al., 1982; van Raaij, 1981). Risk attitude (RA), also referred in the literature as risk aversion or risk propensity is, according to Winsen et al. (2014), the actor's orientation towards risk taking and it can range from risk averse to risk seeking attitudes. Since different people hold different attitudes towards risk, they also deal differently regardless of their individual risk perception.

The importance of RP and RA for understanding individual's behavior towards risk, also known as risk management strategies (RMS), is relatively well described in the literature, but they have rarely been combined in an integrated approach in order to explain how they collectively guide farmers in their decision-making process (Keil et al., 2000; Sitkin & Pablo, 1992; Winsen et al., 2014). Further, RP and RMS have been tested as single constructs, while their potential mediator role has been scarcely addressed (Chen, 2013). We hypothesize that risk attitude and multi-dimensional risk perception constructs may collectively play a crucial direct and indirect role in driving farmers' choices to implement certain risk management strategies.

Thereby, this study contributes to the existing literature proposing a model that explains how risk attitude and risk perceptions influence directly and indirectly on the multidimensional

risk management decision-making process. RA and RMS are examined from multi-dimensional approaches for a better comprehension of farmers' risk behavior. The theoretical model to determine the relationships among risk attitude, risk perception and risk management strategies is tested using variance-based structural equation modelling (SEM) with the partial least squares (PLS) algorithm.

We applied a sequential mixed methods approach combining qualitative and quantitative research, where qualitative techniques are employed in the first stage, informing the data collection process in the second quantitative approach (Cameron, 2009; Wauters et al., 2014).

The empirical application focuses on cacao producers in the Ecuadorian coastal of the Guayas Province. Cacao is one the most important cash crops in Ecuador with 3% share of the agricultural export value (SINAGAP, 2018). Ecuador is the seventh bigger cacao producer in the world (5% of the world total) while it is the biggest producer of fine flavor cacao (around 65% of world total) since many years ago (Purcell et al., 2018). The land devoted to cacao cultivation was 25% of the total agricultural area in 2017, showing an increasing trend (20% in 2016).

Cacao producers in Ecuador develop their activity in an environment of risk and uncertainty. International cacao prices have experienced important variations and instability that have had a repercussion on prices at the national level. In 2017, domestic prices experienced a 33% decrease compared to the previous year (SINAGAP, 2018). Actions that could potentially help to reduce farmers' risk in their activity, such as belonging to a cooperative or counting on crop insurance show a low level of adoption (17% and 4%, respectively), what may seem surprising when considering that cacao is their main source of income for half of the producers (MAGAP, 2018).

In this study, we 1) investigate Ecuadorian cacao farmers' attitude towards various kinds of risks exposure; 2) determine their perceptions of the risks they are exposed to in the study area; and 3) assess the relationships between risk attitudes, risk perceptions and risk management strategies among Ecuadorian cacao farmers.

Overall, the findings of this study may be of practical importance for researchers, policy-makers, and industry stakeholders since the identification, understanding and evaluation of risks is highly needed to improve policy measures and advisory tools (Hansson & Lagerkvist, 2014).

The remainder of the paper is organized as follows: section 2 presents the theoretical model, section 3 is devoted to material and methods while section 4 describes the main results; finally, the manuscript is concluded with discussion and conclusions in section 5.

4.2 Building a theoretical model

Under subjective expected utility theory (Menapace et al., 2016; Savage, 1954), an agent's optimal decision in a risky setting is determined not only by their attitude towards risk, but also by their subjective belief regarding the probability of an uncertain outcome occurring. This framework recognizes that in many risky settings individuals do not know the probability of uncertain events occurring, and thus make decisions based upon subjective beliefs which may not necessarily correspond with true probabilities (Menapace et al., 2016). Thereby, some studies show that risk attitudes and the subjective probabilities that agents perceive of uncertain outcomes occurring, influence their risk behaviour (Bocquého et al., 2014; Eckel & Grossman, 2008; Harrison et al., 2007; Ward & Singh, 2015).

The OECD framework for risk management analysis in agriculture proposes a multidimensional assessment, acknowledging that interactions between the sources of risk, farmers' strategies and government policies do not take place in a linear fashion. On the contrary, continuous feedbacks exist among these factors, leading to a simultaneous determination of risks, risk management strategies and policies (OECD, 2009). This overall framework has been adopted previously in the literature (Wauters, et al., 2014; Winsen et al., 2014) and underpins our study where we analyze the risk management decision-making process as a multidimensional construct that is influenced by both farmer attitudes towards risk and farmer risk perception.

Despite decision-making of farmers in risk contexts has been analyzed considering risk attitude and risk perception dimensions (Iqbal et al., 2016; Lucas & Pabuayon, 2011), the role that these two variables play, has rarely been addressed in an integrated approach (Winsen et al., 2014) and hardly through multidimensional constructs (Chen, 2013). We addressed this gap in literature by modelling risk perception (RP) and risk management strategies (RMS) as reflective, multidimensional, second-order constructs. Figure 4.2.1 describes the key dimensions that compose our model, risk attitude (RA), risk perception (RP) and risk management strategies (RMS) so as to integrate them as constructs into a nomological network.

Risk Management Strategy (Risk Reducing Strategy)	Any action with the deliberate goal to modify the probability and or impact of adverse events.
Risk Perception	Explains how an individual assesses both the threat probability and the damage potential.
Risk Attitude (Risk Preference, Risk Aversion or Risk Propensity)	The actor's orientation toward risk taking.

Figure 4.2.1 Key definitions of risk components

Source: Chen, 2013; Grothmann & Reusswig, 2006; Wauters, et al., 2014; Winsen et al., 2014).

4.2.1 Risk Management Strategies

Risk management can be defined as any action with the deliberate goal of modifying the probability and/or impact of adverse events (Wauters et al., 2014). Literature on farmers' choice of risk management strategies often focuses on the adoption of single activities (e.g. Finger & Lehmann, 2012; Menapace et al., 2016) and/or risk management for a single dimension, such as price risk management strategies or the adoption of production and marketing contracts (Jackson et al., 2009; Uematsu & Mishra, 2011). However, farmers use a large portfolio of risk management strategies to react to different risk sources. Therefore, these and their interrelations with other risk components need to be considered based on a holistic risk behavioral approach (Meraner & Finger, 2017; Wauters et al., 2014; Winsen et al., 2014). Farmers' risk management can generally be classified according to three broad dimensions: 1) risk reduction strategies, that involve any measure to decrease the probability that adverse events impact on the farm, 2) risk mitigation strategies allow the risk to happen, but reduce its impact and 3) risk coping strategies, that restore the damage when it happens (OECD, 2009; Wauters, Frankwin, et al., 2014). Therefore, our approach acknowledges that farmers can and do apply a variety of these risk management strategies simultaneously, each of them comprised of specific components.

4.2.2 Risk Perception and Risk Attitude

The concept of perceived risk embeds two dimensions: the perceived probability of an uncertain event happening and the perceived impact or negative consequence (Dunegan et al., 1992; Sjöberg, 2000; Wauters et al., 2014). Thereby, risk perception explains how an

individual assesses both the threat probability and the damage potential (Chen, 2013; Grothmann & Reusswig, 2006). This multidimensional risk perception at the individual level can significantly influence how farmers address risk management decision-making process. Previous studies found out that risk perception tends to be positively associated with demands for risk reduction or risk mitigation. Furthermore, the nature of likely future consequences of impacts may play a more significant role than probability assessments in the demand for risk mitigation (Sjöberg et al., 2004; Sjöberg, 1999). Based on these findings, we propose the following hypotheses:

H1: Perceived probability of different risk sources will significantly influence the intention to implement risk management strategies.

H2: Perceived impact of different risk sources will significantly influence the intention to implement risk management strategies.

Risk attitude, also referred to as risk preference, risk aversion or risk propensity, can be defined as the actor's orientation towards risk taking (Winsen et al., 2014). Its measurement has been addressed since early days both in psychology (Luce, 1959) and economics (Dillon & Scandizzo, 1978; Halter & Dean, 1971). The different procedures to elicit risk attitudes include traditional non-incentivized survey methods based on Likert scale statements and both unframed (context-free) and framed hypothetical and incentivized experiments (Charness et al., 2013; Jamison et al., 2012). Most incentivized experiments (e.g. the lottery task designed by Holt & Laury, 2002) (HL method) assume that individuals behave according to standard expected utility theory (EUT) in which only one behavioral factor characterizes the evaluation of risky prospects (e.g. risk aversion, or curvature of the utility or value function) (Abdellaoui et al., 2011). Over the years, however, researchers have come to recognize that risk attitude measures represent context or domain-specific choices, rather than an inherent predisposition toward risk per se (Franken et al., 2017; March & Shapira, 1987). Furthermore, there are additional sources of variation in attitudes toward risk such as the distortion of probabilities that humans make in a non-linear fashion or the distinctive behavior shown by people when facing risk in the losses domain (Abdellaoui et al., 2011; Andersen et al., 2010; Bauermeister & Mußhoff, 2018; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992).

Rather than assuming that only one behavioral factor characterizes the evaluation of risky prospects, we adopted the cumulative prospect theory (CPT) proposed by Kahneman and

Tversky (1979; 1992), to acknowledge that farmers may be loss averse and hence they may weight disproportionately high events with low probability when valuing risky prospects (Ward & Singh, 2015). CPT estimates three joint parameters to assess risk attitude. The first parameter (σ) measures the curvature of the prospect value function, i.e. producer behavior when confronted with risk in the gains domain; it can be thought of as a measure of risk aversion. The second parameter (α), corresponds to the probability weighing function that captures the degree to which low probability events are disproportionately weighted when valuing risky prospects. The third parameter (λ) represents loss aversion, i.e. producer behavior when facing risk in the losses domain (Cárcamo & von Cramon-Taubadel, 2016; Hansson & Lagerkvist, 2012; Pennings & Leuthold, 2000; Starks & Trinidad, 2007; Ward & Singh, 2015).

We expect that the more willing the farmers are to take risk, i.e. the lower their risk aversion, the more inclined they are to implement some risk reducing strategy (Hellerstein et al., 2013; Winsen et al., 2014). Hence, we propose the following hypothesis:

H3: Risk aversion will have a significant and negative relation on the intention to implement risk management strategies.

On the other hand, we expect that farmers with low loss aversion to be more willing to take risks and hence more inclined to implement risk-reducing strategies. Thus, we propose the following hypothesis:

H4: Loss aversion will have a significant and negative relation on the intention to implement risk management strategies.

We also analyze the influence of risk attitude on risk perception, more specifically how risk aversion and loss aversion affect perceived probability and perceived impact of the different risk sources. As previous studies have argued, an individual's risk attitude influences the manner in which he evaluates a risky situation (Bergfjord, 2013; Fahad et al., 2018; Iqbal et al., 2016). Risk-avoiders (i.e. high-risk aversion or high loss aversion patterns) may pay more attention to the negative consequences of a decision/event and overstate the possibility of loss, thus perceiving high levels of risk. On the contrary, those who are very willing to take risks (e.g. low risk aversion or low loss aversion) may focus on the potential benefits and therefore have lower risk-perception scores compared to risk-avoiders for a given event (Cho & Lee, 2006; Forlani & Mullins, 2000; Keil et al., 2000; March & Shapira,

1987; Wang et al., 2016). We thus elaborate the following hypotheses to be tested in our context:

H5: Risk aversion will have a significant and positive relation on the perceived probability of the different risk sources.

H6: Risk aversion will have a significant and positive relation on the perceived impact of the different risk sources.

