Credit Constraints in Rural Financial Markets in Chile: Determinants and Consequences

Alvaro Reyes Duarte

Thesis committee

Thesis supervisors

Prof. dr. A. Kuyvenhoven
Emeritus Professor of Development Economics
Wageningen University

Prof. dr. B.W. Lensink
Professor of Finance and Development
Wageningen University

Thesis co-supervisor

Dr. ir. H.A.J. Moll
Former Associate Professor, Development Economics Group
Wageningen University

Other members

Prof. dr. ir. A.G.J.M. Oude Lansink, Wageningen University
Dr. A. van Tilburg, Wageningen University
Prof. dr. C.L.M. Hermes, University of Groningen
Dr. W.W. Boonstra, Rabobank Netherlands, Utrecht

This research was conducted under the auspices of Wageningen School of Social Sciences

Credit Constraints in Rural Financial Markets in Chile: Determinants and Consequences

Alvaro Reyes Duarte

Thesis
submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. dr. M. J. Kropff,
in the presence of the
Thesis Committee appointment by the Academic Board
to be defended in public
on Tuesday November 15, 2011
at 4 p.m. in the Aula.

Alvaro Reyes Duarte

Credit Constraints in Rural Financial Markets in Chile: Determinants and Consequences

PhD Thesis Wageningen University, Wageningen, NL (2011)
With references, with summaries in English and Dutch

ISBN 978-94-6173-039-8

Dedicated to my wife Anita and my daughter Magdalena

Funding

The research described in this thesis was financially supported by Universidad Santo Tomas and Government of Chile (Beca Presidente de la Republica, Mideplan-Conicyt).

Acknowledgements

At the completion of this thesis several people come to mind who undoubtedly have influenced my life and education and, by consequence, the person I am. First are my parents, Luis Reyes and Carmen Duarte, who gave me the tools to build my education based on responsibility, rigor, and a love for work. I have no words to express my gratitude for all they provided during my childhood. To Rodrigo and Carolina, my brother and sister, I also extend my gratitude for their moral and logistic support.

I want to extend my sincere gratitude to my supervisors. Prof. Dr. Robert Lensink, offered me critical recommendations on how to improve my papers and challenged me with new insights and perspectives, which always I appreciated. Prof. Dr. Henk Moll always gave me his guidance which enabled me to advance my knowledge and professional skills. His help was the beginning of discussions and insights that led to important conclusions in this work. Last but not least, Prof. Dr. Arie Kuyvenhoven has not just supplied critical ideas and suggestions to improve the content of this thesis and practical advice on scientific writing but also provided advice and guidance for my life here in Wageningen. I also want to express my gratitude to his wife, Cora, with whom I had the opportunity to share my experiences from Chile and ideas about how to improve our societies.

I gratefully acknowledge the financial support of the President of the Republic scholarship from the government of Chile (Beca Presidente de la Republica) and the Universidad Santo Tomas of Chile. This support allowed me to completely concentrate on my studies while my family and I were in Wageningen. Many thanks to all the interviewers and colleagues from the Universidad Santo Tomas and to the farmers who participated in the survey for their excellent cooperation. Special thanks also goes to Sharon for her editorial service and advice.

Working with the Development Economics group of Wageningnen Univesity has been an invaluable experience. I thank the present and former staff and fellow PhD researchers for creating an excellent professional and social environment. My great thanks goes to Prof. Dr. Erwin Bulte for giving me a physical space in which to work and wise advice during critical moments of this study. My thanks also extends to the rest of Development Economics group, especially to Rob Skipper, Marrit van der Berg, Pan Lei, Kees Burger, Nico Heerink and Rein Haagsma for reading, offering me suggestions, and/or welcoming all my questions. I also want to extend my gratitude to PhD students and former staff members for their assistance in some part of this thesis. My thanks go to Ruerd Ruben, Girmay, Ricardo, Mose, Fedes, Ezra, Gonne, Lonekke, Marteen, Maren and Wu Yan. For their excellent administrative support and facilitation during my stay in Wageningen, I am especially thankful to Ingrid Lefeber and to Marian Jonker.

A special mention also goes to my colleagues and friends Roselia Servin and Benigno Rodriguez who never failed to furnish both professional support and friendship whenever it was necessary. I also thank my paranymphs and Caucasella Diaz and Huashu Wang, for their dedication and logistical support.

I want to also thank my friends. Two groups of friends were very important for me and my family while I was completing the thesis. First is our spiritual group, *Franciscanos de Maria*, who were always next to us, sharing our faith and bringing us friendship and support. Second is the Chilean community in Wageningen, those people who better understand how it is to be abroad, far away from Chile. Thanks goes to Ninoska, Laurens, Isabel, Roberto, Marcela, Paula, Carlos, Alejandra, and Christian for making our stay in Wageningen so much easier. Many thanks to other Latino friends I met in Leeuwenborch (Ignacio, Victor Hugo, and Jaime Arana) for such as inspiring conversation at lunch time.

I come from a small country where we are proud of who we are but where we still face several limitations in development. Somehow, Chile has similar conditions to those of The Netherlands, both being small countries, export oriented, with highly concentrated natural resources, but with a huge difference in equality. These similarities were one of my motivations to apply to a PhD program in The Netherlands. Accordingly, I want to express my gratitude to all the people in this country who have contributed to my learning about development and economics, and also about organization, equality, and a different way of living. Thank you Juan, Betty, Loreto, Bram, Rob Bogers, Marleen and Barbara, for introducing the Dutch culture to me.

However, the most important external contribution in this thesis was my family. Anita, my beloved wife, provided a warm environment for me during cold days in The Netherlands. Her generosity, sacrifices, and patience through the difficult times of research will live in my memory. She has never failed to supply me energy and encouragement to return to work. The completion of this thesis is primarily indebted to her unflagging help and support. I have also received great inspiration from my daughter, Magdalena who has spent her first year and half in The Netherlands. Thank you, Magdalena for being part of our family.

Wageningen, November 2011.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

1.1 Background

Agriculture contributes to economic development in several ways. It influences development not only directly through employment and better income from agricultural activities, but also indirectly by providing a market for agricultural inputs, transport services, technical assistance, etc. Agriculture also plays an important role in reducing poverty and is even linked to areas that are more exposed to international agricultural trade (Valdes and Jara, 2008).

It is frequently argued that rural development needs to be accompanied by farmers' access to credit, for two main reasons. First, access to credit enhances production efficiency at the farmer's level. If they are unconstrained in their access to credit, farmers can separate consumption from farm production decisions. As such, credit unconstrained farmers can optimally choose the inputs for the production processes they use (Carter, 1989; Feder et al., 1990; Foltz, 2004). Second, access to credit facilitates investments which can improve the economic performance of the farmer by reducing costs through the adoption of better technology or by increasing income through adapting production to new challenges posed by phenomena such as global warming and changing customer preferences.

Unfortunately, Rural Financial Markets (RFMs) often work inefficiently in the sense that both formal and informal financial institutions do not meet the total demand for financial products of rural households in a specific period. This mismatch between demand and supply can be explained by several market imperfections such as monopolies in credit markets as exercised by informal lenders (Bell et al., 1997a); large transaction costs incurred by

borrowers in applying for loans; imperfect information leading to adverse selection and moral hazard problems (Stiglitz and Weiss, 1981; Carter, 1988); and screening, monitoring and enforcement problems faced by lenders (Hoff et al., 1993).

Although it is important to develop a model that reveals asymmetric information and points out its causes, limited research has been carried out on RFMs of middle-income countries such as Chile. Chile is an interesting case to study RFMs for three main reasons. First, the Chilean financial sector is one of the most competitive and deregulated markets in Latin America. As in other developing countries, however, the Chilean credit market is characterized by information asymmetry and other market imperfections, which result in difficulties in the screening and monitoring process, such as substantial transaction costs and a high risk of default in credit transactions. These difficulties may lead to lower rural credit allocation. In fact, of the total credit provision of commercial banks, private banks decreased their credit provision toward the agricultural sector in relative terms from 10% in 1990 to 4.1% in 2009 (Table 1.1). However, this situation may well reflect other causes, apart from credit constraints, such as lower demand for credit as a result of the financial crisis or the participation of other credit providers which may substitute for or complement formal sources of credit.

Table 1.1: Credit in the agriculture and forestry sectors of Chile (millions of U$ at the end of February of each year), 1990 - 2009

Sector	1990	1995	2000	2005	2006	2007	2008	2009
Agriculture	1.275	1.260	1.836	2.017	2.553	3.023	4.242	4.283
Forestry	123	204	210	275	484	445	448	375
Total agriculture and forestry	1.404	1.472	2.046	2.292	3.038	3.468	4.689	4.658
Relative share (%)	10,3	5,2	4,4	3,7	3,7%	3,8%	3,6%	4,1%
Total financial system	13.652	28.545	46.321	61.969	81.533	92.331	130.624	114.417

Source: ODEPA (2010) with information from SBIF(2009)

Second, the agricultural sector in Chile is a dynamic economic sector. Agriculture and forestry value added has grown at a stable rate of 4.8% during the last five years, while the other sectors of the economy have grown at a lower rate (Table 1.2). Within the agricultural and forestry sector, market-oriented farmers [1] make up the bulk of production and are estimated to account for 96.5% of the land owners, 96.4% of fruit farm area, and 94.9% of vegetable farm area (ODEPA, 2005).

Table 1.2: Changes in GDP and agricultural and forestry value added, Chile, 1996 - 2005

Year	Share of agricultural and forestry GDP in GDP	Annual percentage change	
		Agricultural and forestry GDP	GDP
1996	4.2	-	-
1997	4.0	1.7	6.6
1998	4.1	5.0	3.2
1999	4.1	-0.8	-0.8
2000	4.2	6.0	4.5
2001	4.3	6.1	3.4
2002	4.4	4.5	2.2
2003	4.5	6.0	3.9
2004	4.6	8.8	6.2
2005	4.5	5.7	6.3
1996-2005	4.3	4.8	3.7

Source: Banco Central de Chile (2010)

Third, in Chile formal and informal financial institutions are widespread across the agricultural sector, especially in fruit and vegetable production. The formal institutions, mainly banks, are characterized as being competitive and deregulated, with a long tradition of working with farmers in Chile. The informal institutions are mainly trading or input supply companies. Fruit-trading companies usually play the role of marketing or processing a farmer's harvest in exchange for credit and other services such as technical assistance. In the case of input supply companies, credit via in-kind loans instead of cash advances are provided.

[1] The classification used in Chile according to the Economic Development Agency of Chile (CORFO), which distinguishes small-, medium- and large-scale farmers is as follows: Micro entrepreneurs are those who have annual gross income up to 78,000 $US; Small entrepreneurs from 78,000 $US to 808,000 $US; Medium entrepreneurs from 808,000 $US to 3,231,000 $US; and large entrepreneurs from 3,100,000 $US. Our definition for market-oriented farmers counts for small-, medium- and large-scale farmers.

Thus, a closer examination of deregulated rural financial markets for market-oriented farmers in Chile appears to be worthwhile. However, existing empirical literature on credit rationing of Chilean farmers is very limited. Despite some provisional evidence that credit rationing is a significant problem in Chile (Conning and Udry, 2007), the issue still awaits rigorous empirical examination in measuring credit constraints, in determining the effect of informal credit institutions on credit constraints, and in determining the credit constraint effect on production and investment patterns.

The remainder of this chapter is organized as follows: In section 1.2 the research questions and structure of this thesis are presented. In section 1.3 an overview of the agricultural sector in Chile is provided. Section 1.4 describes the study area and the main aspects that were taken into account to prepare the survey. Finally, section 1.5 discusses the methods of analysis applied in this study.