H7: Loss aversion will have a significant and positive relation on the perceived probability of the different risk sources.

H8: Loss aversion will have a significant and positive relation on the perceived impact of the different risk sources.

Furthermore, we also analyze how the interaction between risk attitude and risk perception influence risk management strategies. Risk may be perceived differently among individuals while their decisions on how to cope with perceived risk will depend on their risk attitude. Regardless of individual risk attitudes, behavioral changes to tackle risk in a given situation will not take place until risk is perceived (Pennings & Wansink, 2004; Trimpop, 1994). Therefore, risk attitude and risk perception may have a direct impact on the risk management strategy adopted, while interactions between these two dimensions of risk may also be expected. More specifically, we hypothesize a mediator effect of risk perception components (probability and impact) between risk attitude dimensions and risk management strategies. Thereby, we formulate the following hypotheses:

H9. The relationship between risk aversion and risk management strategy is positively mediated by perceived probability of risk.

H10. The relationship between risk aversion and risk management strategy is positively mediated by perceived impact of risk.

H11. The relationship between loss aversion and risk management strategy is positively mediated by perceived probability of risk.

H12. The relationship between loss aversion and risk management strategy is positively mediated by perceived impact of risk.

4.3 Material and methodological approach

4.3.1 The sample

We examine the abovementioned hypotheses in the context of Ecuadorian smallholder cacao producers located in nine rural sites from two districts of the Guayas province, Lorenzo de Garaicoa and Yaguachi Viejo. We first conducted in-depth semi-structured interviews with 43 farmers to get an exhaustive overview of the sources of risk, the shocks that they perceive and the way they deal with these shocks and with future uncertainties.

This information, together with a thorough review of previous studies, allowed us designing a survey with two differentiated parts. In the first farmers were asked about risk perception and usefulness of different risk management strategies. On the second part of the survey, risk attitude data was collected using experimental lottery designs with differing real payoffs. 188 farmers participated in the survey that was designed to be self-administrated with the assistance of facilitators that helped farmers when required. Survey administration lasted around 90 minutes.

4.3.2 Data collection and variables

Three sets of latent constructs were defined in this study: risk management strategies, risk perception and risk attitude. The following paragraphs define these constructs and the indicator variables that define them.

Based both on the in-depth interviews and on previous research (Wauters et al., 2014; Winsen et al., 2014), we measured the farmers' willingness to adopt different risk management strategies in the future. This is, rather than measuring actual risk behavior, we followed Winsen et al. (2014) and measured intended behavior, i.e. to what extent farmers consider different risk strategies as a valid option for their farm. These were divided into four latent categories- diversify (Risk reduction), optimize and off-farm (Risk mitigation) and coping (Risk coping)¹⁴ - and assessed through 6 indicator variables measured by Likert-scale questions to obtain these risk components. A 7-point Likert-type item from 1 (would definitely not apply) to 7 (would definitely apply) was employed for all questions (see table 1 for further details). In Table 1 we show the different variables that are part of the study.

¹⁴ Initially we had 2 additional latent categories (External and Buffer) which were finally disregarded in the modelling process since they did not comply with certain requirements of the modeling of structural equations.

The 'Diversify' dimension refers to the implementation of diversification strategies in order to reduce risk; it is measured by two indicator variables encompassing the trend to diversify sources of income and production, respectively. 'Optimize' relates to strategies that manage risk by optimizing the production process; it is built considering two indicators, modernization and enlargement of the farm scale. 'Coping' refers to dealing with the consequences of a given impact once it has happened as strategy for risk management; the tendency to work harder in times of financial hardship of risk is used as a single indicator for this latent strategy. The 'Off-farm' strategy is also assessed with a single item, reliance on off-farm income at the household level (OECD, 2009; Wauters, et al., 2014; Winsen et al., 2014).

Following recommendations of previous studies that warn against simplifying measurement of risk perception (Mellers & Chang, 1994; Winsen et al., 2014), we adopted a higher order model to assess this dimension of risk. A second-order latent variable was built to assess risk perception as the combination of two dimensions: the perceived probability of an uncertain event happening and the perceived impact of the different risk sources. To structure the first-order construct, we developed a multidimensional risk perception scale and took into account four categories of risk sources (observed variables): price, production, institutional and commercialization¹⁵ (Harwood et al., 1999; OECD, 2009; Winsen et al., 2014). We asked farmers to score, for each of these risk sources, their perceived probability (on a 7-point scale from 1 (very unlikely) to 7 (very likely)) and their perceived impact (from 1 (very small impact) to 7 (very big impact)). We modelled risk perception as a reflective-reflective second-order latent variable since we expected both the observable and first-order latent variables to fulfil Jarvis, MacKenzie, & Podsakoff (2003) criteria for reflective measurement theory, which was empirically evaluated with confirmatory tetrad analysis (CTA) (see below).

To elicit producers' risk attitude, we used a series of lottery-based experiments proposed by Tanaka, Camerer, & Nguyen (2010), hereafter TCN, and Liu (2013). TCN is an elicitation technique based on lottery tasks with a large number of independent binary choices in the form of a multiple price list (MPL) and it has already been tested amongst farmers in different developing countries (cf. Cárcamo & von Cramon-Taubadel, 2016; Hey & Orme, 1994; Liu, 2013; Stott, 2006; Tanaka et al., 2010; Ward & Singh, 2015).

¹⁵ For the Perceived Probability dimension, we considered three categories of risk sources, since the Production category did not meet some of the structural equation modeling requirements.

We followed the procedure detailed by these previous studies where during the experiment farmers faced three series of binary choices to elicit their risk. The two series consisted of 14 rounds and the last one of 7 rounds. In total, producers were presented with 35 rounds of choices. In each of them, the farmer had to decide which lottery he would choose. In the first two series, each round was composed of a safe lottery (lottery A) with constant payoffs across all rounds, and a risk lottery (lottery B) with increased payoffs as the rounds progressed. Farmers would win a certain amount of money, if the winning outcome in lottery B involved a larger payment. In contrast, in the third series there was no certain outcome in lottery A, since both lotteries A and B involved winning and losing outcomes.

We informed the producers that they could switch their preferences in each series from lottery A to lottery B at most one time (monotonic switching)¹⁶. The switching point is useful for identifying the underlying behavioral parameters, for which we applied the midpoint method (Liu, 2013; Q. Nguyen, 2011; Tanaka et al., 2010; Ward & Singh, 2015). The switching points in Series 1 and 2 jointly determine risk aversion (σ) and probability weighting (α) parameters, while the switching point in Series 3 determines the loss aversion parameter (λ). We present the details of the experimental design and its mathematical implications in Appendix B.

Table 4.3.1 Latent variables assessed and description of their indicators

Latent Variable	Indicators	Code	To what extent do you agree with the following statements (1 Strongly disagree - 7 Strongly agree)
RISK MANAGEMENT STRATEGIES (RMS)	Diversify	RMSDI1	Plant different products at the same
		RMSDI2	Maintain different sources of income (sale of products, agricultural tourism)
	Optimize	RMSOP1	Invest in technical improvements of the farm
		RMSOP2	Invertir en ampliar los terrenos de la finca
	Coping	RMSCO1	Work harder in bad times
	Off-farm	RMSOF1	Obtener ingresos fuera de la finca
RISK PERCEPTION (RP)	Perceived Probability (PP)		
	Comercialization (COMPP)	PPCOM1	Lack of policies to improve marketing conditions
		PPCOM2	Disrespect for the contract conditions by companies (Ingenio Valdez, exporters, etc.)
		PPCOM3	Mixtures between National Cacao and CCN-51 at the time of sale

¹⁶ The options of never switching (always choosing lottery A) or switching at row 1 (always choosing lottery B) were also available to all of the participants.

	Institutional (INSP)	PPINST1	Unexpected changes in government economic policies, causing negative impact on the farm	
		PPINST2	Disappearance of the government program to support the National Cacao	
		PPINST3	Discrimination in the delivery of seeds and supplies	
	Price (PRIPP)	PPPRIC1	Excessive decrease in the prices of commercialization of their agricultural products	
		PPPRIC2	Excessive increase in costs of agricultural inputs	
		PPPRIC3	Very little income compared to costs for a long period of time	
	Perceived Impact (PI)			
	Comercialization (COMPI)	PIMPCOM1	Increase in intermediaries, who get the most profit	
		PIMPCOM2	Disrespect for the contract conditions by companies (Ingenio Valdez, exporters, etc.)	
		PIMPCOM3	Mixtures between National Cacao and CCN-51 at the time of sale	
	Institutional (INSPI)	PIMPINST1	Unexpected changes in government economic policies, causing negative impact on the farm	
		PIMPINST2	Cancellation of agricultural aid programs by the government (kits, insurance, training, etc.)	
		PIMPINST3	Disappearance of agricultural associations in the sector	
	Price (PRIPI)	PIMPRIC1	Excessive decrease in the prices of commercialization of their agricultural products	
		PIMPRIC2	Excessive increase in costs of agricultural inputs	
		PIMPRIC3	Very little income compared to costs for a long period of time	
	Production (PROPI)	PIMPRO1	Loss of production due to excess rainfall	
		PIMPRO2	Loss of production due to severe drought	
		PIMPRO3	Loss of production due to pests and diseases	
	RISK ATTITUDE (RA)	Risk Aversion (σ)	-	-
		Loss Aversion (λ)	-	-
Probability weighting (α)		-	-	

4.3.3 Analytical procedures

The theoretical model was tested by an empirical application, using variance-based structural equation modelling (SEM) with partial least squares (PLS) (Hair et al., 2017; Hair et al., 2011; Lohmöller, 1989; Wold, 1982). PLS-SEM estimates the parameters of a set of equations in a structural equation model by combining principal components analysis and

regression-based path analysis (Mateos-Aparicio, 2011; Ringle, 2018). This technique allows the incorporation of unobservable constructs measured by indicators or observed variables and its application develops in two stages: 1) specifying the structural or inner model, by means of establishing links between constructs through a set of paths, which usually reflect the hypotheses, based on a priori established theories or concepts; 2) specifying the measurement or outer model, by means determine the relationships between the constructs and their corresponding indicator variables (reflective or formative), based on a measurement theory that allows obtaining reliable and valid measurements; PLS use a set of tests to validate the results obtained in these stages (Chin, 1998; Hair et al., 2017).

Also, PLS-SEM path modelling is a suitable tool to avoid measurement model misspecification that can result in inaccurate estimates of the parameters. PLS-SEM uses the confirmatory tetrad analysis (CTA-PLS) that enables researchers to empirically evaluate whether the measurement model specification chosen and based on theoretical ground is supported by the data (Hair et al., 2017; Rigdon, 2005). All measurement models were considered as reflective and empirically tested with the CTA-PLS procedure.

Furthermore, PLS-SEM allows considering those situations in which the strength or even the direction of a relationship between two constructs depends on a third variable (i.e. indirect or mediating effects), and thus, a change in the exogenous construct results in a change of the mediator variable, which, in turn, changes the endogenous construct (Hair et al., 2017; Nitzl et al., 2016). This type of relationship was proposed and tested in our model.

Finally, we use PLS-SEM due to its suitability to examine complex constructs that can also be operationalized at higher levels of abstraction, allowing for more parsimony and reduced model complexity while increasing the bandwidth of content covered by the respective constructs (Edwards, 2001; Lohmöller, 1989; C. M. Ringle et al., 2018). This procedure, usually referred to in the context of PLS-SEM as hierarchical component models (HCMs), allowed us to using in our model a number of first-order constructs to measure a second-order construct.