1.2 Research aims

The aim of the research presented in this thesis is to measure access to credit and empirically determine the effects of credit constraints on investment and production for market-oriented farmers in central Chile. More specifically, the aims of this study are to:

- Identify the main factors that influence access to credit for market-oriented farmers.
- Determine whether informal financial institutions act as complements to or substitutes for farmers' strategies for funding.
- Determine the effect of credit constraints by formal financial institutions on farm productivity.
- Identify the factors that limit farm investment.

In approaching these objectives two innovative methods are used throughout this thesis. First, qualitative information collected in interviews is used to identify three categories of credit constraints from both the demand and supply side of the credit market, namely, quantity, risk, and transaction-cost constraints (Guirkinger, 2008; Guirkinger and Boucher, 2008; Boucher et al., 2009; Fletschner et al., 2010). Second, a panel-data structure is used in all econometric analysis in this thesis, which allows us to obtain estimators that are more efficient than those based only on cross-sectional analysis.

The choice of central Chile as study area is based on the presence of the predominant agricultural activities fruit (including vineyards) and vegetable production. Both activities account for 80% of agricultural export production. The area considered in this study, regions V, VI and Metropolitalina, represents 85% and 55% of fruit and vegetable production, respectively. In addition, the fruit and vineyard subsector is one of the most dynamic subsectors within agriculture, characterized by a high level of investment, with an increase in terms of land area by 38 and 57% respectively, during the last ten years (Qualitas Agroconsultores, 2009) .

Together with this introductory chapter, this thesis contains six chapters. Because most chapters were prepared as articles, data and study area descriptions in different chapters can overlap. References for all chapters are combined at the end of this thesis.

Chapter 2 identifies the main factors that influence Chilean farmers' access to credit. To better understand how rural financial markets function in Chile, the determinants of classifying credit provision and rationing into four categories are explored. Attention is paid to the role that social capital variables play in determining a credit constraint.

Chapter 3 deals with the role of informal financial institutions in providing credit for market-oriented farmers in Chile. The hypothesis that firms with limited access to bank loans

have a lower demand for informal credit is tested, suggesting a complementary relationship between both sources of funding.

Chapter 4 analyzes the effect of a credit constraint on production in the vegetable and fruit sectors at the farm level. The hypothesis that credit unconstrained farmers can separate consumption from farm production decisions is tested. As such, credit-unconstrained farmers can optimally choose the inputs for the production processes they use (Carter, 1989; Feder, Lau et al., 1990; Foltz, 2004). The analysis is done by econometric estimation of the reduced form output supply equation for a subgroup of farmers found to be credit constrained.

Chapter 5 extends the discussion about the effect of credit constraints on the decision to invest in farm assets. Again we test the hypothesis that credit-unconstrained farmers can separate investment patterns from transitory income shocks. As such, credit-unconstrained farmers can optimally undertake new investments and adopt new technologies (Khandker and Faruqee, 2003).

Finally, Chapter 6 discusses the main findings and presents the key conclusions of this study. It points out the implications for the development of Rural Financial Markets in Chile and makes suggestions for future research.

1.3 Overview of the agricultural sector in Chile

1.3.1 Socio-economic aspects

Among Latin-American countries, Chile is regarded as an upper-middle income country with a Gross National Income of US$ 9,400 per capita ($US 13,270 per capita at Purchasing Power Parity) (World Bank, 2010). Chile possesses one of the most open economies in the world, growing at an average annual rate of 4.4% over the last 8 years. Meanwhile, inequality is one of its largest problems, with a Gini coefficient of 0.58, the second highest value in the region after Brazil.

As in many developing countries, agriculture today is radically different from the way it was 30 years ago. Globalization has reshaped rural areas in many countries through the expansion of export-oriented crops, while farmers producing import-competing commodities have had to improve their efficiency in order to remain competitive (Fleming et al., 2010). Chile is no exception.

Based on the 2007 agricultural census (the most recent census) of an estimated 269,000 farms in Chile, 255,000 (95%) are classified as micro-scale farmers, 13,000 (5%) as small-, 1,050 (0.4%) as medium-, and 175 (0.1%) as large-scale farmers (Table 1.3). Micro-scale farmers are estimated to account for 44% of the land owners, small-scale farmers 30%, medium-scale 13%, and large-scale farmers the remaining 13%. Together, small-, medium- and large-scale farmers represent the 56% of the owned land, and 78% of the total value of agricultural output (Table 1.3).

Table 1.3: Distribution of number of farms, total area and total value of agriculture output by type of farmer in Chile, 2007

Type of farmer	Number of farms		Land area		Total value of agricultural output		Average farm size
		%	Ha	%	Millions US$	%	Ha
Micro-scale farmers	254,906	95	4,459,168	44	1,902	22	17
Small-scale farmers	13,184	4,5	3,060,922	30	3,391	38	232
Medium-scale farmers	1,050	0.4	1,384,814	13	1,695	19	1,285
Large-scale farmers	175	0.1	1,299,450	13	1,842	21	7,425
Total	269,315	100	10,168,355	100	8,829	100	38

Source: Qualitas (2008) with information supplied by the VII National Agriculture Census, INE (2007)

Comparing census data from 1997 to that from 2007, the data show a movement toward larger production scales. In the last ten years the number of farms has declined 20% in central regions in Chile. These regions have the most sophisticated agricultural economies and have experienced a decrease in farm numbers and an increase in average farm size. This phenomenon causes a property concentration: 4,533 farms make up 79.7% of the total productive land, meanwhile 165,801 farms smaller than 10 hectares make up 1.8% of the total productive land (Qualitas Agroconsultores, 2009).

The concentration is also reflected in terms of the total value of agricultural output. While micro-scale farmers accounted for 30% of the gross productive value in 1997, their share declined to 22% in 2007. The same trend is observed for small-scale farmers, whose share in output declined from 44% in 1997 to 38% in 2007. Medium and large-scale farmers increased their share from 15% to 19% and from 11% to 21%, respectively (Table 1.4).

Table 1.4: Distribution of total value of agriculture output by type of farmer, Chile, 1997 and 2007

Type of farmer	Total value of agricultural output 1997		Total value of agricultural output 2007	
	Millions US$	%	Millions US$	%
Micro-scale farmers	2,026	30	1,902	22
Small-scale farmers	2,920	44	3,391	38
Medium-scale farmers	990	15	1,695	19
Large-scale farmers	723	11	1,842	21
Total	6,658	100	8,829	100

Source: Qualitas (2008) with information supplied by the VII National Agriculture Census, INE (2007)

Another trend is that the agricultural sector is more sophisticated and technologically advanced than it was only 10 years ago. Fruit orchards, vineyards and forest plantations have increased in terms of land area by 38%, 58% and 19%, respectively. By contrast, annual crops, vegetables, and natural grasslands have declined in land area by 26%, 15% and 15%, respectively (Table 1.5). Irrigated land has increased by 3.4%. This increase is even more spectacular in technical irrigation such as micro-aspersion and mechanic irrigation with increases of 298% and 85% surface area, respectively. Meanwhile gravitational irrigation has decreased 16% in the same period. All these data illustrate the intensification and use of modern agriculture techniques.

Table 1.5: Land Area by farm activity in Chile, years 1997 and 2007

Farm Activity	Land Area (hectares)		Relative change (%)
	1997	2007	1997-2007
Annual crops	648.111	480.833	-25,8
Ornamental plants	1.472	2.193	49,0
Seed	29.778	42.400	42,4
Vegetables	111.871	95.194	-14,9
Natural grasslands	608.538	518.502	-14,8
Fruit orchard	234.480	324.279	38,3
Vineyards	81.845	128.993	57,6
Forest plantations	2.226.014	2.655.317	19,3

Source: Qualitas (2009) with information supplied by the VII National Agriculture Census, INE (2007)

Fruit export production is concentrated between Regions III and VII, in the central part of the country. These regions enjoy favorable natural and climate conditions for temperate fruit production and have relatively good infrastructural facilities. The whole sector is characterized by a high level of investments and use of modern agricultural techniques. Much of the technical expertise, originally from California, was acquired through a combination of initially government support, and later private-sector research investment. Large export firms own many of the advanced packing facilities and provide technical assistance and credit to medium-sized farms from which they receive the fruit. Hence the fruit-growing regions have been radically transformed, leading to a marginalization of peasant production, and are now dominated by modern agribusiness.

There is little detailed information available on buyer concentration in the Chilean agricultural sector. There is, however, some evidence of a high degree of buyer concentration and of increasing vertical coordination through contracts and integration in agroprocessing. This is reinforced by the growing concentration of retail food sales in supermarket chains, which puts pressure on the competitiveness of small producers in terms of sales volume and quality control. Foster and Valdes (2006) report that of the 16 most important agricultural products, only the market for potatoes corresponds to the stylized model whereby the activities of many market participants are determined by spot prices generated in open markets. All other product markets, which have a high degree of buyer concentration, are

coordinated through marketing or production contracts, or are completely integrated. The evidence suggests that the degree of industrial processing in agriculture is already high and that this process is intensifying. Interestingly, the export-oriented sectors of fresh fruit and wine have lower processor concentration relative to import-competing sectors.

1.3.2 Agricultural policy

Over the last 30 years Chile has pursued an open trade policy, with agriculture products as key exports, where fruits in particular have become both cash crops and non-traditional crops. At the same time, traditional crops, in particular cereals, continue to be an important source of income for many Chilean farmers, especially for those located in southern Chile. Unlike non-traditional crops, traditional food crops face import competitions, especially from South-American countries more specialized in cereals.

In the mid-1970s the Chilean government introduced a more market-based resource allocation policy. The role of the government became less important, measures to liberalize trade were introduced, and trade and private-property rights were strengthened. In regard to financial-sector policies, interest rate ceilings as well as preferential rates for the agricultural sector were abolished. The reforms had a profound impact on land markets and on firms that provide services to the agricultural sector, such as input suppliers and transport companies. The new land policy provided unrestricted access to landownership and improved the protection of property rights. Individual land titles were redistributed to the beneficiaries of the land reform programs. Moreover, input and product markets were privatized.

The agricultural sector was especially affected by trade liberalization, because it implied a reduction or even a complete elimination of nontariff barriers on most imports and an elimination of export restrictions. In addition, a uniform import tariff was introduced, starting at a rate of 90% in 1975 and gradually falling to 10% in 1979.

The most influential trade policy change in recent years was the introduction of free trade agreements, with Canada (1997), Mexico (1999), the European Union (2003), the Republic of Korea and the United States (2004), New Zealand and Singapore (2005), China and Peru (2006), and Japan (2007). These agreements resulted in a reduction of the effective average tariff rate across all goods to about 2% in 2007.

Trade liberalization attracted trade companies that saw great opportunity to export fruits, wine and processed food. Transnational fruit corporations such as Dole and Del Monte and large local export-oriented firms such as David del Curto, expanded Chile's international markets due to their advanced global networks (Gwynne, 2003) and investments in new productions techniques (Barrientos, 1997). These types of firms utilized contract farming extensively in which export firms offered farmers credit for working capital, technical assistance and crop inputs in exchange for the farmers' promise to provide the harvest that would subsequently be marketed by the export firm. Credit for farmers primarily financed fresh-fruit production with a few exceptions in such crops as sugar beets, tobacco, tomatoes, and certain types of horticultural production for the agro-industry.

Agricultural trade liberalization has had two main effects. First, trade liberalization changed the composition of production and trade. As expected, the exportable subsectors—fruits, vegetables and forestry—rose in importance, while livestock and field crops declined. Following the reforms, there was an increase in export growth rates. Annual growth rates averaged 10% or more for two decades for fruit and wine production. This growth was accompanied by a rise in the use of fertilizers per hectare, an expansion of irrigated land, greater use of machinery, the introduction of new varieties, and the adoption of non-traditional crops. This occurred especially in areas where farmers had linked their operations with export firms and where contract farming was common.

Second, the tendency toward greater export orientation has made an important contribution to the increase in employment and household income and to the reduction in rural-urban migration. Recent literature reports that poverty reduction and lower rates of rural-urban migration are linked to export agriculture rather than to agriculture as a whole (Foster and Valdes, 2006; Fleming, Abler et al., 2010).

However, contract farming has not been without its critics. Primarily because the credit and insurance terms in these contracts can lead to dependency on the part of farmers and restrict flexibility in farmers' decision process to market their production. On the other hand, some fruit corporations and large fruit farms have acquired land at low prices from small-scale farmers, taking advantage of debt and low bargaining power created by fixed-contract farming (Carter, 1988; Gwynne and Ortiz, 1997).

The government's overall policy strategy continues to be conducive to the growth of the export-oriented sector and to the modernization of import-competing activities in agriculture. This policy induced cluster formation, which is seen by the Chilean government as an important instrument to improve linkages between firms and reduce problems of asymmetric information.

However, one of the pitfalls of Chilean agricultural policy is the lack of detailed information about general and specific data for the agricultural sector. Lack of productivity, investment and cost data for Chilean agriculture limits any attempt to address any important question about the economic process taking place in Chile. Although intentions to get a general picture of the agriculture sector exist, these intentions are insufficient for such a dynamic and diverse sector as agriculture. For instance, the National Statistics Institute carries out an agriculture census every 10 years, and other institutions that have access to the data base on the agricultural sector, such as the Central Bank of Chile and National Tax Agency, do not share this information with other institutions for strategic reasons. This situation causes

misinformation in evaluating government programs and leads to slow reactions to improve poorly performing programs.

1.3.3 Rural financial markets

Financial services are delivered to the rural population by organizations that exist along a continuum from informal to formal, with often diffuse boundaries between categories. In general, formal financial institutions are licensed and supervised by a central authority. They include public and private commercial banks; state-owned agricultural or rural development banks; savings and loan cooperatives; microfinance banks and special-purpose leasing, housing, and consumer finance companies. Informal providers of financial services include rotating saving and credit associations, money lenders, pawnshops, businesses that provide financing to their customers, and friends and relatives. In between these two ends of the continuum are financial nongovernment organizations, self-help groups, small financial cooperatives, and credit unions.

The general perception of informal lenders in developing countries concerns various money lenders, pawnshops, landlords, friends and relatives. For market-oriented farmers in Chile, however, the most important informal providers of financial services are trading and input supply companies. Although we recognize that the boundaries between formal and informal lenders are often blurred, we distinguish formal financial institutions as those which are licensed and supervised by a central authority. In fact, in many respects these firms operate today in much the same essential way that informal trade-money lenders have operated in Chile and elsewhere in the world (Conning and Udry, 2007). The latter is especially relevant for the analysis in Chapter 3 where the definition of informal lenders includes only traders and input suppliers.

1.3.3.1 Formal financial sector

Chile's banking system has changed significantly over the last 30 years. During the period 1974–83, the Chilean government almost completely liberalized the financial sector by abolishing virtually all financial controls. However, the liberalization destabilized the economy, forcing the government to step in and rescue failing banks in 1983. The government also introduced a supervisory system for the financial sector (*Superintendencia de Bancos e Instituciones Financieras*), which is still in place. This regulatory framework is intended to reduce bank failures and helps to ensure an adequate level of bank solvency (Fuentes and Vergara, 2003).

The Chilean banking sector is now one of the most developed and promising of the region. The sector contains 20 active commercial banks[2]: 12 foreign-owned, 7 Chilean-owned and one state-owned bank. During the last 20 years, the financial sector has experienced outstanding growth. In 2001 the ratio of credit allocated by deposit money banks to GDP was 63.6%, the highest figure in Latin America, surpassing that of Brazil (Gallego and Loayza, 2004; Hernandez and Parro, 2004).

[2] Excludes branches of foreign banks that are mainly devoted to cash and portfolio management activities.

Table 1.6: Loan portfolio in agriculture in Chile, 2003-2007 and number of bank offices, 2007

	Loan portfolio in Agriculture (million US$)					Number of bank offices	
BANK	2003	2004	2005	2006	2007	Rural Central Area	Total country
Scotiabank Sud Americano	18.463	67.759	91.480	10.459	130.964	15	40
Banco Chile	662.517	792.148	726.838	768.575	979.733	55	280
Banco Itaú Chile	9.045	18.709	30.277	77.872	139.359	15	40
Banco Estado	144.670	111.588	105.163	188.010	280.774	60	320
Banco Bice	88.515	107.813	142.144	212.088	289.132	15	30
Banco Del Desarrollo	142.329	178.037	219.992	263.895	297.410	21	40
Banco Bilbao, Vizcaya	12.559	12.889	177.923	244.526	775.137	15	40
Corpbanca	147.909	252.376	318.454	338.493	398.999	25	190
BCI	30.848	413.673	476.453	64.709	822.778	31	210
Santander Santiago Chile	488.622	583.684	789.898	1163.259	1243.409	40	250
TOTAL	**1745.474**	**2538.676**	**3078.622**	**3331.885**	**5357.697**	**299**	**1930**

Source: SBIF (2009)

As shown in Table 1.6, the primary agricultural credit provider in Chile is Banco Santander (a foreign bank), followed by Banco Chile (a Chilean bank), Banco Bilbao (foreign), and Banco BCI (Chilean). These loans are characterized by being heavily collateralized and made available mainly to medium-sized and large farms. While bank officials in Chile do sometimes visit farm borrowers, these visits usually tend to take place prior to a loan approval and with the aim of appraising the value of collateral assets, not to monitor the project during execution (Conning and Udry, 2007). Table 1.6 also shows that while all the commercial banks have offices across the country, branches are mainly concentrated in the central area.

Generally speaking, a formal loan application has to go through the following process in rural financial markets in Chile: Prospective borrowers have to submit a loan application at the local bank branch, together with a business plan describing the purpose of the loan. This loan application has to be accompanied by a description and official proof of collateral. A local loan officer visits the prospective borrower, evaluates the business plan, and decides

whether to extend the loan. However, as pointed out by Karcz (1998) and Petrick (2004b), the reliability or reputation of a borrower as indicated by previous punctual repayment of loans is at least as important for obtaining credit as is the sufficient availability of collateral. It is important to note that in Chile all banks have access to a financial recording system (DICOM), which records previous formal loan performance including defaults and delayed payments and thus acts as a reputation score.

In general, default rates in Chile's financial system are quite small (4%) and the delayed payments are in the order of 8%.

1.3.3.2 Informal financial sector

Informal financial institutions obtain credit from formal financial institutions, which is then reloaded to farmers, households or traders (Moll, 1989). The latter are sometimes eligible for a direct loan from these formal institutions, but prefer to use informal channels for reasons related to transaction cost, financing advantages or marketing. A common characteristic of these informal lenders is that they perform active monitoring (Conning and Udry, 2007). This means that informal lenders keep agents focused on efforts to improve the chances that the financed projects will not fail, and/or to reduce the possibility that the project cash flow may be diverted to purposes other than meeting promised repayments. In this sense, they act as delegated monitors.

Attracted by economic liberalization, monitored loans via contract farming arrangements offered by export and agroindustry trades grew from a relatively small base to become the dominant mode of finance by the mid 1990s, well ahead of bank lending (Conning and Udry, 2007). Thus, the informal financial sector in rural areas in Chile mainly consists of contract farming and input suppliers. Although moneylenders, relatives and friends still exist as a source of credit in some areas, using their services is very limited in the central area.

Contract-farming firms

Contract-farming firms provide in-kind or cash short-term credit advances. Usually the credit is tied to transactions on other markets such as credit advances provided by fruit-trading companies or agro-industry traders. Under such arrangements farmers are offered heavily monitored production financing tied to the provision of technical assistance and crop inputs in exchange for the promise to market all or a part of their harvest through the trader at agreed-upon terms. This type of credit primarily finances fresh-fruit production, with a few exceptions in crops such as sugar beets, tobacco, tomatoes and certain types of horticultural production for the agroindustry (Conning and Udry, 2007).

In the case of fruit production, installments are offered at the beginning of the season and are paid back at the harvest. Trading companies may visit the farmers' fields at the time of harvest or at other important decisions. For this reason, this kind of credit is known as monitored credit. Interlinked credit contracts may provide means to alleviate screening, incentive and enforcement problems (Hoff, Braveman et al., 1993). The 15 largest exporting companies process 50% of Chile's total fresh fruit and vegetable exports, and they play a fundamental role in marketing Chilean production (Decofrut, 2008). These companies frequently contract to market or process a farmer's harvest in exchange for credit and other services such as technical assistance and farm input sales (Conning and Udry, 2007). The most important fruit-trading companies are Dole, Unifrutti and David del Curto, processing 13.8%, 10.8% and 9.6% of the fruit-trading volume, respectively, in the 2007-2008 season (Table 1.7).

Table 1.7: Main fruit-trading companies operating in Chile, 2007-2008

Company	Owner	Main Trading Products	Traded Volume, season 2007-2008 (ton)
Dole	Non-resident	Apple, grapes, pears	157,030
Unifrutti	Non-resident	Apple, grapes, pears	120,997
David del Curto	Resident	Apple, grapes, pears	109,296
Copefrut	Resident	Apple, kiwi, pears	102,512
Del Monte	Non-resident	Grapes, apple, pears	86,227
Frusan	Resident	Grapes, apples, pears	82,302
Rio Blanco	Resident	Grapes, kiwi, avocados	76.994
Agricom	Resident	Avocado, grapes, apple	73,872
Geenvic	Resident	Apple, grapes, kiwi	61,624
Aconex	Resident	Grapes, apple, plum	59,259
Subsole	Resident	Grapes, kiwi, avocado	57,347
Propal	Resident	Avocado, lemons, oranges	51,134
Verfrut	Resident	Grapes, apples, peaches	49,672
Frutam	Resident	Apple, pears ,grapes	44,027
Rucaray	Resident	Apple, grapes, pears	41,536
Others			1,136,390
Total			2,310,219

Source: Author's computation based on the data provided by Decofrut (2008)

Input supply firms

Input supply firms provide in-kind short-term credit usually repayable at harvest. Usually they operate in a restricted geographic area or in a specific section of the market. These firms sell inputs such as seeds, fertilizers or farm machinery. The in-kind product is both the type of credit provided and an avenue for active monitoring. This form of credit delivery can be interpreted as monitoring because it makes it more difficult for borrowers to divert credit to other private uses. The input supply sector consists of 18 companies which generate a combined overall turnover of US$ 100 billion per year. Together these companies have 93 offices throughout the country, 54 of which are located in central Chile. Based on the number of offices, the most important input suppliers are Copeval, Coagra and Tattersal (Table 1.8). Other companies are smaller with a lack of open access information about turnover or market participation.

Table 1.8: Main input supply companies operating in Chile, 2004

Company	Starting year	Input Sold	Number of branches	Total turnover 2004 (million US$)
Copeval	1972	Seed, fertilizer, pesticides, machinery	17	7,417
Coagra S.A.	1970	Seed, fertilizer, pesticides, machinery	10	5,270
Tattersall	1950	Seed, fertilizer, pesticides	10	4,698
M y V	1965	Seed, fertilizer, pesticides,	9	w/i

Source: Author's computation based on the data provided by each firm. w/i stands for "without information"

Together input supply firms and contract-farming firms provide a wide-ranging supply of short-term credit with convenient contract terms as flexible repayment and credit delivery at the beginning of the crop cycle for farmers in Chile. Informal lenders are able to extend those flexible loans to farmers because they actively monitor their clients through visits, interlinked credit contracts, or in-kind product delivery. In contrast, formal credit is more inflexible in terms of contract conditions, but is able to provide long-term funding. This situation leads to a complementary scenario where farmers may likely use rigid formal credit to meet their long-term credit needs, because the credit volume is large enough to cover the screening, monitoring and enforcement costs of formal credit contracts. On the other hand, farmers would use informal credit to meet their short-term credit needs with flexible contract conditions.