In spite of the possibilities offered by PLS-SEM, to the authors' knowledge, no previous studies exist about risk behavior in developing countries that apply variance-based SEM models in agricultural contexts (Chen, 2013; Fahad et al., 2018; Franken et al., 2017).

4.4 Results

The structural equation model shown in Figure 4.4.1 serves to evaluate empirically the hypotheses stated above. This model focuses on the role of the two main components of perceived risk, perceived probability and perceived impact, as mediating the relationship between risk attitude and risk management strategies. Figure 4.4.1 displays the structural model results. We argue that perceived probability, perceived impact and risk management strategies, should be modelled as a reflective-reflective second-order latent variables. In the next section, the risk attitude parameters corresponding to the lower-order measurement model are assessed and then the higher-order construct is evaluated.

4.4.1 Estimation of risk attitude parameters

The estimates obtained for the experimental lottery procedure to measure risk attitudes of producers are shown in Table 4.4.1. Results are significantly different from zero for the three estimated parameters ($p < 0.001$). The probability weighting function parameter (α) shows a value significantly lower than 1 while the loss aversion parameter (λ) shows a value significantly higher than 1 (in both cases at 99 percent significance level ($p < 0.001$)). This implies that producers are risk and loss averse.

The average of the coefficient of loss aversion (σ) is 0.499, indicating that cacao producers are risk averse, what is in line with findings of previous authors Harrison et al. (2010) report values of 0.464 and Liu (2013) reports value of 0.48). The average value obtained for the probability weighting parameter (α) is 0.823, suggesting that producers distort the probabilities of unlikely extreme events. This is similar to findings by (Cárcamo et al. (2016) (0.849) and Ward & Singh (2015) (0.74). The value of the coefficient of loss aversion indicates that producers are roughly three and a half times more sensitive to losses than they are to gains. These results are consistent with those of Liu (2013) (3.47) and Nguyen (2011) (3.255).

Table 4.4.1 Estimates of risk attitude parameters

Parameter	Description	Mean	Standard Deviation
Σ	Coefficient of risk aversion	0.499***	0.258
A	Probability weighting function parameter	0.823***	0.420
Λ	Coefficient of loss aversion	3.428***	2.556

*** $p < 0.001$.

4.4.2 The structural equation model

The structural equation model shown in Figure 4.4.1 serves to evaluate empirically the formulated hypotheses. This model focuses on the direct influence of the first-order constructs risk aversion and loss aversion, and the direct and indirect influence of the second-order constructs perceived probability (PP) and perceived impact (PI), on the risk management strategy construct (RMS). In the following sections, the measurement model is assessed, followed by the assessment of the structural model results. Finally, the mediation role of perceived probability and perceived impact is also examined.

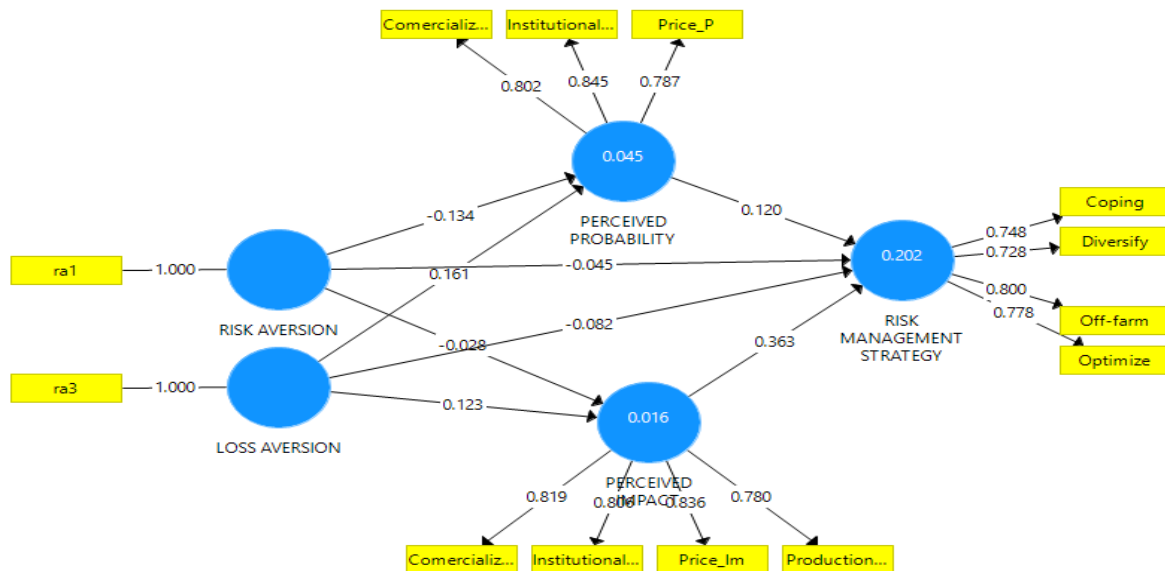


Figure 4.4.1 Conceptual model for determine the small cacao producers' risk behaviour

Note: We used a bootstrapping routine (Hair et al., 2017) with 5000 subsamples, 188 observations per subsample, and a no sign change option to determine the significance of the path coefficients

4.4.3 Measurement model assessment

Second-order latent variables need to fulfil measurement requirements (Edwards, 2001) in order not to be questioned. According to Gudergan et al. (2008), the confirmatory tetrad analysis for PLS-SEM (CTA-PLS) can validate the appropriateness of a reflective measurement model specification, while according to (Chin, 1998), the reflective or common factor measurement variables are assessed in terms of internal consistency reliability, convergent validity and discriminant validity. Cronbach's α , composite reliability (CR) and Dijkstra–Henseler's rho (ρ_A) were employed to test reliability while indicator reliability and average extracted variance (AVE) were used to evaluate convergent validity. Discriminant validity was assessed using the Fornell and Larcker cross-loading and heterotrait–monotrait

ratio of correlations (HTMT) (Hair et al., 2017; Henseler et al., 2015). In the case of the variables corresponding to risk attitude, these measures are not applied since they are one-dimensional constructs. The statistics used to confirm the validity of the second-order latent variables are summarized in Table 4.4.2.

Table 4.4.2 Summary results for convergent validity and internal consistency reliability of the three reflective measurement models

Latent Variable	Indicators	Convergent Validity		Internal Consistency Reliability		
		Loadings	AVE	Dijkstra-Henseler's rho (ρA)	Composite Reliability	Cronbach's Alpha
		> 0.70	> 0.50	> 0.70	0.70-0.90	0.70-0.90
RISK ATTITUDE	Risk Aversion	-	-	-	-	-
	Loss Aversion	-	-	-	-	-
RISK PERCEPTION	Perceived Probability		0.659	0.745	0.853	0.741
	COMPP (Comercialization)	0.802***				
	INSPP (Institutional)	0.845***				
	PRIPP (Price)	0.787***				
	Perceived Impact		0.657	0.827	0.884	0.826
	COMPI (Comercialization)	0.819***				
	INSPI (Institutional)	0.806***				
	PRIPi (Price)	0.836***				
	PROPI (Production)	0.780***				
RISK MANAGEMENT STRATEGIES	Coping	0.748***	0.584	0.780	0.849	0.765
	Diversify	0.728***				
	Off-farm	0.800***				
	Optimize	0.788***				

***p < 0.01 based on a two-tailed *t*-test for *t* (4999).

The reliability indicator specifies which part of an indicator variance can be explained by the underlying latent variable and it is measured by indicator loadings criterion. High outer loadings on a construct shows that the associated indicators are highly related (Götz et al., 2010). All indicators of PP, PI and RMS constructs, retrieved values above the threshold value of 0.70 (Hair et al., 2017) (Table 4.4.2), indicating their reliability (Henseler et al., 2009), while the second-order latent variables' measurement model yielded a good performance. Therefore, the conceptualization of risk perception and risk management strategy as second-order constructs ensured that relevant theoretical components were not missing while model parsimony is achieved.

The convergent validity is also measured by the average variance extracted (AVE) criterion (Fornell & Larcker, 1981). AVE values above 0.5 are recommended as threshold value (Chin, 1998; Henseler et al., 2009) since it indicates that more than 50% of the variance of the reflective indicators has been accounted for by the latent variable. Results showed that all the AVEs were greater than threshold value for PP, PI and RMS (Table 4.4.2), indicating that all items are explaining their corresponding underlying latent construct. Finally, we note that convergent validity is not evaluated for single constructs such as risk aversion and loss aversion (Hair et al., 2017). Internal consistency reliability is assessed by ensuring that estimates for Cronbach's α (Cronbach, 1951), CR (Chin, 2010) and ρ_A (Dijkstra & Henseler, 2015) are higher than 0.70 and below 0.90 (Hair et al., 2017). The simultaneous assessment of these three indicators is undertaken due to: i) Cronbach's α tendency to underestimate the true reliability (and thus working as a lower bound), ii) CR tendency to overestimate it (acting then as an upper bound), while iii) ρ_A is considered an approximately exact reliability measure of the PLS-SEM composites. The performance of these indicators suggests that all of them should be reported for a robust check of internal consistency reliability (Hair et al., 2017; Ringle et al., 2018). In our model, PP, PI and RMS showed values within the recommended thresholds (Table 4.4.2), indicating that the correlations between the items are large and, therefore, all constructs in the model were properly measured by their corresponding indicators.

In this study the confirmatory tetrad analysis (CTA) was performed to verify the reflective nature of the second-order constructs. The null hypothesis for this test considers all tetrads (i.e. covariance pairs for the indicator variables) in a measurement model equal zero. If a

reported confidence interval for the covariance includes zero, the null hypothesis is confirmed and the reflective direction of relationships of the measurement model cannot be rejected (Gudergan et al., 2008; Hair et al., 2018). Since CTA-PLS test requires at least four items per construct, we applied this test for PI and RMS constructs. The results showed that all non-redundant tetrads of PI and RMS supported the measurement specifications as reflective models (Table 4.4.3).

Table 4.4.3 Confirmatory tetrad analysis results for Perceived Impact and Risk Management Strategy

Latent Variables	Model-implied non-redundant vanishing tetrad	Tetrad value	Bootstrap SD	Bootstrap t value	p value	$CI_{adj.}^a$
Perceived impact	1: COMPI,INSPI,PRIPI,PROPI	0.065	0.044	1.497	0.135	[-0.018; 0.153]
	2: COMPI,INSPI,PRIPI,PROPI	0.016	0.049	0.331	0.741	[-0.079; 0.114]
Risk Management Strategy	1: Coping, Diversify, Off-farm, Optimize	-0.022	0.036	0.595	0.552	[-0.094; 0.048]
	2: Coping, Diversify, Optimize, Off-farm	-0.139	0.082	1.696	0.09	[-0.303; 0.019]

a $CI_{adj.}$ = 90% bias-corrected and Bonferroni-adjusted bootstrap confidence intervals.

The heterotrait–monotrait ratio of correlations (HTMT) is adopted to assess discriminant validity due to its superior performance compared to the Fornell-Larcker criterion and to the cross-loadings technique (Fornell & Larcker, 1981; Henseler et al., 2015). HTMT is defined as the mean value of the indicator correlations across constructs (i.e. the heterotrait-heteromethod correlations) relative to the (geometric) mean of the average correlations of the indicators measuring the same construct (Ringle et al., 2018). The HTMT estimates are evaluated against the threshold values of either 0.85 (more conservative criterion; (Kline, 2011) or 0.90 (in the special case of conceptually similar constructs (Gold et al., 2001)). Table 4.4.4 shows HTMT values for all pairs of constructs in a matrix format. As can be seen, all HTMT values are lower than the more conservative threshold value of 0.85. These results indicate that the different constructs used in our model are truly distinct from each other, in terms of both correlation and indicators representing a single construct (Hair et al., 2018).