1.4 Research methodology

1.4.1 Study area

The study area is the regions V, VI and Metropolitana, the central part of Chile. This area selection is based on the country's most important fresh fruit and vegetable production, and includes the Los Andes, San Felipe (V Region), Rancagua (VI Region), San Bernardo, Buin, Paine and Melipilla (Region Metropolitana) counties. Figure 1.1 provides an overview of the counties included in the study area. Agriculture in this area is mainly irrigated, and a well-developed system of reservoirs, irrigation and drainage canals greatly reduces the risk associated with the amount and timing of water delivery. The predominant agricultural

activity is fruit production; major crops are table grapes, kiwi fruit, nectarines, apples, apricots, pears and avocados. Much of Chile's fruit production from this area is exported during the northern winter to the United States, Canada and Europe. Chile also produces and exports large quantities of wine, forest products, planting seeds, fresh flowers and processed fruits and vegetables.

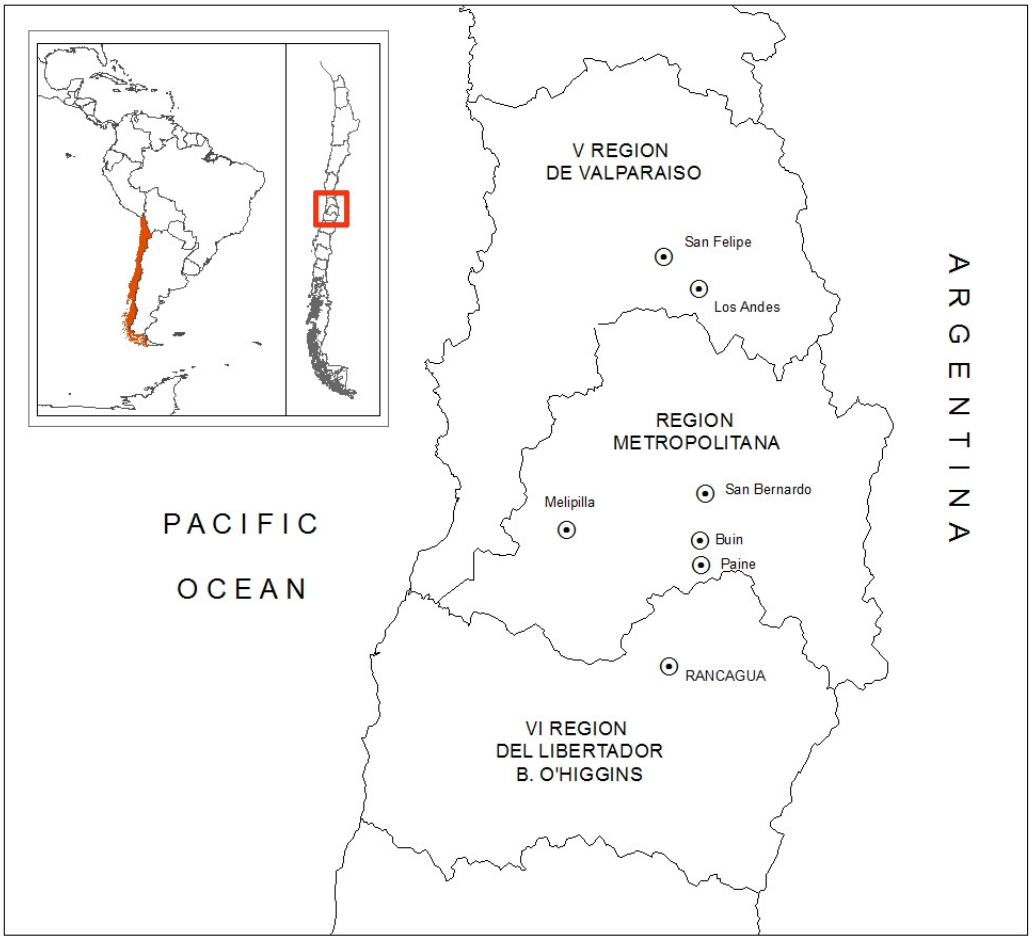


Figure 1.1: Map of the study area in central Chile

Large estates (*fundos*) occupy a substantial part of Chile's agricultural lands. These are remnants of the Spanish colonial period, when extensive land grants were made to army officers and colonial officials. In the early 1920s, nearly 90% of the farmland in central Chile was in large estates. Although a massive land reform was introduced in 1967 and reinforced in 1971, during the liberalization period in the 1980s and 1990s individual land tittles were

distributed to the beneficiaries of the agrarian reform program. The land title distribution started a dynamic land market, which facilitated the merging of land into large productive firms. Based on the 2007 agricultural census, the average land size for agricultural activity is 60 hectares, with 21 hectares for the study area. If we focus on farmers with a minimum of 10 hectares, a characteristic linked with market-oriented farmers, the average size for individual farms in Chile is almost 64 hectares (Table 1.9).

Table 1.9: Average farm size for different regions in Chile, 2007

Regions of Chile	**Range of hectares**		
	0-9.9	**10-1,000**	**Total**
XV de Arica y Parinacota	2.39	150.81	25.97
I de Tarapacá	1.51	83.92	12.07
II de Antofagasta	1.67	39.50	3.02
III de Atacama	2.25	85.40	16.51
IV de Coquimbo	2.63	74.74	18.15
V de Valparaíso	2.67	80.42	21.85
Región Metropolitana de Santiago	3.32	68.39	27.87
VI de O'Higgins	2.72	62.73	23.98
VII del Maule	2.80	55.68	23.28
VIII del Bío-Bío	3.15	50.25	19.63
IX de La Araucanía	4.38	53.79	27.23
XIV de Los Ríos	4.23	65.50	36.02
X de Los Lagos	4.50	63.27	37.65
XI Aysen	3.97	241.09	203.03
XII de Magallanes y Antártica	2.56	225.82	89.68
Total country	**3.32**	**63.83**	**60.16**
Central Chile	**2.83**	**68.40**	**24.21**

Source: Author's computation based on the data provided by Instituto Nacional de Estadisticas (2007)

1.4.2 Data collection

The data used for this study have been obtained from a survey of a random sample of farms in central Chile, recorded by the Natural Resources Information Center (CIREN). The survey only considers market-oriented farmers, defined as farmers who manage a minimum of 10 productive hectares and who sell their crops to a third party. Subsistence, non-cultivated and recreational farms are excluded because formal financial institutions primarily target market-oriented farmers, who are the primary players in the Chilean agricultural sector. The

minimum of 10 productive hectares was chosen because it is considered the minimum farm size required to support family life expenses in Chile.

In early 2006, the questionnaire[3] was pretested and slightly modified afterwards. In the pre-test survey we collected information from 52 farmers located in four counties in the central region of Chile. In this pre-test we also aimed to collect information about production cost. However, due to the variation in farm outputs and misunderstanding of some cost management concepts, we decided to leave out the cost items. The pre-test and the final version of the survey were conducted by a well-trained group of students from the agricultural department of Universidad Santo Tomas.

The final version of the survey consists of 13 sections. Section 1 covers the identification of the respondent and general information about the firm. Section 2 includes the core questions dealing with credit behavior, including information on loan sources, loan applications, credit contracts, credit from suppliers, traders and collateral. Section 3 looks for information about production activities including yields, sales channels of plant and animal products production, and agricultural practices. Sections 5-9 encompasses tallied information on assets and machinery of the farm, communication systems, accounting, and the labor force. Section 10 contains questions about marketing and problems with sales channels. Section 11 asks questions about investment and finance, including information on current and past period investment expenses. Section 12 closes with questions related to the biggest problem reported in the previous season. Section 13 is intended to provide information on the course and success of the interview.

The survey was carried out in 2006 and 2008 and contains data on the 2005–06 and 2007–08 seasons, respectively. In terms of weather conditions, 2005 was considered a dry

[3] For the final version of the questionnaire see Appendix 1.

year, while 2008 was considered a representative year. On the other hand, 2008 was the beginning of the world financial crisis which also hit the Chilean financial sector.

The first wave of the survey contained a random sample of 200 farms located in the seven counties in the central region of Chile mentioned before. The second wave contained information from 200 farmers, 177 of which were in the first wave. The same questionnaire was used for the two waves. The difference in the sample set for the two rounds was due to the fact that out of the original sample of 200 farmers, five could not be traced again, two left farming altogether, seven refused to participate in the second round, seven did not want to share "strategic" financing information, and two failed to meet the minimal land-size requirement. In the second wave, we introduced two additional questions to the survey: the distance to the closest bank office and the duration of the relationship with that institution.

The same data base is used throughout the thesis, although different variables are used in each chapter as dependent and explanatory variables. Thus in Chapter 2, social-capital variables, such as the number of relationships that a farm has with an export and/or input supplier and the length of farm-bank relationships, are introduced and analyzed in their effect on determining credit constraint status. Chapter 3 focuses on variables representing formal credit constraint status and its effect in use of informal sources of lending. Chapter 4 intends to explain the influence of credit constraint on farm productivity, while in Chapter 5 the credit constraint is used as a variable explaining the intention to invest.

The proposed survey addresses explicitly specific questions related to access to credit which are absent in most of the datasets in the country. As explained before, Chile lacks a detailed data base in the agricultural sector, and so the data collected for this thesis during the two rounds of questioning are innovative in studying the Chilean market. Using appropriate econometric techniques for panel data is convenient in this case because it limits the effect of unobservable heterogeneity due to individual characteristics.

Limitations of the survey include a number of potential sources of measurement errors encountered during the implementation of the survey. As previously explained, in the pre-test we tried to collect information about production cost. However, production cost information that was collected had errors due to misunderstanding some cost concepts and to the reluctant reaction of some farmers to answer these questions. Consequently, all return and efficiency variables were measured without considering production costs.

Another limitation is the variable that measures investment. Investment is a dynamic variable that changes over time where the amount of change depends on the initial investment level. Thus we need to know the initial values of investment for each farmer. This problem was managed by using past values of investment collected by memory. Although this method may cause measurement errors, it was the best possible way to collect information needed for Chapter 4.

Finally, data collection inevitably suffers from some degree of sample selection bias. Although farmers were randomly selected from each county, in many cases farmers refused to answer the questionnaire, and had to be replaced by other farmers. This may cause sample selection problems because willingness to answer the survey could be correlated with the likelihood of being credit constrained.

1.4.3 Methods of analysis

1.4.3.1 Credit constraints

According to the literature, credit constraints refer to a situation where the demand for credit exceeds the supply of credit at the prevailing interest rate (Feder, Lau et al., 1990; Kochar, 1997; Petrick, 2004b). This definition is referred to as "pure credit rationing" (Jaffee and Stiglitz, 1990b). Under this definition individuals in some cases are able to obtain loans, while other seemingly identical individuals, who are willing to borrow at precisely the same terms, do not. Borrowers are either rejected or receive a lower amount than desired.

Boucher et al. (2009) introduced a broader definition of credit rationing. They consider not only "pure credit rationing" or in Boucher's words, "quantity rationing" but also risk and transaction-cost rationing. Farmers are transaction-cost rationed if the effective demand for credit is zero due to transaction costs. Risk rationed farmers are farmers who decide not to demand a loan since they prefer to undertake a safe lower-return investment for which no loan is needed instead of a higher-risk investment for which a loan is needed. This situation arises because the credit contract forces the borrower to bear a minimum amount of risk by showing collateral. The main implication of using the definition by Boucher et al. (2009) is that credit rationing may also be identified in cases where the effective demand for credit is lower than the supply of credit.