Table 4.4.4 Discriminant validity results following the heterotrait-monotrait ratio of correlations (HTMT criterion)

Latent Variable	LOSS AVERSION	PI	PB	RISK AVERSION	RMS
LOSS AVERSION					
PERCEIVED IMPACT	0.136				
PERCEIVED PROBABILITY	0.190	0.816			
RISK AVERSION	0.035	0.051	0.161		
RISK MANAGEMENT STRATEGY	0.028	0.523	0.450	0.089	

4.4.4 Structural model assessment

Once we have confirmed that the construct measures are reliable and valid, we proceed to examine the structural model path coefficients as well as its explanatory and predictive power. For the evaluation of the path coefficients, the collinearity (variance inflation factor) between the latent variables was estimated as well as their significance and relevance, while the evaluation of the model predictive quality include the determination coefficient R^2 , the effect size f^2 and the Stone-Geisser-criterion (Q^2).

Assessment of collinearity in the structural model was performed through the estimation of the variance inflation factor (VIF). The highest inner VIF value was 1.73, well below the threshold value of 5 (Hair et al., 2011) and the more stringent criterion of 3.3 (Diamantopoulos & Siguaw, 2006), indicating that the structural model and predictor variables were free of multicollinearity (Table 4.4.5).

Table 4.4.5 Variance inflation factor (VIF) values in the Structural Model

	LOSS AVERSION	PERCEIVED IMPACT	PERCEIVED PROBABILITY	RISK AVERSION	RISK MANAGEMENT STRATEGY
LOSS AVERSION		1.001	1.001		1.029
PERCEIVED IMPACT					1.677
PERCEIVED PROBABILITY					1.728
RISK AVERSION		1.001	1.001		1.026
RISK MANAGEMENT STRATEGY					

To assess the extent to which the data reflect the hypothesized relationships, the standardized path coefficients are examined through parametric tests to obtain t or p values

(Ringle et al., 2018). Since PLS-SEM technique does not require that the data are normally distributed, parametric significance tests may provide misleading results when applied to test the significance of path coefficients (Davison & Hinkley, 1997; Efron & Tibshirani, 1986). Therefore, recent studies (Aguirre-Urreta & Rönkkö, 2018; Hair et al., 2017; Ringle et al., 2018) rather suggest using bias-corrected and accelerated (BCa) bootstrap confidence intervals to test the significance of all structural model relationships. When the confidence interval in bootstrap test does not encompass zero, the hypothesis that the path equals zero is rejected and a significant effect is assumed for the path coefficient. Table 4.4.6 shows the confidence intervals for the path coefficients in our model.

Hypotheses H2, H7 and H8 are supported by our results indicating that there is: i) a significant and positive association between perceived impact of risk and risk management strategies, ii) a significant and positive association between loss aversion and perceived probability of risk, and iii) finally a significant and positive association between loss aversion and perceived impact of risk. Hypothesis H5 is significant but with sign opposed to the initially hypothesized, that is, there is a significant and negative association between risk aversion and perceived probability of risk. On the contrary, hypotheses H1, H3, H4 and H6 are not supported by our findings. Non-significant results were found for: i) the positive association between perceived probability of risk and risk management strategy, ii) the negative relation between risk aversion and risk management strategies, iii) the negative relation between loss aversion and risk management strategies, and finally iv) the positive relation between risk aversion and perceived impact of risk.

Table 4.4.6 Results of the significance test for the Structural Model Paths

Hypotheses	Path	Path Coefficients	95% Confidence Intervals	Hypothesis results ^a
H1	PP → RMS	0.120	[0.004, 0.260]	Not supported
H2	PI → RMS	0.363	[0.203, 0.561]	Supported
H3	RISK AVERSION → RMS	-0.045	[-0.158, 0.065]	Not supported
H4	LOSS AVERSION → RMS	-0.082	[0.190, 0.026]	Not supported
H5	RISK AVERSION → PP	-0.134	[-0.249, -0.027]	Opposite to supported
H6	RISK AVERSION → PI	-0.028	[-0.153, 0.091]	Not supported
H7	LOSS AVERSION → PP	0.161	[0.041, 0.276]	Supported
H8	LOSS AVERSION → PI	0.123	[0.002, 0.239]	Supported

^a Significance level of $p < 0.05$ with 5000 sub-samples bootstrapping.

The predictive power of the research model can be evaluated by means of the coefficient of determination R^2 that measures the model predictive accuracy. It can also be viewed as the

combined effect of the exogenous variables on endogenous variables, representing a measure of in-sample predictive power (Chea, 2018; Rigdon, 2012). The overall potential explanatory power of behavioral risk in the model equals 20.2% (R^2 for RMS is 0.202; Figure 4.4.1). Values of R^2 for the latent constructs are shown in Table 4.4.7. According to Hair et al. (2017; 2011), R^2 values of 0.25, 0.50, and 0.75 represent weak, moderate, and substantial predictive levels respectively, although these authors also recognize that it is difficult to provide rules of thumb for threshold R^2 values since these highly depend on the model complexity. Since R^2 may be biased towards models with many exogenous constructs to explain an endogenous latent variable in the structural model (Hair et al., 2017), we also estimated the values for the adjusted coefficient of determination (R^2_{adj}) that takes into account the number of independent variables. Table 4.4.7 shows that the R^2_{adj} value of RMS does not differ substantially with respect to R^2 .

Blindfolding and predictive relevance Q^2 . The assessment of model predictive quality is improved by accounting for the out-of-sample predictive power proxy that uses the Stone-Geisser's Q^2 value (Geisser, 1974; Stone, 1974). This is obtained through blindfolding procedure, a sample reuse technique that excludes every data point in the endogenous construct's indicators and approximates the parameters with the staying data points (Hair et al., 2017; Henseler et al., 2009; Ringle et al., 2018). Hair et al., (2017) suggested that the blindfolding procedure should be applied to endogenous constructs that have a reflective measurement only. Q^2 values bigger than zero indicate the model has predictive relevance for that endogenous construct. Q^2 values of all endogenous constructs PI, PP and RMS are above zero and hence provide clear support for the model predictive relevance regarding endogenous latent variables in the risk behavioral model.

Table 4.4.7 Indicators of the model in-sample and out-of-sample predictive power

	R^2	R^2_{adj}	Q^2
PERCEIVED IMPACT	0.016	0.005	0.003
PERCEIVED PROBABILITY	0.045	0.035	0.021
RISK MANAGEMENT STRATEGY	0.202	0.184	0.093

In addition to R^2 values, the change in the effect size parameter f^2 is evaluated when a specified exogenous construct is omitted from the model, allowing to evaluating whether the omitted construct has a substantive impact on the endogenous constructs (Hair et al., 2017). We adopted threshold values for effects size following Cohen's (1988) guideline for small

(0.02), medium (0.15) and large (0.35) effect size. In Table 4.4.8 we can see that loss aversion has a small effect on PP (0.027), and PI has a small effect on RMS (0.098). That is, exclusion of loss aversion and/or PI from the path model, causes the R2 value dropping for PP and RMS respectively. These results complement the bootstrap test results which showed a significant effect between these endogenous and exogenous constructs, corresponding to the hypotheses H2 and H7, that have, thus, a significant impact with small effect. Therefore, in this study, loss aversion is the best significant predictor of perceived probability while perceived impact of risk is the best significant predictor of risk management strategy.

Table 4.4.8 The effect size (f^2) of exogenous constructs on the endogenous constructs

	LOSS AVERSION	PI	PP	RISK AVERSION	RMS
LOSS AVERSION		0.015	0.027		0.008
PI					0.098
PP					0.010
RISK AVERSION		0.001	0.019		0.002
RMS					

4.4.5 Mediation analysis

To gain a better understanding of the role of risk perception (PP and PI) in our model, we analyzed its potential mediating effect between risk attitude (risk aversion and loss aversion) and risk management strategy. More specifically, H9–H12 in our research model represent mediation hypotheses, which posit how, or by what means, independent variables (risk aversion and loss aversion) affect a dependent variable (risk management strategy) through mediating ones (perceived probability and perceived impact).

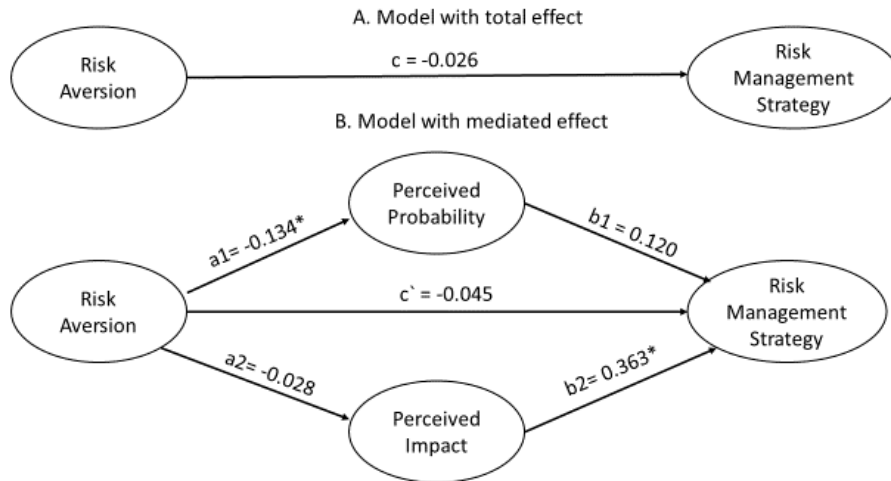
Mediation can be either full or partial. A full mediation occurs when the effect of the independent variables on endogenous variable is completely transmitted with the help of the mediator variables, that is, the influence of the independent variables on the dependent variable (direct effect) is not significant, but the influence of the mediating variables on the dependent variable (indirect effect) is significant. Technically speaking, in a full mediation scenario the independent variable exerts its influence only under the presence of the mediator variable on dependent variable. All other situations under the condition that both the direct effect and the indirect effect are significant represent partial mediation (Cepeda et al., 2017; Hair et al., 2017).

For testing indirect effects we followed the procedure developed by (Chin, 2010) and Nitzl et al. (2016) - due to its flexibility regarding distributional assumptions. The nonparametric bootstrapping procedure involves two steps: (i) determining the significance of the direct and indirect effects and (ii) determining the type of effect and/or of mediation (see Cepeda et al., 2017 and Nitzl et al., 2016 for mor details).

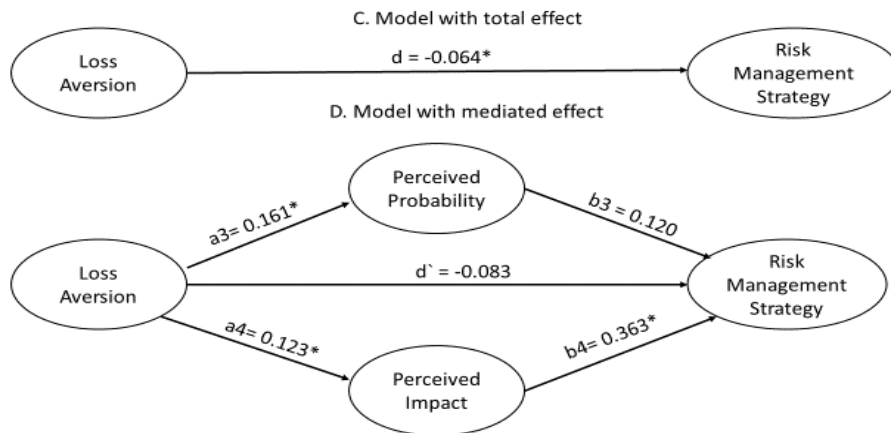
Several indirect effects are tested in this model: i) Risk attitude on RMS, estimated by the product of the path coefficients and each of the paths in the mediation chain (represented by a_1b_1 and a_2b_2 in the Figure 2), ii) Loss Aversion on RMS (a_3b_3 and a_4b_4), iii) Risk aversion and Loss Aversion on RMS (c' and d' respectively) and iv) the total effects (c and d respectively), the latter being estimated by the sum of the direct and indirect effects. Following (Chin, 2010), we include both the direct and the indirect paths and perform N bootstrap resampling, calculate the product of the direct paths that form the indirect path under assessment, and estimate their significance using percentile bootstrap. This generates a 95% confidence interval for mediators. When zero is excluded from the interval, the indirect effect is significantly different from zero at 95% confidence.

As section b of Figure 4.4.2 and Table 4.4.9 show, loss aversion has a significant total effect on RMS through perceived impact, indicating that H12 is supported. When mediators are introduced (section d), loss aversion no longer has a significant direct effect on RMS (H4). This means that the perceived risk probability fully mediates the influence of loss aversion on RMS (Baron & Kenny, 1986; Nitzl et al., 2016). The other mediation effects are rejected and therefore H9, H10 and H11 are not supported.

Once determined the significance of the mediation effects of perceived risk impact the type of mediation and its magnitude are assessed. Given that the direct relation between loss aversion and RMS is not significant, and both the indirect and the total effects are significant, there is a full mediation of perceived impact of risk between loss aversion and RMS.



- H3: Risk Aversion \rightarrow RMS = c'
H9: Risk Aversion \rightarrow Perceived Probability \rightarrow RMS = a_1b_1
H10: Risk Aversion \rightarrow Perceived Impact \rightarrow RMS = a_2b_2



- H4: Loss Aversion \rightarrow RMS = d'
H11: Loss Aversion \rightarrow Perceived Probability \rightarrow RMS = a_3b_3
H12: Loss Aversion \rightarrow Perceived Impact \rightarrow RMS = a_4b_4

Figure 4.4.2 Path mediation model

**p*<0.05

Table 4.4.9 Summary of mediating effects tests (see Figure 2 for full comprehension of the mediation effects tested).

	Coefficient	Bootstrap 90% confidence interval			
		Percentile		BC	
		Lower	Upper	Lower	Upper
Direct effects					
H3: c'	-0.045	-0.159	0.065	-0.156	0.068
a_1	-0.134**	-0.246	-0.024	-0.245	-0.023
a_2	-0.028	-0.153	0.096	-0.153	0.096
b_1	0.120	-0.012	0.260	-0.015	0.257
b_2	0.363**	0.202	0.531	0.194	0.523
H4: d'	-0.082	-0.189	0.027	-0.188	0.028
a_3	0.161**	0.042	0.282	0.041	0.281
a_4	0.123**	0.004	0.239	0.004	0.239
b_3	0.120	-0.012	0.260	-0.015	0.257
b_4	0.363**	0.202	0.531	0.194	0.523
Indirect effects	Point estimate	Percentile		BC	
H9: a_1b_1	-0.016	-0.044	0.002	-0.044	0.003
H10: a_2b_2	-0.010	-0.058	0.036	-0.058	0.036
Total indirect effect	-0.026	-0.085	0.031	-0.085	0.031
H11: a_3b_3	0.019	-0.002	0.052	-0.003	0.052
H12: a_4b_4	0.044	0.002	0.103	0.000	0.102
Total indirect effect	0.064	0.009	0.124	0.007	0.122

** $p < 0.05$ based on a one-tailed t -test for t (4999)

BC: bias corrected.

4.5 Discussion and Conclusions

National and international policies have led countries to reorientate their agricultural policies towards deregulation and a more market-oriented approach. This is the case for Ecuadorian cacao production, considered also a global commodity. The protection that farmers may have from the market volatility has been removed with risk dimensions adding a significant degree of complexity to decision analysis (Hardaker et al., 2015). This adds to the numerous exogenous factors to agricultural production where risk is omnipresent in farming decisions (Menapace et al., 2016).

Despite farmers of the world have always understood the existence of risk and have adjusted to it when running their farms, rather little practical use has been made of formal methods of risk analysis in agriculture (Hardaker et al., 2015). Understanding farmers' decisions

under risk and uncertainty can help to steer the policy in the right direction so that the objectives of the policy are realized (Wauters et al., 2014).

The way smallholders perceive and manage the multiple risks that may affect their agricultural production has been assessed by a number of authors and studies in a partial way (Akhtar et al., 2018; Riwthong, Schreinemachers, Grovermann, & Berger, 2017; Velandia, Rejesus, Knight, & Sherrick, 2009). The multidimensional framework adopted by this study shows the appropriateness of joint assessment of the different dimensions of risk for an adequate comprehension of small farmers' rationale when dealing with risk.

Our work investigates farmers' risk management at farm level and how risk perception and risk attitude dimensions influence both directly and indirectly on the implemented strategies. Similarly, to previous studies (e.g. (Assefa et al., 2017; Wauters et al., 2014; Winsen et al., 2014) we adopt a multidimensional and integrated perspective combining the main risk components, i.e. risk attitude, risk perception and risk management strategies. Analysing the two later as higher-order constructs and the former through lotteries, allows to parsimoniously investigate their relationships.

Most studies that analyze producers' risk preferences focus on the influence of these preferences on farm-related decisions such as technology adoption, agricultural insurance uptake, and crop diversification (Liu, 2012; McIntosh et al., 2019; Nguyen, 2011; Tanaka et al., 2010; Ward & Singh, 2015). However, the factors that influence a producer's risk and preferences have been scarcely explored in developing countries (Cárcamo et al., 2016). Similarly, few studies have tried to relate the different components of risk in a single model. Winsen et al. (2014) assesses the three dimensions tested in our study, although pointing our model limitations that may arise due to elicitation method of respondents' risk attitude through responses to a series of statements and whose validity is questioned by some authors (Hellerstein et al., 2013). Indeed, although risk attitudes can be studied from different theoretical frameworks, some studies found that Likert scale and non-incentivized framed survey questions are not sufficient substitutes for incentivized methods, like lottery-choice tasks, especially in developing countries (Cárcamo & von Cramon-Taubadel, 2016; Liu & Huang, 2013; Sanou et al., 2017; Ward & Singh, 2015). The behavioral model tested to understand the multidimensional relationships between risk attitude, risk perception and risk management strategies provides relevant insights to understand farmers' decisions under risk and uncertainty. Methodologically, our work contributes to risk analysis by adopting a more holistic perspective, integrating risk attitudes, perceptions and management

strategies in a single model that analyzes their mutual interactions including testing for mediation that may exist between some of its components and adopting lottery tasks for measurement of risk and loss aversion.

The relationships between the different risk components are assessed through a structural equation model where risk components were operationalized at higher levels of abstraction, that is, as hierarchical component models (HCMs). This modeling approach led to more parsimony and reduced model complexity. The appropriateness of a reflective-reflective second-order model specification to risk perception and risk management strategies is validated by confirmatory tetrad analysis (CTA-PLS). Although the R-squared values are low, the overall potential explanatory power of behavioral risk of our model (20%) is similar to that obtained on other studies (e.g. Dohmen et al., 2011, 22%; Nielsen et al., 2013, 23%). The model predictive relevance was good and five of the twelve tested hypotheses resulted in significant results, with one of the mediation hypotheses retrieving significant results. Our major finding is that it is risk perception (perceived risk impact) and not risk attitude, the dimension that has a direct significant impact on the intention of implementing risk management strategies, playing it also a mediating role between risk aversion and mitigation strategies. Risk perception has been signaled by previous studies as an important determinant of risk behavior (e.g. Boholm, 1998; Slovic et al., 1982; Winsen et al., 2014) and our study shows its role as direct and mediator influence.

Evidence in the literature on the effect of risk attitude and risk perception on risk behaviour (RMS) is non-conclusive. Studies such as these conducted by Sitkin and Pablo (1992) and Winsen et al. (2014) found out that the effect of risk attitude is more important than that of risk perception to determine risk behaviour, what is somewhat opposed to our results and those of Sitkin and Weingart (1995) and Keil et al. (2000). Contextual differences and controlling for individuals' perception have recently been shown to be relevant in risk elicitation methods (Meraner et al. (2018); Rommel et al. (2019)). Hence, some of these disparities in results may reside on these factors. Another source of disparities lies in our consideration of risk as influenced and affected by its three basic components which are mutually related; this perspective is scarcely adopted in risk studies, especially in rural developing countries (Asravor, 2018; Bishu, O'Reilly, Lahiff, & Steiner, 2016; Di Falco & Veronesi, 2014; Yesuf & Bluffstone, 2009). Finally, differences in results may reside in the assessment of risk elements as one-dimensional and/or multidimensional constructs. Studies like these conducted by Chen, 2013; Luo et al., 2010; Rezaei et al., 2016; Zhou et

al., 2018 have demonstrated the multidimensional nature of risk elements. Simulation studies such as Kuppelwieser & Sarstedt, 2014 have proven that the predictive validity of models is affected when multidimensional models are treated as one-dimensional, since dimension-specific effects become confounded in a composite effect.

Our findings counteract previous evidence found by (Holt & Laury, 2002; Menapace et al., 2012; Pennings & Leuthold, 2000) on the influence of risk attitude on risk perception. Their findings are not dependent on the approach used to measure risk attitudes, since some of them use experimental lotteries while others apply Likert scales.

Previous studies have shown how risk attitude influences risk perception while existing an indirect effect of that on risk behaviour (RMS) (Cho & Lee, 2006; Keil et al., 2000; Menapace et al., 2012; Nielsen et al., 2013; Sitkin & Pablo, 1992; Sitkin & Weingart, 1995). Our study adds to this evidence but analysing risk perception as a second-order construct.

In the literature, different experimental methods have been applied for eliciting risk attitudes. In fact, over the last decade approximately 20 new methods to elicit risk preferences have been published (Meraner et al., 2018). More recently some studies have applied different risk experiment methods in different contexts and have found correlation on the results when using incentivized experiments (Meraner et al., 2018; Rommel et al., 2019; Zhang et al., 2018) (e.g. Tanaka, Holt & Laury procedures) while this has rarely being the case with the non-incentivized risk measures (like Likert scale), recommending incentivize approaches for more robust results (Sauter et al. (2018)) especially in rural developing country settings (Sanou et al., 2017).

Risk attitudes are analyzed in our model through risk and loss aversion dimensions. Loss aversion impacts on RMS mediated by risk perception. Loss aversion influences on both perceived probability and impact of the different risk sources. We also found that the perceived impact of different risk sources plays a mediation role between loss aversion and RMS but we do not find empirical evidence that greater risk aversion or greater loss aversion are directly associated with a higher uptake probability of risk management tools. Therefore, the effect of risk perception on risk behavior is more important than the effect of risk attitude.