Boucher et al. (2009) define five categories of borrowers:

a) Unconstrained borrowers. The household is unaffected by a credit limit from the formal financial sector and obtains the desired amount.

b) Unconstrained non-borrowers. The household is unaffected by a credit limit, but does not borrow in the formal sector because it has no profitable project that requires a formal loan.

c) Quantity rationed. Households face a binding credit limit because their loan application is rejected, do not seek a formal loan because the loan requirements cannot be met, or they obtain a loan but a lower amount than requested.

d) Transaction-cost rationed. Households do not face a binding credit limit, but they do not seek a formal loan because the transaction costs associated with the loan application are too high.

e) Risk rationed. Households do not face a binding credit limit, but they do not seek a formal loan because the risk related to the collateral needed to obtain the loan is too high.

The direct-elicitation method (Boucher, Guirkinger et al., 2009) is applied to determine the relevant borrower category for each firm throughout this thesis (see Appendix 2).

Petrick (2005) explains six methods to determine credit constraints: 1) direct measurement of loan transaction costs (Cuevas and Graham, 1986; Meyer and Cuevas, 1992); 2) qualitative information collected in interviews (Feder et al., 1989; Jappelli, 1990; Boucher, Guirkinger et al., 2009); 3) quantitative information collected in interviews (Diagne, 1999; Diagne et al., 2000; Zeller and Sharma, 2002); 4) spill-over models (Bell, Srinivasan et al., 1997a); 5) static household models (Feder, Lau et al., 1990; Moschini and Hennessy, 2001; Petrick, 2004a); and 6) dynamic investment models (Bond and Meghir, 1994). According to Petrick's classification, primary qualitative information collected in interviews is used in Chapters 2 and 3, a static household model in Chapter 4, and an approximation of a dynamics investment model in Chapter 5. Meanwhile, all the chapters rely on the three categories of credit constraints: quantity, transaction cost and risk constraints.

1.4.3.2 Multilevel analysis

Multilevel analysis refers to modeling when data are clustered in some way. In panel data for instance, data are clustered because multiple observations over time are nested within individual observations. Such a structure of the data provides rich information on process operation at different levels. Multilevel analysis capitalizes on this richness of data allowing for dependence or correlations among responses observed for units within the same cluster.

Although with a different purpose, multilevel analysis is applied throughout this thesis. In Chapter 2 multilevel analysis is applied in a multinomial-modeling context to allow for each mutually exclusive credit constraint alternative depending on a set of farm-specific variables, capturing individual unobservable heterogeneity by using alternative-specific random intercepts.

Alternatively, Chapters 3, 4 and 5 use multilevel analysis to consider both potential endogeneity problems and individual unobservable heterogeneity. In doing so, a system of equations is estimated simultaneously: the main equation that we want to estimate and an endogenous dummy equation. To induce correlation, a shared random-effect term is introduced in both equations. Although in each of these three chapters mentioned above the endogenous dummy variable stands for credit constraint status, the main equation in Chapter 3 is whether informal credit is used. In the case of Chapter 4, the main equation represents output production, while in Chapter 5 the main equation is whether or not a farmer invests. In both Chapters 3 and 5, the credit constraint dummy variable is included in the main equation and is treated as an endogenous variable. In Chapter 4 the credit constraint variable is the selection condition and is not included in the main equation. The main equation is observed only if the selection condition is met. Although in different ways, all these three chapters take in consideration endogeneity problems using multilevel analysis.

Chapter 2

Credit Constraints of Market-Oriented Farmers in Chile[4]

Abstract

Using data from two surveys conducted in 2006 and 2008 with 177 farmers, this chapter determines whether market-oriented farmers in central Chile are credit constrained, and it identifies the main factors that influence formal credit provision. In so doing, this study explicitly tests whether social capital variables play a role in determining credit constraints. That is, the authors explore the determinants of classifications into four categories of credit provision and rationing, using a panel multinomial logit model. The results suggest that most market-oriented farmers are unconstrained. Empirical evidence supports the importance of relationship variables for improving access to financial capital.

2.1 Introduction

The study of access to credit in rural areas is important because Rural Financial Markets (RFMs) link to national-level financial markets. This linkage reduces seasonal, sector and regional fluctuations in the demand for and supply of credit; subsequently, it creates the potential for rural populations to participate in investments outside the rural sector (Moll, 2005). Moreover, access to credit may increase the production efficiency of rural small businesses, including farmers, and help promote a dynamic business environment in rural areas. Without credit constraints, consumption and investment decisions get separated, which enables businesses to set the inputs for the production processes at an optimal level (Carter,

[4] This chapter is accepted as : Reyes, A. and R. Lensink, The Credit Constraints of Market-Oriented Farmers in Chile. Interaction of Formal and Informal Rural Credit Institutions in Central Chile. *Journal of Development Studies*. In press.

1989; Feder, Lau et al., 1990; Foltz, 2004). Access to rural credit also may stimulate new investments and induce new technologies (Khandker and Faruqee, 2003).

However, RFMs are often inefficient, which means they cannot provide all the financial products that rural households demand during a specific period. This mismatch in demand and supply reflects several market imperfections, including (1) monopolies in credit markets, as exercised by informal lenders (Bell, Srinivasan et al., 1997a); (2) large transaction costs incurred by borrowers applying for loans; (3) imperfect information that leads to adverse selection and moral hazard problems (Stiglitz and Weiss, 1981; Carter, 1988); and (4) screening, monitoring, and enforcement problems faced by lenders (Hoff, Braveman et al., 1993).

The imperfection of RFMs is especially severe in developing countries. According to Moll et al. (2000), only large-scale farmers in El Salvador's RFMs receive credit from formal financial institutions. Moreover, the loans provided by these formal institutions are substantially larger than those provided by other suppliers. Similar results emerge in India (Bell, Srinivasan et al., 1997a; Kochar, 1997), Tunisia (Foltz, 2004), Pakistan (Khandker and Faruqee, 2003), and Poland (Petrick, 2004b). This study aims to examine whether market-oriented farmers in central Chile similarly are credit constrained, as well as identify the main factors that influence formal credit provision and constraints for market-oriented farming in Chile.

Our contribution is threefold. First, this study applies a broad definition of credit constraints to market-oriented farmers in Chile. In line with Guirkinger (2008), Boucher et al. (2009) and Fletschner et al. (2010) we explicitly differentiate between credit constraints due to high transaction costs or risk aversion and quantity constraints. By using this approach, we can also distinguish different categories and thus provide a more detailed picture of credit constraints and their determinants. Boucher et al. (2009) focus on Peru, and find evidence for

the importance of credit constraints. Their study suggests that the fraction of households that is credit constrained is about 50%. Unlike Peru, Chile has a financial sector that is highly competitive and deregulated, which may mitigate financial market imperfections. In 1974–83, the Chilean government liberalized the financial sector by abolishing virtually all financial controls. However, this liberalization destabilized the economy, forcing the government to step in during 1983 and rescue failing banks (Fry, 1994). The government also introduced a financial supervisory system (*Superintendencia de Bancos e Instituciones Financieras*) that remains in place. This regulation framework attempts to reduce bank failures and helps ensure an adequate level of bank solvency (Fuentes and Vergara, 2003).

The Chilean financial sector comprises 20 active commercial banks:[5] 12 foreign-owned, seven private Chilean-owned, and one state-owned (SBIF, 2009). In the past 20 years, the financial sector has undergone outstanding growth; in 2001, the ratio of credit allocated by deposit money banks to gross domestic product was 63.6%, far greater than the next highest ranking, Brazil (Gallego and Loayza, 2004; Hernandez and Parro, 2004). Yet anecdotal evidence suggests persistently severe financial constraints for farmers; in the period between 1990 and 2009, private banks decreased their credit provision to the agricultural sector in Chile from 10% to 4.1% of the total credit provided by commercial banks (ODEPA, 2005). Thus it is important to investigate the extent to which rural Chile is still plagued by credit constraints.

Second, this study focuses on the importance of social capital, in the form of long-term relationships, for broadly defined credit constraints in the context of market-oriented farming in developing countries. Several authors have argued that private information occupies a central place in bank–customer relationships and that the extent of private information increases with the amount of contact between a bank and its customers over time (Diamond,

[5] Excluding branches of foreign banks that are mainly devoted to cash and portfolio management activities.

1991; Rajan, 1992; Berglof and von Ernst-Ludwig, 1994; Boot and Thakor, 1994; Chemmanur and Fulghieri, 1994; von Thadden, 1995; Ongena and Smith, 2001).

When a bank evaluates a request for credit, it can collect private information about the applicant first-hand or obtain this information from other lenders that already have dealt with it. Theory suggests that information sharing may overcome an adverse selection problem in the credit market (Pagano and Jappelli, 1993) and reduce moral hazard by raising borrowers' efforts to repay loans (Padilla and Pagano, 2000) or causing them to avoid excessive lending because each borrower can patronize several banks (Brown et al., 2009). Thus, interconnected relationships, such as a business cluster, can signal that the borrower is trustworthy, so bankers may be willing to require less paperwork in loan applications. In addition, from farmers' perspective, the more interconnected are firms with different clusters, the better information they can gather about alternative funding sources for their project.

Third, this study uses a rich data set, based on a panel of 177 farmers for over two years. Most comparable studies rely on cross-section data. A key advantage of our study thus is that it uses efficient and unbiased panel estimators. Specifically, we identify determinants of credit constraints by estimating a multinominal logit model with random effects, which controls for unobserved heterogeneity.

We focus particularly on market-oriented farmers, the main players in the Chilean agriculture sector. In the Chilean agricultural and forestry sectors, market-oriented farmers[6] account for 96.5% of the landowners, whose holdings constitute 96.4% of the total fruit farm area and 94.9% of the total vegetable farm area (ODEPA, 2005).

We organize the remainder of this chapter as follows. Section 2 explains some basic concepts with respect to social capital, and the relationship between social capital and credit

[6] The Economic Development Agency of Chile (CORFO) distinguishes micro, small, medium, and large-scale entrepreneurs as follows: micro entrepreneurs have an annual gross income up to US$78,000; small entrepreneurs earn from $78,000 to $808,000; medium entrepreneurs take in $808,000–$3,231,000; and large entrepreneurs make at least $3,100,000. Our definition of market-oriented farmers applies to small, medium, and large-scale farmers.

constraints. It also sets out our focus on two proxies for social capital, clusters and the length of bank relationships. In section 3 we provide a description of business clusters in the Chilean context. Section 4 contains a literature review regarding measures of credit constraints and explains our approach. We then describe the empirical model and present the results in section 5. Section 6 summarizes the findings.

2.2 Social capital and credit rationing

The economic backwardness of many countries can be explained by massive failures in co-ordination (Kondonassis et al., 2000). Co-ordination failures occur if there is no individual incentive for market agents to trade and benefit from transacting with each other. The following example may help explain this: If farmers could obtain a loan, they would probably invest in the resources to produce higher-quality output. A bank manager is willing to lend a farmer money if the farmer is able to repay the loan, and the farmer would be able to repay the loan if (s)he could sell the produce to a trader. The trader, in turn, would guarantee the purchase if (s)he knew there was sufficient volume and quality to cover the costs, which depends on the farmer's access to finance. However, these transactions may never happen because of high mutual uncertainty over quality and volumes. In rural economies this uncertainty is the rule rather than the exception due to long production cycles, small volumes of transaction, uncertain demand, and poor quality assurance tools.