The implications of these findings are several. Accounting for loss aversion can make a difference in the design of effective and efficient risk management policies through contracts or insurance schemes, but is important to take into account the farmers' perceptions of risk sources, because those farmers who perceive more risk are significantly more likely to

implement these risk reducing strategies. Although risk attitudes in our model do not play a direct role in farmers' decisions to apply risk mitigation strategies, they have a significant influence on risk perceptions, especially aversion to loss. The fact that farmers are more sensitive to losses than to equivalent gains has already been found in other studies (Liu & Huang, 2013). In our experiments, farmers value losses more than gains of the same magnitude and therefore they tend to overweight low-probability extreme events, i.e. they are loss averse and hence exhibit an inverse S-shape probability weighting function, meaning that. These results support the design more effective and efficient policies that take account for the asymmetry between gain and loss outcomes and take into greater consideration low-probability extreme events.

The analysis of the two-dimensional construct employed to assess risk perception and its influence on risk management strategies shows that it is perceived impact and not perceived probability of risk that plays a role in the implementation of RMS, being the former the more significant while it simultaneously plays a mediator role between loss aversion and RMS. Thereby, these results suggest that RMS implemented by small farmers are mostly related to the consequences farmers foresee rather than to the probability of occurrence of the perceived risks. These farmers who have a higher perception of risk impact on their activities due the price volatility, exploitation from intermediaries or changes in agricultural government policies programs, are more inclined to implement any of the strategies abovementioned.

Our finding on the leading role of perceived impact over perceived probabilities of risk is in line with several risk perception studies carried out specially in European agriculture, for example in the Netherlands, Norway and Germany (Flaten et al., 2005; Meuwissen et al., 2001; Schaper et al., 2010; Wauters et al., 2014). However, there are far fewer studies carried out in developing countries that allow us to make comparisons. On the contrary, in the study conducted by (Winsen et al., 2014), none of the perceptions of any of the major risk sources has a significant impact on any of the intended risk behaviors. However, the authors multiplied the items of perceived probability and perceived impact and, as they recognize, this aspect may not provide a realistic measure. Since we consider the perceived probability and perceived impact as two dimensions of risk perception, which are initially treated separately as reflexive measures and which allowed us to form second level constructs.

Loading of convergent validity test for the reflective measurement model of PI shows that Price (PRIPI) is identified as the top rated source of risk, closely followed by Commercialization (COMPI). These results are somehow expected under current cacao value chain circumstances in Ecuador where small cacao farmers do not have differentiated value chains for commercialization of their two varieties of cacao (fine flavor cacao and the hybrid variety) and both are sold at the same prices in the local market (Díaz-Montenegro et al., 2018; Jano, 2007). In 2017, cacao prices in the local market were at their lowest level of the last 5 years. Furthermore, cacao production in Ecuador is highly fragmented, where 79% of producers are smallholders with plots of 1 to 5 hectares, and only 17% belongs to a producer association (MAGAP, 2018). This situation increases their vulnerability in the value chain where they act as mere price-takers with low negotiation capacity. Intermediaries control the local market and bridge the gap between producers and exporters. A common practice in negotiation is that intermediaries bring down the prices at farm gate; this has significantly worsened since the decrease of the world market price (Fountain & Huetz-Adams, 2018). In our survey, farmers were especially concerned about the excessive presence of intermediaries "who take the most of the profit". Farmers perceived the institutional dimension (INSPI) as the third most important source of risk. Farmers who participated in our study were especially concerned about the unexpected changes in the government's economic policies, the cancellation of the agricultural aid programs and / or the disappearance of the agricultural associations. Finally, the production (PROPI) scores in fourth place. Only 29% of Ecuadorian cacao producers have irrigation infrastructure, hence they consider drought an important source of risk, while "Moniliasis" is considered as the main pest that harms producers.

Our results on loadings of convergent validity tests for the reflective measurement models indicate that four of the six risk management strategies tested achieve high loadings (above 0.700), showing that on average sampled farmers do positively value implementing an array of strategies to reduce their vulnerability to different risk sources linked to their agricultural activity, using a large portfolio of different risk management strategies in order to react to different risk sources (Meraner & Finger, 2017; Wauters, et al., 2014; Winsen et al., 2014).

These results would call for integrated policies targeting the sources of risk through multidimensional strategies. Amongst the six strategies proposed in this work to manage risk, off-farm strategy scored the highest in accordance with previous studies that show how off-farm strategies in developing countries have shown to be the more rewarding in term of

income and wellbeing for the farm household, especially when off-farm labor entails non-agricultural activities (Díaz-Montenegro et al., 2018; Jansen et al., 2006; Nielsen et al., 2013; Walelign, 2016). Despite cacao being the main source of income for half of the cacao farmers in Ecuador (MAGAP, 2018), they also have a portfolio of off-farm activities, many of which are non-agricultural activities (Díaz-Montenegro et al., 2018). *Optimize* is the second most important strategy for risk management in our sample. Optimization relates to the production process such as investment in technical optimization of the farm, or investment in scale enlargement. The National program that Ecuador implemented since 2012 was directly targeted to optimizing strategies to support the production of fine flavor cacao in the country. However, these strategies on their own have proved insufficient to both reduce the vulnerability of small farmers and promote the cultivation of the fine flavor cacao variety (Díaz-Montenegro et al., 2018). *Coping* with the consequences that a given risk may produce, such as working harder in times of financial uncertainty, may help to mitigate impacts of risks. However, the results obtained in the measurement of perceived impact of risks may signal that these coping strategies are perceived as insufficient by farmers to deal with risk. Other studies like Hardaker et al., 2015; Harvey et al., 2014 identified a set of the risk coping strategies used by farmers, and highlight key adaptation needs, for example to climate change. *Diversify* is also perceived as a suitable risk management strategy by surveyed farmers. Diversification was presented to them as a mixture of activities covering several dimensions such as production or on-farm income (tourism, farmers market) whereas strategies such as postponing private purchases or keeping a money saved for bad times, do not result relevant for farmers.

Previous studies addressing farmer behavior toward risk, indicate that risk averse farmers tend to passively deal with risk and are less inclined to adopt ex-ante risk management strategies, rather relying on ex-post curative measures (Hellerstein et al., 2013; Winsen et al., 2014). On the contrary, the more risk seeking is a farmer, the more likely that he will implement ex-ante management strategies (Winsen et al., 2014). In our case, two of the strategies do not retrieve significant loadings in building the RMS construct, buffer and external, being the former a typical ex-post and the latter a typical ex-ante risk management measure. Non-significant results for “external” strategies may relate to the fact that in Ecuador counting on crop insurances or forward contracts is relatively uncommon. Similar results have been observed by previous studies showing that forward contracting or crop insurance strategies (gathered within the “external” strategy) are not seized by farmers who seem to put more faith in internal strategies (Wauters, et al., 2014).

In the case of Ecuador, policies to incentivize production of fine flavor cacao over the hybrid variety are showing little success so far (Díaz-Montenegro et al., 2018). Current national policies focus almost exclusively in one of the management strategies, crop technical management, while price and commercialization aspects remain unattended. Lack of security in terms of long-term policy application, may also prevent farmers to switch to fine flavor cacao cultivation, opting rather for off-farm activities that can easily be made compatible with planting the hybrid variety. Our results show some pathways that may contribute to steer policy in the right direction so that the two-fold objective of the policy of improving welfare of smallholders and booting fine flavor production are accomplished.

4.6 References

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Chapter 5: Conclusions

5.1 Conclusions

Cacao is a food product that can be considered a global commodity whose production is in the hands of smallholders that depend on its harvest as their main source of income. The widespread worsening of social and economic conditions in cacao producing countries as a result of those power imbalances have triggered a proliferation of public and private governance responses such as cooperative research, technical assistance, extension, and education on one hand, and standards and third-party certification schemes on the other hand, respectively. Some developing countries like Ecuador regard fine flavor cacao production as a suitable development strategy due to its premium price in international markets, considering that smallholders may improve their welfare status if able to connect directly with international markets. Some Latin American countries have led different cacao and fine flavor cacao initiatives. In the case of Ecuador, the government has implemented the National Cacao Reactivation Project (PRCN) since 2012. This program was namely focused on providing technical solutions for the improvement of farming practices of the Nacional cacao variety (CN) while actions focused on the value chain have been way less prominent.

This thesis addresses the situation of the Ecuadorian cacao value chain and the small cacao producers from a complex perspective, considering their productive activity from a complex perspective where livelihood strategies and risk dimensions are assessed. The approach adopted contributes to the literature on livelihood strategies' assessment adopting innovative methodological approaches to seize whether national policies are having the desired effect on promoting CN cacao variety and simultaneously improving the livelihood of smallholders. Furthermore, this work addresses risk from a multidimensional perspective contributing to understand how smallholders perceive and manage risk in their agricultural activities. The findings of this study may certainly contribute to a more targeted policy development that accounts for the rationality and productive strategies of smallholders for an increased achievement of development goals.

In this thesis the elements that characterize the value chain of cacao in Ecuador are analyzed in order to understand its dynamics and how these affect the small Ecuadorian cacao producer. Secondly, we tried to determine to what the extent the problems identified in the value chain have been tackled by the Ecuadorian national program (PRCN) aimed at promoting the traditional variety of national cacao (CN). This program aimed at creating a profile of a small cacao producer CN, which besides having incentives in the production

phase for this variety; also had market incentives that could make him chose this variety over the hybrid one. Finally, we are also interested in understanding the preferences and risk perceptions of these producers and how their interrelation ends up configuring their risk management strategies at the farm level.

The value chain of Ecuadorian cacao cannot be analyzed and understood without taking into account the characteristics and forms of development of the global cacao value chain. The analysis showed that the governance of the downstream stages of global cacao value chain is concentrated in few agents, creating a set of asymmetrical power relations that block the value transmission towards small producers upstream. The analysis of the value chain of fine cacao, on the other hand, casts serious doubts about the feasibility of small producers prioritizing its production. Since it is a reduced market (a 6% of the world production of cacao) difficult to reach by individual producers, it requires producers to associate while the price premium is not entirely guaranteed due to oversupply risks.

the analysis conducted in this thesis shows that underlying problems such as how the market defines price, the lack of bargaining power of farmers, market concentration in the hands of intermediaries, or the merge of the two cacao varieties in a single national value chain have not been considered in the PRCN program. As a result, the CCN-51 variety is still favored by Ecuadorian farmers, even more strongly nowadays than before PRCN program enacting due to its higher productivity and the lack of price differential between the two varieties. The situation described above suggests the need for a broader economic policy, not so focused on productive aspects but addressing also the market and association needs of small producers of the CN variety. Clear rules are also required to set the standards that the CN variety must fulfill in the commercialization process, together with the implementation of mechanisms that improve the bargaining power of the farmers. To summarize, the findings in this thesis call for the establishment of a differentiated value chain for the CN variety through which price, quality or associative features are differential factors that motivate the farmer to opt for the production of this variety.

An important challenge for Ecuador is to establish agricultural cooperatives at the national level that strengthen the associativity of this sector, currently at fairly low levels. Ecuadorian legislation sets the basis for it through the Law for the Popular and Solidarity Economy. Improving and promoting the cultivation of the fine flavor variety requires from policy makers a broader vision of the measures required that cannot be solely focused on serving the needs of the small farmer at the production level. In fact, these supports can be counteracted

by the difficulties they may find in terms of inadequate prices or barriers to access to the international market niches that characterize this variety.