In order to improve economic performance of farmers, market transactions need to be coordinated by either market or non-market mechanisms. However, inducing more competition on such failing markets may not be the solution. It may also not be advisable to increase the role for government interventions since governments are "neither sufficiently informed or sufficiently accountable to correct all market failures" (Bowles and Gintis, 2002, F409).

In recent decades, there has been a striking interest in the importance of social capital for reducing co-ordination problems. However, social capital is a broad concept which is defined differently across studies. Some authors measure social capital in terms of cultural values, for example, by accounting for the degree of altruism in a society (Fukuyama, 1995). Others, such as Putnam (2000, p.19), define social capital as "connections among individuals— social networks and the norms of reciprocity and trustworthiness that arise from them". According to most definitions, social capital is strongly related to trust. It refers to the set of rules, norms and values that permit people to work with each other, and trust each other. The importance of social capital is clear since developmental problems are strongly related to a lack of mutual confidence and trust. Every commercial transaction has within itself an element of trust, especially in credit markets since these transaction are conducted over a period of time.

There is vast literature on the role of social capital; see for example Durlauf (2002), Bowles and Gintis (2002), Glaeser, et al. (2002), and the references therein. This literature shows that social capital becomes important when market institutions fail. Especially in credit markets in developing countries, which are characterized by asymmetric information and consequently severe adverse selection and moral hazard problems, the development of social capital is important. The reason is that social capital, such as in the form of networks, may facilitate screening and monitoring of borrowers, and hence improve access to credit. In credit markets where efficient information services are absent, the development of social capital may help to improve information sharing between borrowers and lenders.

Empirical studies have used dozens of proxies for social capital (see for example Durlauf, 2002). In our study we focus on how social capital is related to bank-farmer relationships. We do not intend to cover the entire spectrum of bank-farmer relationships. Rather we focus on two variables, the number of cluster relationships and the length of the

bank relationship, to shed some light on the importance of social capital in explaining access to credit for market-oriented farmers in Chile.

A cluster is broadly defined as a group of supply chain actors — input suppliers, farmers, processors, traders, extension agencies, and banks — who interact repeatedly. Being a member of a cluster measures different aspects of social capital, which is normally understood as the quantity and quality of interpersonal relationships. Chain actors' access to key resources is critical (Slack et al., 1995), but may be hindered by co-ordination problems. Clusters may allow improved access to organizational capability at the grassroots level; information on markets, technologies and product quality; and finance. For our analysis, the cluster effect on credit is especially important. We hypothesize that financial access is positively related to social capital.

We also consider the importance of the length of the relationship with the bank . In line with the cluster effect, a longer bank-farmer relationship may increase trust, and hence social capital in credit markets. By means of relationship lending, banks collect private information on rural farms, which is rare and costly in developing countries. Consequently, the farm and the banks enter in a long-term relationship that assures the farm's access to credit and gives the bank access to information about the farm (Baas and Schrooten, 2006). Schaefer (2003) argues that in such relationships banks increase the value of the farm or firm's information. This implies that by means of long-term relationship, a firm transmits information about the company and its projects to the bank, who may consequently reduce the loan interest rate and collateral requirements. Long-term relationships may also reduce transaction costs of applying for a loan. The transaction costs decrease because the borrower does not need to provide as much information to the bank (Degryse and Ongena, 2005). Moreover, knowledge about the procedures to be followed when applying for a loan will increase over time.

2.3 Business clusters in the agricultural sector

In the mid-1970s, the Chilean government introduced a more market-based resource allocation. The role of the government became less important, measures to liberalize trade were introduced, and trade and private property rights were strengthened (Valdes and Jara, 2008). With regard to financial sector policies, interest rate ceilings as well as the preferential rates for the agricultural sector were abolished. The reforms had a profound impact on land markets and on firms that provide services to the agricultural sector, such as input suppliers and transport companies. The new land policy provided unrestricted access to landownership and improved the protection of property rights. Individual land titles were redistributed to the beneficiaries of the land reform programs. Moreover, input and product markets were privatized.

The agricultural sector was especially affected by trade liberalization because they included a reduction or even a complete elimination of nontariff barriers on most imports and an elimination of export restrictions. In addition, a uniform import tariff was introduced, at 90% in 1975 gradually falling to 10% in 1979.

The most influential trade policy change in recent years was the introduction of free trade agreements, with Canada (1997), Mexico (1999), the European Union (2003), the Republic of Korea and the United States (2004), New Zealand and Singapore (2005), China and Peru (2006), and Japan (2007). These agreements resulted in a reduction of the effective average tariff rate across all goods to about 2% in 2007 (Valdes and Jara, 2008).

The trade liberalization attracted trade companies who saw great opportunity to export fruits, wine and processed food. They organized themselves as business clusters, led by export and input supplier firms. Within these clusters, different companies such as specialized suppliers, service providers and associated institutions, cooperated in order to increase productivity by means of, for example, getting access to credit and marketing their products.

Within such clusters, export firms offered farmers credit for working capital, technical assistance, and crop inputs in exchange for the farmers' promise to provide the harvest that would subsequently be marketed by the export firm. Credit for farmers primarily financed fresh fruit production, with a few exceptions in such crops as sugar beets, tobacco, tomatoes and certain types of horticultural production for agro-industry (Conning and Udry, 2007). As the cluster coordinator, input supplier firms provide in-kind short-term credit, generally payable at harvest. Usually they operate in a restricted geographic area or in a specific section of the market. These firms not only sell inputs, such as seeds, fertilizers, or farm machinery, but also offer technical assistance, training courses, and fruit quality certification.

2.4 The sample

The survey is based on a random sample of farms in central Chile, recorded by the Natural Resources Information Center (CIREN). We only consider market-oriented farmers, defined as farmers who manage a minimum of ten productive hectares and sell their crops to a third party (market). We exclude subsistence, non-cultivated, and recreational-oriented farms, because formal financial institutions do not primarily target them; instead, as we noted, market-oriented farmers are the main players in the Chilean agricultural sector. We choose ten hectares as the minimum productive area because it represents the minimum size required to support a family in Chile.

The survey, conducted in 2006 and 2008, refers to data about the 2005–06 and 2007–08 seasons, respectively. The first wave contains a random sample of 200 farms located in seven counties in central Chile (Los Andes, San Felipe, Rancagua, San Bernardo, Buin, Paine and Melipilla), selected because they represent the most important fresh fruit and vegetable production regions. The second wave contains information from 200 farmers, 177 of which were in the first wave. The same questionnaire applies across both waves. However, in the second wave, five farmers could not be found again, two had left the farming industry, seven

refused to answer, seven did not want to share "strategic" financing information, and two failed to meet the minimal land size requirement. Furthermore, the second wave contains an additional question, that is, the length of time the firm had had a relationship with a bank. This variable appeared in the first wave but only for farmers who had obtained credit. The second interview asked the rest of the sample if farmers recalled having a bank relationship.

In Table 2.1, we provide the descriptive characteristics of the 177 farmers, separated by year. The mean farm size is 78 and 76 hectares for 2006 and 2008, respectively, similar to the average size for all individual farms in central Chile with a minimum of ten hectares (see Table 1.9). The average firm–bank relationship was relatively long, at 13 years in 2006.

Table 2.1: Sample statistics by year (n = 177, each year)

Variable	Definition	2006 Mean	2006 Standard Deviation	2008 Mean	2008 Standard Deviation
CLUSTER	Number of relationships that a firm has with export and/or input supplier firms.	1,27	0,66	1,56	0,88
LENGTH	Length of firm–bank relationship (years)	13,30	12,53	14,92	12,61
HECTARES	Owned land (hectares)	77,57	95,44	76,02	91,38
YEAR_ADM	Amount of farming years	0,03	0,18	0,03	0,18
INSURANCE	Binary dummy with a 1 if the firm use insurance instruments, 0 otherwise	0,26	0,44	0,20	0,40
NO_PROGRAM	Binary dummy, equal to 1 if the firm had neither an employee-training program nor a GAP certification, 0 otherwise	0,05	0,21	0,05	0,21
ALMOND	Binary dummy, equal to 1 if the farm's main product was almonds, 0 otherwise	0,07	0,26	0,07	0,26
AVOCADO	Binary dummy, equal to 1 if the farm's main product was avocados, 0 otherwise	1,27	0,66	1,56	0,88

2.5 Are market-oriented farmers in Chile credit constrained?

2.5.1 Method to measure credit constraints

Credit constraints exist when the demand for credit exceeds its supply at the prevailing interest rate (Feder, Lau et al., 1990; Kochar, 1997; Petrick, 2004b). This definition involves "pure credit rationing" (Jaffee and Stiglitz, 1990b). Thus some people obtain loans, whereas seemingly identical persons, willing to borrow at precisely the same terms, do not. These borrowers are either rejected or receive less credit than desired. Boucher *et al.* (2009) introduce a broader definition of credit rationing though that also includes risk and transaction cost rationing. That is, farmers are transaction cost rationed if no effective demand for credit exists due to the transaction costs. Risk-rationed farmers decide not to demand a loan because they prefer a safer, lower return investment that demands no loan, rather than a higher risk investment that requires a loan, because the credit contract forces the borrower to bear a minimum amount of risk in the form of collateral. Boucher *et al.*'s (2009) definition therefore implies that credit rationing occurs even when effective demand for credit is lower than its supply. In turn, Boucher *et al.* (2009) identify five categories of borrowers:

a) **Unconstrained borrowers**. The household is unaffected by credit limits in the formal financial sector and obtains its desired amount.

b) **Unconstrained non-borrowers**. The household is unaffected by a credit limit but does not borrow in the formal sector because it has not undertaken a profitable project that would require a formal loan.

c) **Quantity rationed**. Households face a binding credit limit because their loan application is rejected, do not seek a formal loan because they cannot meet loan requirements, or obtain a loan but for less than requested.

d) **Transaction cost rationed**. Households do not face a binding credit limit, but they do not seek a formal loan because the transaction costs associated with the loan application are too high.

e) **Risk rationed**. Households do not face a binding credit limit, but they do not seek a formal loan because the risk implied by available credit contracts is too high.

We apply a direct elicitation method (Guirkinger, 2008; Boucher, Guirkinger et al., 2009; Fletschner, Guirkinger et al., 2010) to determine the relevant borrower category for each farm. Depending on responses, we classify farmers into the five categories listed above.[7] Table 2.2 contains common answers and the associated rationing category.

Table 2.2: Common answers to qualitative questions

Answers	Constraint Status
I received the desired loan from formal lenders in the past three years.	Unconstrained (borrowers)
I do not need a loan. Interest rate is too high. Farming does not give me enough to repay a debt.	Unconstrained (non-borrowers)
I received a loan from formal lenders in the past three years, but not the desired amount. I applied for a loan in the past three years but my application was rejected. I did not apply for a loan because I did not think the formal institution would accept my application.	Constrained (quantity rationed)
I did not want to risk my land. I did not want to be worried/I was afraid. Formal lenders are too strict; they are not as flexible as informal ones. Formal lenders do not offer refinancing.	Constrained (risk rationed)
The bank branch was too far away. Banks require too much paper work associated with application.	Constrained (transaction-cost rationed)

2.5.2 Results

In Table 2.3, we summarize the results of interviews that classified the farmers as credit constrained or unconstrained[8] (Boucher, Guirkinger et al., 2009). A remarkable outcome is that most farmers believed themselves credit unconstrained—the percentage of unconstrained farmers even increased over time, from 83.6% in 2006 to 86.4% in 2008.

The percentage of farmers constrained due to risk rationing also was very low: 2.8% in 2006 and 3.4% in 2008. A similar finding holds for the percentage of farmers constrained by transaction costs, or 2.8% and 0.6% in 2006 and 2008, respectively. The percentage of

[7] See details about direct elicitation methods in Appendix 2.
[8] See section 1.4.2 for details on data used.

quantity-constrained farmers was 10.7% and 9.6% in 2006 and 2008, respectively. Within the group of quantity-rationed farmers in 2006, 8.5% were borrowers and 2.3% were non-borrowers. In 2008, these values were 9% and 0.6%, respectively.

Table 2.3: Classification of farmers by credit constraint status (%)

Credit Constraint Status	2006	2008
Unconstrained		
Borrowers	36.2	36.7
Non-borrowers	47.5	49.7
Total credit-unconstrained farmers	**83.6**	**86.4**
Constrained		
Quantity rationed	10.7	9.6
Risk rationed	2.8	3.4
Transaction cost rationing	2.8	0.6
Total credit-constrained farmers	**16.4**	**13.6**

Note: Results are percentages and refer to surveys in both rounds (n = 177, each year).

Without a comparable counterfactual country, we cannot unambiguously determine why perceived credit constraints might be relatively low in Chile compared with other developing countries. Yet it seems as if the financial sector policies in Chile—including deregulation and an adequate regulatory framework—have been successful and resulted in the widespread locations of commercial banks. With our data set, we cannot determine why the degree of credit rationing would be relatively low at the country level. Instead, we conducted a further study of the reasons for differences in credit status within Chile.

2.6 Determinants of credit constraints

2.6.1 Econometric specification

The analytical model distinguishes five categories of borrowers: price-rationed borrowers; price-rationed non-borrowers; and quantity-, risk-, and transaction cost-rationed borrowers. The percentage of risk- and/or transaction cost-rationed farmers is very low, so we merged these categories, which simplified the analysis considerably without affecting the main results. Hence, in our econometric analysis we focus on the following four categories: price-rationed borrowers; price-rationed non-borrowers; quantity rationed borrowers, and transaction cost and risk-rationed borrowers.

We use a multinomial logit model with random effects to determine the factors that influence credit constraint. For a detailed technical description of this model, see Appendix 3. This convenient approach focuses on a single category from mutually exclusive categories in which the dependent variable is multinomial. In our case, we have four mutually exclusive categories that depend on a set of farm-specific variables.

The multinomial logit model with random effects estimates the probability that a farmer managing at least ten hectares in central Chile belongs to one of the four mutually exclusive alternatives. The coefficients we will estimate measure the effect of a variable on the probability of being classified as one of the alternatives, compared with a reference category. We chose unconstrained borrowers as the reference category.

There are several advantages of using a multinomial logit model with random effects. First, it allows us to capture individual unobservable heterogeneity by allowing alternative-specific random intercepts. It is likely that farmers belong to different categories of credit constraints, and that part of the credit constraint status heterogeneity is related to the unobservable farm and individual characteristics. Second, it accounts for the fact that each individual makes several choices which cannot be assumed to be independent. Probabilities of each category for repeated observations on the same individual share the same unobservable random effects and are assumed to be correlated.

However, the multinominal logit model with random effects also has some methodological limitations. The random effects model does not control for endogeneity problems due to unobserved time-varying and time invariant variables that are correlated with the error term. The choice to enter a business cluster may be endogenous, and be induced by credit constraints. However, this is not very likely in the Chilean context since the formation of the clusters is induced and coordinated by the export firms and the input suppliers to attract clients, and not by the borrowing farm. It may also be the case that unobserved management

characteristics are correlated with the choice of a particular production program, which would bias our parameter estimates. While our approach may partly suffer from these drawbacks, we do not believe that endogeneity problems would invalidate our main results with respect to the relationship variables. The reason is that clusters are formed for relatively long periods, and are predetermined with respect to the different categories of rationing, which implies that it is likely that the relationship variables are exogenous with respect to the different credit constrained categories.

2.6.2 Variables explaining credit constraints

The credit market is characterized by asymmetric information, with adverse selection and moral hazard problems that induce commercial banks to ration credit (Freixas and Rochet, 1997). Several variables may reduce credit constraints. We focus our analysis on two social capital/ relationship variables that have received relatively little attention, especially in developing countries: the number of clusters and the number of years the farmer has had a relationship with the bank. In Table 2.4, we list the expected sign for each variable that we consider.

Table 2.4: Explanatory variables for multinomial logit model and expected results compared with reference category (unconstrained borrowers)

Groups	Variable	Unconstrained Non-borrowers	Constrained (quantity rationed)	Constrained (transaction cost or risk rationed)
Relationship variables	CLUSTER	-	-	-
	LENGTH	NS	-	-
Control Variables	HECTARES	+	-	
	YEAR_ADM		-	
	INSURANCE		+/-	
	NO_PROGRAM		+	+
	ALMOND		+	
	AVOCADO		-	

2.6.2.1 Relationship variables

According to prior literature, participating in a business cluster may increase firm productivity, because it increases cooperation among the participating firms. More cooperation implies more information about alternatives funding sources and less paperwork

required by banks to provide a loan. In addition, more cooperation may lead to more risk sharing and/or to better access to some form of insurance.[9]

We therefore hypothesize that an increase in the number of relationships that a farm has with export firms and/or input supplier firms (number of clusters) has several effects. First, the probability of being a quantity-constrained borrower decreases because belonging to more clusters signals that the farm is creditworthy. If a farm is related to more clusters, it would also make more funds available, reducing the need to borrow from outside sources and hence the probability of becoming a quantity-constrained borrower, especially relative to the probability of becoming an unconstrained borrower. Second, the probability of becoming a transaction cost- and risk-rationed borrower declines, because relationships with more clusters suggest that the farm is creditworthy, so the need for the bank to screen the farm declines, as does the demand for paperwork. Third, we predict that the probability of becoming an unconstrained non-borrower, relative to probability of becoming an unconstrained borrower, decreases as the probability of becoming an unconstrained borrower increases due to the decline in the probability of being rationed.

A longer bank relationship also improves the accuracy of the bank's information about the creditworthiness of the farm and reduces monitoring costs (Degryse and Ongena, 2005; Baas and Schrooten, 2006). It is more likely that a bank would be willing to extend a loan if its relationship with the farm were longer. In addition, the transaction costs related to applying for a loan decrease, because the borrower probably can provide less information to the bank. Degryse and Ongena (2005) report that to obtain a loan, a new borrower may have to visit the bank branch between two and three times, whereas a repeat customer is not required to undertake additional visits. Yet the impact of this trend on the probability of becoming an unconstrained non-borrower is unclear. Alternatively, the probability of becoming a

[9] We thank a referee for this suggestion.

constrained, quantity-rationed farmer may decline if the length of the bank–farm relationship increases. The same trend should hold for the probability of becoming a risk- and/or transaction cost-rationed farmer. [10]

It should be noted that we have used the log of the length of the lender-borrower relationship, while the cluster size is not taken in logs. The reason is that by using logs for the lender-borrower relationship we want to control for the fact that it is highly likely that the length of the relationship is especially important in the beginning of the relationship, and becomes less important when the relationship has lasted for a long time. After several years, banks know their clients, such that increasing the relationship time even longer does not have a substantial effect. [11]

2.6.2.2 Control variables

We include control variables that empirical bank literature cites as important for explaining credit constraints. Collateral can signal the quality of a borrower (Bester, 1985), and the availability of collateral may reduce moral hazard (Hoff and Stiglitz, 1990; Boucher, Guirkinger et al., 2009). A bank should be more willing to provide a loan when the borrower can back the loan by pledging some collateral. An increase in the availability of collateral therefore should reduce the probability of being a quantity-rationed borrower. We use total land owned by the farmer as a proxy for collateral; it includes cultivated and non-cultivated areas in the field. We expect that the probability of becoming an unconstrained non-borrower increases if the amount of collateral increases, because wealthier, unconstrained farmers have more financial capital to self-finance.

[10] In principle, an increase in the length of the bank-firm relationship may also increase the probability that the borrower reaches a credit ceiling since, for example, the bank knows better the capacity of repayments of the firm. Although we hypothesize that an increase in the length of the relationship will reduce credit constraints, the econometric tests may suggests otherwise.

[11] For robustness we also estimated the models by taking logarithms of both relationship variables. This didn't change the results in terms of significance. These results can be obtained on request.

For constrained, quantity-rationed farmers, we expect the sign for the collateral variable to be negative, which implies that an increase in the amount of hectares available decreases the probability of being classified as a quantity-constrained borrower, because farmers with more land have more collateral to show formal credit institutions and thus should receive the loans they request.

Farmers' management skills also may reduce credit constraints (Barry and Robison, 2001), because a high quality entrepreneur should be more likely to repay a loan. High-quality entrepreneurs also can better convince potential lenders that they are creditworthy. We use several variables to represent management skills, including years of farming experience (Feder, Lau et al., 1990; Petrick, 2004b), and whether the farmer has completed a training or certification program. We hypothesize that the probability of becoming a constrained quantity-rationed farmer relates negatively to management skills. We also included a dummy variable indicating whether the farmer has made use of insurance instruments. The impact of insurance on credit constraints is ambiguous. On the one hand, more insurance may reduce risks for the bank, and hence improve access to credit. On the other hand, full insurance may be a signal for bad borrowers. In this case, insurance will increase the probability of being credit constrained. This latter argument is based on Leland and Pyle (1977). They use a model with asymmetric information and two types of borrowers: good and bad borrowers, who only differ in their probability of success. The good borrowers take less risk than the bad borrowers, and hence have a higher probability of success. The bank, because of asymmetric information, cannot distinguish the good from the bad borrowers and accordingly sets a common interest rate for both groups. This common interest rate discriminates against the good borrowers, who therefore wish to convince the bank, i.e. signal, that they are good borrowers. In the model of Leland and Pyle, the good borrowers can signal that they are good by taking incomplete insurance. The reason is that both types of borrowers are risk averse,

and hence would prefer to have full insurance. The cost of not being fully insured is, however, lower for the good borrowers than for the bad borrowers since the probability of failure is lower for the good borrowers. The bank knows this, and hence will understand that only the good borrowers will decide to be less than fully insured, and consequently decides to ask a lower interest rate from the good borrowers.

Finally, we use variables that reflect farm characteristics (Barslund and Tarp, 2008), which may relate to farmer management skills. We also assume that the degree of skill the bank's officer has in terms of assessing an agricultural project is important. In other words, banks should be willing to extend a loan if their officers have more experience assessing certain types of project. We include two variables to take into account the farm's activity: avocado and almond. Chile has a strong tradition of producing avocado, which is the second biggest export in its agriculture sector. Almonds represent a new agricultural project with less tradition in Chile. Therefore, for constrained quantity-rationed farmers, we anticipate a negative sign for well-known activities such as avocados but positive signs for new projects such as almonds.

2.6.3 Results

We present in Table 2.5 the results of the multinomial logit model (MNL) with random effects. There is some evidence in support of the random effects model over a MNL model without random intercepts (see Appendix 4, Table A4.1). The likelihood ratio (LR) test compares the MNL model with and without random effects and shows that the random effect of individual farms varies significantly between categories. The Bayesian Information Criterion (BIC) and Akaike's Information Criterion (AIC) are provided to compare the different specification models[12]. Using BIC, the model presented in Table 2.5 is preferred

[12] As a proof of robustness of the estimation, we tested two complementary models. The results produce similar estimations for all models (See Appendix 4, Tables A4.2 and A4.3).

over the others in Appendix 4, Table A4.2 and A4.3. Although the AIC favors the model in the Appendix 4, Table A4.2, we chose model presented in Table 2.5 because is simpler.