Some of the problems and characteristics of the value chain of Ecuadorian cacao encountered in the first chapter of this thesis, were confirmed in the empirical analysis conducted in the fieldwork described in the second chapter of this thesis, carried out in nine municipalities in the Guayas province of Ecuador. This work built on previous studies assessing Ecuadorian cacao production (e.g., (Galarza, 2012; Melo & Hollander, 2013; Useche & Blare, 2013) and adopted a robust statistical approach aligned with the theoretical frameworks applied to investigate livelihood strategy profiles. Different from traditional cluster analysis (Babulo et al., 2008; Nielsen et al., 2013; Walelign et al., 2016), the improved latent class three-step approach allows for more statistically robust and less arbitrary final grouping and profile assignment (Bolck et al., 2004; Collins & Lanza, 2010; Magidson & Vermunt, 2002).

The results of this study reveal that the decision of small farmers to plant either one or other variety is framed within a larger economic-productive system. One of the most relevant findings of this second chapter was that CN cacao does not ensure the living conditions of small farmers, and accordingly the entire dedication to producing this variety is not found to be part of a specific livelihood strategy. The implications of this finding are crucial for the evaluation of the PRCN program that is being implemented with these small cacao producers. The outcomes of this study indicate that continuing with a “business-as-usual” policy will reduce the options to outline groups of farmers dedicated to this variety, since the market does not provide incentives for them to continue in this line of production.

Another important finding in this second study was that capital assets significantly determine the subsistence strategies of small farmers, which is in line with previous studies applied to rural contexts in developing countries. This aspect was practically ignored by the PRCN, which at no time proposed to provide at least the most basic assets (land, basic services, machinery) to small farmers. These assets play a dynamic role and are also the ones that allow them moving towards more rewarding life strategies. Without such asset endowments, cacao farmers are constrained by entry barriers (Amekawa, 2011). The PRCN program should consider building of a minimum stock of productive assets, without which the poorest may experience asset depletion and increased vulnerability (Donovan & Poole, 2013; Sheck et al., 2013).

A third important finding in this study was related to the differences in income structure that were shown between the groups. Among the four profiles identified, two of them had a major dependence on agricultural income at farm level (70%) while the two-remainder showed a less dependent structure (50%) and therefore more diversified sources of income, generated both in and off farm. Although there were no profiles that could be classified as CN “pure producers”, the profiles with less diversified income were those that had a greater dedication to the cultivation of this variety together with a smaller endowment of assets and a more intensive use of labor on their farms. Overall, this, these are highly vulnerable groups that will find unsurmountable difficulties to switch to more diversified strategies as long as their asset endowment is not improved. This finding allowed confirming the importance of asset endowment within any agricultural development strategy.

The third chapter presents an applied research related to how risk attitudes (RA) and risk perception (PR) of small cacao producers in Ecuador are interrelated to jointly determine their management strategies of risk (RMS). This study contributes to the body of literature on risk analysis in agriculture in two main ways. First risks are regarded from a holistic perspective that is as mutually influential components, distinguishing this study from most previous literature that addresses the components of the risk separately. Risk attitudes of farmers influence the way they perceive the probability of occurrence of adverse events, as well as their perception of impact severity of these events. In turn, both risk attitude and risk perception components determine the adoption of risk management strategies where the mediation role played by risk perception is also assessed. This work also contributed to risk literature by considering risk perception and risk management strategies as multidimensional constructs that can be operationalized at higher levels of abstraction. Higher-order models or hierarchical component models (HCMs) most often involve testing second-order structures that contain two layers of components (e.g., Ringle et al., 2012; Wetzels et al., 2009). Most of the studies in the field of risks applied to agriculture have considered risk components as one-dimensional constructions. Studies as Kuppelwieser & Sarstedt, 2014 have shown that that the unidimensional operationalization misleads researchers because dimension-specific effects become confounded in a composite effect.

Findings regarding risk attitude unveiled two key issues. First, loss aversion (and not risk aversion) influences on both perceived probability and impact of the different risk sources and second, none of the components of risk attitude (risk and loss aversion) have a significant impact on risk management strategies. The behavior of risk aversion is similar to

that found in previous studies and in the context small cacao producers it is highly relevant. These individuals will be more reluctant to join the value chain of cacao (in any of its two varieties) if they perceive that the potential losses are greater than the gains they could be obtaining. This highlights the need for clear policies that cover the different aspects of the value chain through production and market accessibility while simultaneously the incentives (e.g. technical assistance, associativity, premium price) are clearly established as benefits that the small producer will obtain by the production and marketing of their product.

Outcomes of risk perception assessment highlight the importance of influencing the perception of risk of small producers and more specifically their perception of the severity of the impact of adverse events, given that this element of risk exerts a direct influence on risk management strategies and also plays a mediator role between aversion and strategies. Within the context of our study, the lack of clear policies, especially for the CN variety, price volatility, or market relations are perceived as adverse situations whose potential occurrence influences the loss aversion and impact perception of the farmer. In fact, price (PRIPI) and commercialization (COMPI) were identified as the greatest sources of risk for farmers. Findings of this study may contribute to inform policy development to implement a set of targeted risk mitigation strategies to influence thereby the aversion to loss and the perception of the likelihood of impact.

Finally, farmers use a large portfolio of different risk management strategies in order to react to different risk sources. The off-farm strategies scored the highest in accordance with previous studies that show how off-farm strategies in developing countries have shown to be the more rewarding in term of income and wellbeing for the farm household, especially when off-farm labor entails non-agricultural activities (Díaz-Montenegro et al., 2018; Jansen et al., 2006; Nielsen et al., 2013; Walelign et al., 2016). These results would call for integrated policies targeting the sources of risk through multidimensional strategies, directed to the production, to the market, to the associativity and considering the production of cacao in any of its varieties as a subsystem within a larger agricultural system that should be considered in the design of any assistance program for small cacao producers of Ecuador.

5.2 Limitations and setbacks of the present study

Some of the limitations of this thesis relate namely to the methods used and the sampling process undertaken. Results should be interpreted with caution and extrapolation to other regions or scenarios is not straightforward as highlighted in these chapters as results of

similar studies conducted in other regions produced different results. This is specially the case of risk analysis where existing literature produces a dearth of results that are not necessarily aligned. In particular, empirical research aiming to elicit risk attitudes faces problems of within- and between-method inconsistencies, which reduce the explanatory and predictive power of risk research (Meraner et al., 2018). IN this thesis fieldwork was undertaken with low accounting of contextual framework which may have relevant influence on task involvement. Consideration of contextual may help reducing inconsistencies faced by risk assessment studies. Meraner et al., 2018 and Rommel et al., 2019 suggest that by framing a risk elicitation method according to the subjects' specific context, involvement can be triggered and inconsistencies and misspecifications can be reduced.

The analysis of farmers' livelihood profiles included a series of on-farm and off-farm activities carried out by farmers, but, in particular, off-farm activities were framed within this general denomination. A more detailed analysis with respect to both agricultural and non-agricultural activities that farmers carry out off-farm could have provided a broader discussion regarding what economic activities farmers specifically perform when they are outside of their farms. This would be important from the policy development point of view to consider these other productive activities that farmers may be engaged on. Acknowledging a broader spectrum of productive activities undertaken by small producers is methodologically challenging since data richness has to be combined with robust methodological assessment.

Despite the livelihood strategies' assessment and risk analysis study were undertaking with the same simple of smallholders, the analysis of each block of information was undertaken separately. This provides somehow disconnected results between livelihood profiles and risk behaviour. The methodological approach adopted does not allow testing the linkage between livelihood profiles and risk behaviour, and therefore whether a pool of capital assets or a given livelihood strategy contributes to differential risk behavioural patterns.

This study was conducted in a specific moment as a one-time observation of the effect of the PRCN program on the livelihood of the smallholders. Hence, the evaluation and conclusions derived on the effect of this policy are limited since longitudinal data could not be obtained due to time and budget constraints linked to this thesis.

Access to agricultural areas remains a problem in Ecuador. Much of the field research was developed in winter season when accessibility is reduced in certain rural areas where it was initially planned to collect information.

5.3 Future research lines

Future research lines that this study opens are two-fold: on the one hand these are related to improving the application of the methodologies presented in this work while on the other, focus on assessing cacao production in Ecuador through different methodological approaches that may allow deepening the understanding of the value chain functioning, providing valuable information for policy development.

The combination of the experimental lotteries with the subjects' specific contextual background (measured based on expert knowledge) would help to better contextualize some of the results obtained through these experiments. This combination of qualitative and quantitative methods is one of the greatest challenges facing the field of study of risks and that could help reduce inconsistencies between methods we have today.

The application of complementary methodologies such as choice experiments can complement our findings about risk behaviour, allowing determining how and why farmers prefer certain risk mitigation strategies from a different perspective to the one considered in our study.

Assessment of livelihood strategies can be undertaken in a more refined way considering with more detail the array of off-farm activities that smallholders are engaged in. As it was found out when carrying out the field work in this thesis, smallholders develop a broad number of activities that being properly captured would enable more targeted policy recommendations derived from livelihood assessment.

A combined analysis of asset mix, livelihood profiles and risks would allow to determining whether the risk behavior of smallholders is related to their membership to a given livelihood profile and asset mix. This would enable better and more targeted policy recommendations tailored for each profile.

Larger sample sizes than these used in this study would allow multi-group analysis, through which an analysis of risks applied to the different livelihood profiles can be carried out. This would allow, combining the methodologies applied in chapters 2 and 3, to determine risk behavior by farmers' livelihood profiles, helping to focus the policy by providing

Longitudinal data assessment by future assessment of livelihood strategies in the same region would allow to analysing whether the small farmers move among livelihood profiles or whether their risk behaviour varies over time.

Finally, this study opens a promising pathway to assess the value chain at the national level through direct interaction with key actors in the chain through in-depth interviews and participatory techniques with the key agents of the different steps, to better guide policy development.

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Appendices

Appendix A. Livelihood strategies of cacao producers in Ecuador: Effects of national policies to support cacao farmers and specialty cacao landraces

Latent profile analysis solution

LPA was applied in an iterative process by progressively increasing the number of profiles as long as each profile had a sufficient number of households (minimum of 5% of the sample) to reduce ulterior errors in the estimates of the profiles with the external variables. The eight activity variables were used as the indicator variables of the LPA model.

Bayesian Information Criteria (BIC) and Consistent Akaike Information Criterion (CAIC) information criterions suggested the 4-profile model fitted the data best, while Akaike Information Criterion (AIC) values dropped while increasing the number of profiles. Entropy values were always above 0.90 and showed the best results for 2-profile and 4-profile models, indicating adequate classification. These two profiles also showed the lower classification errors. A conditional bootstrap test was performed to assess the significance of the difference in the statistics associated with the 2 and 4-profiles models and indicated that the 4-profile model over performed to the 2-profile model. The 4-profile solution was chosen as the best-fit model since it provided the neatest difference among profiles and the most substantively interpretable results with a good balance between parsimony, fit and interpretability. The local independence also was tested. Its results and implications are show in Tables A.1, A.2 and A.3.

Correction methods

Several correction methods have been proposed in the literature. In this article we applied two of them. For Latent Profile Analysis (LPA) with covariates we used a maximum likelihood (ML) approach that involves estimating the profile-specific means and variances by maximum likelihood (Bakk et al., 2013; Vermunt, 2010). For LPA with distal outcomes we used an approach based on the work of Bolck et al. (2004), and Vermunt (2010) known as improved BCH (Bolck, Croon, and Hagenaars), that involves performing a weighted ANOVA, with weights that are inversely related to the classification error probabilities (Bakk et al., 2013; Vermunt, 2010).

Table A.1. Bivariate Residuals (BVR) of Activity variables for four-profile solution model

		a) BVR without direct effects						
Activity variables		1	2	3	4	5	6	7
1	On-farm family labor	.						
2	Off-farm family labor	2.078	.					
3	On-farm nonfamily labor	1.757	0.002	.				
4	CN	0.185	0.038	0.027	.			
5	CCN-51	0.258	0.084	0.020	41.893	.		
6	Transfer income	0.948	0.338	0.019	0.054	2.489	.	
7	Modality of off-farm family employment	0.000	0.489	0.005	0.310	0.529	0.020	.
8	Modality of on-farm nonfamily employment	0.263	0.010	5.148	0.006	0.028	0.002	0.0367
		b) BVR with direct effects						
Activity variables		1	2	3	4	5	6	7
1	On-farm family labor	.						
2	Off-farm family labor	2.092	.					
3	On-farm nonfamily labor	1.759	0.002	.				
4	CN	0.181	0.027	0.026	.			
5	CCN-51	0.257	0.079	0.020	0.000	.		
6	Transfer income	0.950	0.332	0.019	0.054	2.503	.	
7	Modality of off-farm family employment	0.000	0.523	0.006	0.288	0.534	0.018	.
8	Modality of on-farm nonfamily employment	0.263	0.010	5.150	0.007	0.027	0.002	0.037

Note: in the 4-profile solution model, we also assessed if whether the indicators were mutually independent in each livelihood strategy (local independence) and we decided to which local dependencies should be freed relaxed by introducing direct effects among the indicators via the bivariate residuals (Vermunt, 2010). Only two pairwise variables showed BVRs above 3.84 (section a) We decided to free relax the local dependence between variables numbered 4 and 5, in contrast, we kept it between variables numbered 3 and 8 (section b) despite the fact that their BVR was statistically significant due to the BVR between these variables is reduced from 97.79 in the 1-class model to 5.15 in the 4-class model, meaning that the 4-class model explains almost completely (95%) their association.

Table A.2. Pairwise comparison of Income share

Profiles comparison	<i>Income share variables</i>							
	On-farm agricultural activities		Off-farm agricultural activities		Off-farm non- agricultural activities		Non-agricultural self-employment activities	
	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value
1 vs 2	1.8104	0.180	1.181	0.280	0.635	0.430	1.570	0.210
1 vs 3	10.174	0.001	4.518	0.034	3.161	0.075	1.256	0.260
1 vs 4	6.6452	0.010	0.239	0.630	5.526	0.019	2.876	0.090
2 vs 3	19.053	0.000	5.837	0.016	7.230	0.007	0.010	0.920
2 vs 4	13.790	0.000	0.441	0.510	11.161	0.000	0.825	0.360
3 vs 4	0.471	0.490	5.680	0.017	1.918	0.170	0.676	0.410

Table A.3. Pairwise comparison of *Capital assets*

Profiles comparison	Land		Own_Land		Production implement index		Basic_services_index		Family_size		Education		Savings		Debt		Farmers_association	
	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value	Wald	p-value
1 vs 2	0.116	0.940	1.556	0.210	2.790	0.095	3.134	0.077	2.148	0.140	6.463	0.039	0.063	0.800	3.052	0.081	8.873	0.003
1 vs 3	4.626	0.099	0.689	0.410	0.004	0.950	0.980	0.320	5.573	0.018	3951.652	0.000	0.102	0.750	0.656	0.420	0.181	0.670
1 vs 4	7.385	0.025	5.451	0.020	5.617	0.018	7.698	0.005	2.359	0.120	0.045	0,980	8.410	0,004	4.087	0.043	2.306	0.130
2 vs 3	7.430	0.024	7.476	0.006	2.640	0.100	0.167	0.680	8.821	0.003	4057.776	0.000	0.241	0.620	0.287	0.590	8.858	0.003
2 vs 4	8.780	0.012	9.787	0.002	1.141	0.290	0.982	0.320	4.481	0.034	0.289	0,870	4.646	0,031	8.611	0.003	0.323	0.570
3 vs 4	5.569	0.062	3.977	0.046	5.573	0.018	1.673	0.200	0.140	0.710	2909.527	0.000	7.257	0,007	6.898	0.009	2.569	0.110

Appendix B. Risk Attitude

This appendix is based on Cárcamo et al., 2016.

a.- Mathematical implications

Two standard methods have been used to analyze producers' risk preferences from field experiments: the midpoint method (Liu, 2012; Tanaka et al., 2010; Ward & Singh, 2015) and the structural method (Andersen et al., 2006; Bocqueho et al., 2013; Harrison et al., 2010). The midpoint method is an analytical approach that uses a series of equations to calculate a producer's risk preferences (Harrison & Rutström, 2008). This method uses information from risk experiments around the producer's switching choice during risk experiment's series to jointly create producer's risk preferences' upper and lower bounds (Bocqueho et al., 2013; Liu, 2012; Cárcamo et al. 2016).

During risk experiment, producers face scenarios with two possible outcomes, x and y in the gains and losses domains. Hence, we first establish two coefficients to differentiate among these domains (Bocqueho et al., 2013; Liu, 2012; Tanaka et al., 2010; Ward & Singh, 2015):

$$v(x) = \begin{cases} x^\sigma & \text{if } x > 0 \\ -\lambda(-x)^\sigma & \text{if } x < 0 \end{cases} \quad (1)$$

In (1) σ represents the curvature of the prospect value function in the gains domain. This preference should be greater than zero. $\sigma < 0.5$ denotes a strong concavity in the curvature of the prospect value function, which correlates with a strong risk aversion; $0.5 < \sigma < 0.9$ implies moderate risk aversion; $\sigma = 1$ implies risk neutrality; and σ implies risk seeking behavior.

On the other hand, λ represents producers' sensitivity to losses. If $\lambda > 1$, then producers are more sensitive to losses than gains; if $\lambda < 1$, then they are less sensitive to losses; and $\lambda = 1$ suggests that producers are indifferent.

We follow Tanaka et al. (2010) and calculate the decision weights based on cumulative probabilities, this equation is written as:

$$u(x, y, p) = \begin{cases} v(y) + \omega(p) \cdot (v(x) - v(y)) - v(y) & \text{if } x \geq y \geq 0 \text{ or } x \leq y \leq 0 \\ \omega(p) \cdot v(x) + \omega(1 - p) \cdot v(y) & \text{if } x < 0 < y \end{cases} \quad (2)$$

where $u(x, y, p)$ represents producers' lottery utility with outcomes x and y , and probabilities p and $1 - p$ respectively, and $\omega(\cdot)$ is a probability weighting function that measures whether a producer distorts probabilities of unlikely events. Consistent with Tanaka et al. (2010), Liu (2012), Bocqueho et al. (2013) and Prelec's (1998) this function is defining as:

$$\omega(p) = \exp[-(-\ln p)^\alpha] \quad (3)$$

where α captures whether producers distort the probabilities of events when facing risk situations. If $\alpha < 1$, this function has an inverse s-shape form, which means that producers over-weigh low probability outcomes and under-weigh high probability results. When $\alpha = 1$, there is no probability distortion and the function is a straight line. When $\alpha > 1$ the function takes a s-shape form and producers tend to under-weigh extreme events (Nguyen, 2011; Tanaka et al., 2010).

The midpoint method applies equations (1) through (3) to information generated by the switching choices between lotteries A and B of the risk experiment. Applying these equations produces a set of inequalities for each series; solving for α and σ in these inequalities, we estimate parameters' upper and lower bounds.

Ya que hay muchos valores de α y σ Para satisfacer estas desigualdades, utilizamos la combinación de estos parámetros que maximiza la utilidad esperada de los productores de ambas loterías. Por ejemplo, considere, un productor que en la sección de riesgo cambia en la opción cinco en la serie uno y en la opción seis en la serie dos; En este caso debemos resolver las siguientes desigualdades:

$$\text{Series 1} \begin{cases} 0^\sigma + \exp[-(-\ln 1)^\alpha] * (1200^\sigma - 0^\sigma) > 600^\sigma + \exp[-(-\ln 0.1)^\alpha] * (4900^\sigma - 600^\sigma) \text{ if } \delta_j = A \\ 0^\sigma + \exp[-(-\ln 1)^\alpha] * (1200^\sigma - 0^\sigma) > 600^\sigma + \exp[-(-\ln 0.1)^\alpha] * (5650^\sigma - 600^\sigma) \text{ if } \delta_j = B \end{cases}$$

$$\text{Series 2} \begin{cases} 0^\sigma + \exp[-(-\ln 1)^\alpha] * (4000^\sigma - 0^\sigma) > 500^\sigma + \exp[-(-\ln 0.7)^\alpha] * (6900^\sigma - 500^\sigma) \text{ if } \delta_k = A \\ 0^\sigma + \exp[-(-\ln 1)^\alpha] * (4000^\sigma - 0^\sigma) > 500^\sigma + \exp[-(-\ln 0.7)^\alpha] * (7300^\sigma - 500^\sigma) \text{ if } \delta_k = B \end{cases}$$

In these inequalities, α and σ are the arguments that we jointly maximize to quantify the producer's risk preferences. δ_j and δ_k represent a producers' lottery choice regarding the switching round in series one and two of the risk experiment, respectively. In this example, the values for α and σ that maximize utility are 1 and 0.91 for series one, and 1 and 0.77 for series two; hence, the mean values are 1 and 0.84 for σ and α , respectively.

We calculate λ from the third series of the risk section. Since we know producers' switching choice, and equations (1) and (2), solving for λ produces the loss aversion parameter

equation (4) (Liu, 2012; Tanaka et al., 2010; Ward & Singh, 2015). Since the probability for every outcome in lottery B is the same ($p = 1 - p = 0.5$), α does not play a role in this estimation and is dropped from λ parameter calculation.

$$\lambda_j(\sigma) = \frac{x_{j,A}^\sigma - x_{j,B}^\sigma}{(-y_{j,A})^\sigma - (-y_{j,B})^\sigma} \quad (4)$$

Table 1. Payoff schedule for the first two series of risk experiment (in USD dollar)

Round	Lottery A		Lottery B	
	Probability = 0.3	Probability 0.7	Probability = 0.1	Probability = 0.90
1	8	2	13.6	1
2	8	2	15.0	1
3	8	2	16.6	1
4	8	2	18.6	1
5	8	2	21.3	1
6	8	2	25	1
7	8	2	30	1
8	8	2	37	1
9	8	2	44	1
10	8	2	60	1
11	8	2	80	1
12	8	2	120	1
13	8	2	200	1
14	8	2	340	1
Series 2	Probability = 0.9	Probability = 0.1	Probability = 0.7	Probability = 0.3
15	8	6	10.8	1
16	8	6	11.2	1
17	8	6	11.6	1
18	8	6	12	1
19	8	6	12.4	1
20	8	6	13	1
21	8	6	13.6	1
22	8	6	14.4	1
23	8	6	15.4	1
24	8	6	16.6	1
25	8	6	18	1
26	8	6	20	1
27	8	6	22	1
28	8	6	26	1

Source: Own calculations.

Table 2. Payoff schedule for third series of risk experiment (in USD dollar)

Round	Lottery A		Lottery B	
	Probability = 0.5	Probability = 0.5	Probability = 0.5	Probability = 0.5
1	5	-1	6	-4.2
2	0.8	-0.8	6	-4.2
3	0.2	-0.8	6	-4.2
4	0.2	-0.8	6	-3.2
5	0.2	-1.6	6	-3.2
6	0.2	-1.6	6	-2.8
7	0.2	-1.6	6	-2.2

Source: Own calculations.