Table 2.5: Coefficient of regressors on different categories of credit compared with unconstrained borrowers

Variable	Unconstrained Non-borrowers	Constrained Quantity Rationed	Constrained Transaction Cost and Risk Rationed
Relationship variables:			
CLUSTER	-1.636***	0.626	-12.16**
	[0.002]	[0.296]	[0.019]
Ln(1+LENGTH)	-0.473	-0.213	-22.26**
	[0.354]	[0.705]	[0.031]
Control variables			
HECTARES	0.00524	-0.0513**	-0.0632*
	[0.384]	[0.010]	[0.055]
YEAR_ADM	0.0679*	-0.0101	0.912**
	[0.080]	[0.776]	[0.029]
INSURANCE	-0.572	14.53**	45.74**
	[0.741]	[0.011]	[0.017]
NO_PROGRAM	0.966	1.759**	-1.170
	[0.256]	[0.041]	[0.439]
ALMOND	2.234	4.734*	5.918**
	[0.159]	[0.053]	[0.041]
AVOCADO	-2.389	1.478	67.79**
	[0.198]	[0.297]	[0.034]
CONSTANT	2.302	-2.841**	-67.69**
	[0.160]	[0.041]	[0.040]
Random effects			
Var (μ_{nj})	4.564***	2.910***	64.90**
	[0.000]	[0.010]	[0.033]
Corr (μ_{j2}, μ_{j3})	-1.072		
	[0.271]		
Corr (μ_{j3}, μ_{j4})	0.467		
	[0.437]		
Corr (μ_{j2}, μ_{j4})	-2.420		
	[0.444]		
Tests			
ROC	0.6707	0.8003	0.7774
Wald test(27)	43.94***		
Log-Likelihood	279.9		
Number of observations	354		
Number of individuals	177		
BIC	753.43		
AIC	625.75		
LR test (6)	95.2***		

Notes: p-values in brackets; ***, ** and * indicate 1%, 5% and 10% levels of significance respectively; All variables are estimated using robust standards errors based on the White's heteroskedasticity consistent estimators of variance; Wald test is for test of joint significance of all regressors; Using Bayesian Information Criterion (BIC), this model is preferred over the others in Appendix 4, Table A4.2 and A4.3. Although the Akaike's Information Criterion (AIC) favors the model in the Appendix 4, Table A4.2, we chose this model because is simpler; Likelihood ratio test (LR test) tests (H0) simple multinomial logit model (see Appendix 4, Table A4.1) against (Ha) this model (multinomial logit model with random effects).

The unexplained variance in all categories and correlation between categories three and four, as captured by random effects at the individual level (Var μ_{nj}), differ statistically from zero, which means that the individual effect captured by the MNL model with random effects explains a considerable portion of total heterogeneity. The Wald test for the hypothesis that all coefficients except for the intercept term are equal to 0 is rejected at a 1% level of significance, confirming the theoretical predictions of this model. In contrast, the Receiver Operating Characteristic (ROC)[13] coefficients in the MNL model with random effects indicates acceptable results. As we explained previously, we compared the coefficients of the regressors for the different categories of credit access and constraint with unconstrained borrowers as the base category.

2.6.3.1 Relationship variables

The first relationship variable is the number of clusters that a farm belong to; it has a negative significant effect on the probability of farmers being either unconstrained non-borrowers or transaction cost- and risk-rationed farmers. Therefore, when they are less connected, farmers have fewer alternatives for investing and funding their projects, so their demand for credit decreases. Farms that belong to more clusters face lower transaction costs and risk associated with credit contracts, whether because of their collaboration with other firms in the cluster or because the bank requires less paperwork to complete the contract. However, we find an insignificant effect of the number of clusters a farm belongs to on the probability of farmers being quantity rationed. Instead of screening clients through more informed lenders, banks may prefer to screen their clients by other strategies. We test later whether banks use collateral as a screening process.

[13] An ROC curve is a plot of the true positive rate (sensitivity) against the false positive rate (1 – specificity) for all possible classification thresholds of a diagnostic test. It shows the trade-off between sensitivity and specificity (any increase in sensitivity is accompanied by a decrease in specificity). The ROC curves conventionally lie above the diagonal, such that the area under the ROC curve should be greater than 50%. A rough guide for classifying the accuracy of a diagnostic test is as follows: 0.90–1 = excellent; 0.80–0.90 = good; 0.70–0.80 = fair; 0.60–0.70 = poor; and 0.50–0.60 = fail.

In addition and as the results suggest, longer relationships reduce the probability that farmers are in the transaction cost- and risk-rationed categories. A long-term relationship between farms and banks probably reduces transaction costs and risks because the borrower has more experience filling out credit application forms and the bank requires less paperwork from these known clients. An increase in the length of the relationship does not seem to affect the probability of being quantity constraint. This may be explained by the fact that an increase in the length of the relationship may, as explained in section 2.6.2.1, reduce quantity constraints, but it may also increase the probability that the borrower reaches a credit ceiling since, for example, the bank knows better the capacity of repayments of the farm.

2.6.3.2 Control variables

Regarding the control variables, we find a negative significant effect for possession of land on the probability of being quantity rationed. According to prior literature (Hoff, Braveman et al., 1993; Crane and Leatham, 1995), access to title may affect a farmer's credit market participation through two main mechanisms. First, titled land may be used as collateral, which helps formal financial institutions overcome adverse selection and moral hazard problems. Second, after receiving the land title, a farmer who previously was discouraged from borrowing, due to risk or transaction costs, may seek a loan. These results support the argument that farmers with less collateral are more likely to be quantity constrained by formal credit institutions.

We find a positive significant effect of farming experience on the probability of being an unconstrained non-borrower. This seems plausible since farmers with more experience are more capable of self-financing, largely due to the greater efficiency they achieve through their experience with farming processes. In addition, the results suggest that an increase in farming experience increases the probability of becoming transaction cost-and/or risk rationed. This can be explained as follows. On the one hand, more experience may reduce the probability of

becoming transaction cost rationed. On the other hand, however, more experience may be related to becoming older and becoming more risk averse. If this is the case, the probability of becoming a risk-rationed borrower increases. If this latter effect is bigger than the former effect, an increase in farming experience will increase the probability of being transaction and/or risk rationed.

Also as we expected, we find a significantly positive sign for farmers who lack training or certification programs. Such farmers represent, to formal financial institutions, bad entrepreneurs, so the banks restrict their access to formal credit. We also find a significantly positive sign for almond growers, suggesting that the bank's officers have less experience assessing almond projects, because almonds are not a typical crop in Chile, and thus that banks are less willing to extend a loan for these lesser known enterprises.

Finally, we find a positive, significant effect for the use of insurance on transaction cost- and risk-rationed farmers, and on quantity-rationed farmers. The outcome with respect to quantity-rationing is in line with the Leland-Pyle model (1977). According to this model, bad firms will try to get full insurance, whereas good firms try to signal their quality by being incompletely insured. This implies that the farms that are insured are the bad firms, which will have a higher probability of being quantity rationed, see also section 2.6.2.2. The positive impact on the probability of being transaction costs and/or risk rationed may be explained by the fact that farms that take more insurance, are more risk averse and hence demand less credit because they don't want to take more risk.

2.7 Discussion and conclusions

We have attempted to determine whether market-oriented farmers in central Chile are credit constrained, as well as identify the main factors that influence formal credit provision for market-oriented farming in Chile. We define a farmer as credit constrained if the farm's effective demand for credit exceeds the available supply. However, we consider quantity rationing from the supply side, as well as rationing from the demand side, in line with Boucher *et al*. (2009). In so doing, we can investigate the extent to which credit constraints mainly stem from demand- or supply-side factors. Moreover, by distinguishing several categories of constrained and unconstrained borrowers, we provide a more detailed analysis of which variables are important for explaining the probability of belonging to a particular group of borrowers or non-borrowers.

A notable outcome of our study is that most farmers consider themselves credit unconstrained, irrespective of the type of credit constraints they face. We hypothesize that this perception results from long-term relationships between farmers and banks in Chile, which helps improve screening processes and ensure repayments. Although a long-term relationship between farms and banks has no impact on the probability of being a quantity constrained farmer, it does affect risk and/or transaction cost rationing because probably the borrower has more experience filling out credit application forms and the bank requires less paperwork from these known clients. The negative relationship between the probability of being transaction cost and/or risk rationed and the length of the relationship between farmers and banks may also be explained by the fact that a farmer that has been borrowing for a long time is less risk-rationed.

Our study also suggests that among the group of credit-constrained farmers, quantity rationing seems much more prevalent than risk and/or transaction cost rationing. To explain the main factors that affect the probability of belonging to a particular group of borrowers or

non-borrowers, we estimate a multinominal panel model with random effects. We focus primarily on the effect of two social capital variables: the number of relationships that a farm has with export and/or input supplier firms and length of the bank relationship. Our main result reveals that farmers with more social capital are less risk and/or transaction cost capital constrained. In Chile, in contrast with Boucher et al.'s (2009) predictions, demand factors do not seem to play an important role in restricting credit, again probably because of the relatively long-term relationships between banks and farmers.

An overall evaluation of the pros and cons of the Chilean policy to liberalize the rural financial market, and to liberalize foreign trade, is beyond the scope of this paper. Nevertheless, our results indicate that these policies will not necessarily destabilize the economy in the long run, or reduce access to credit for market-oriented farmers. Our study shows that an important prerequisite for this not to happen is the development of social capital, for example in the form of clusters. An important question is whether these relationships need to be organized and governed by the state. The Chilean example suggests that where credit markets fail in providing credit to farmers, the development of clusters may be the result of a spontaneous process, driven primarily by economic objectives. Thus, explicit government involvement may not be necessary. Further research is required to indicate to what extent this result also holds for other economies.

Chapter 3

Interaction of Formal and Informal Rural Credit Institutions[14]

Abstract

This study examines whether formal and informal loans serve as complements or substitutes for farmers in central Chile. As a special feature, the study explores the determinants that influence access to informal credit using a panel probit model that controls for the endogeneity of credit constraints. With a control for the endogeneity of credit constraints, the analysis suggests that formal and informal credit are complements. This complementary relationship appears due to their distinct uses; that is, formal credit funds investments, whereas informal credit funds working capital. If farmers invest less because they are credit constrained by formal institutions, they need less working capital, so their demand for informal credit also declines.

3.1 Introduction

For decades, economists have discussed why formal and informal financial institutions coexist. Informal lenders appear to survive despite widespread descriptions of their usurious interest rates, and neither government-sponsored credit programs with subsidized interest rates nor market liberalization that encourages lower interest rates by formal financial institutions have pushed them out of the market. Perhaps the reason for their persistence is that informal and formal loans serve as substitutes or complements (Gupta and Chaudhuri, 1997). In either case, formal and informal lenders can coexist. If they are substitutes, the relationship between formal and informal financial institutions is horizontal (Floro and Ray,

[14] This chapter is under review as: Reyes, A. and R. Lensink, Interaction of Formal and Informal Rural Credit Institutions in Central Chile. Submitted.

1997), so the formal sector banks compete directly with informal providers of funds. Borrowers then should try to obtain loans first from the formal market, and then their excess demand spills over into the informal market. Accordingly, borrowers who confront greater credit constraints from formal lenders should increase their borrowing from informal lenders.

If informal and formal loans are complements, the informal and formal financial sectors exhibit a vertical relationship (Floro and Ray, 1997). For example, in agricultural markets, a complementary relationship might emerge because informal credit is the only type available at the beginning of the crop cycle, whereas formal credit becomes available later (Gupta and Chaudhuri, 1997). Inputs needed at the beginning of the production process then get financed by informal credit, but later inputs can be financed by formal credit. Such a complementary relationship also implies a positive relationship between informal and formal credit, such that an increase in formal credit constraints decreases demand for informal credit.

Understanding how informal lenders serve market-oriented farmers' demand for financial services, as well as how they interact with the formal credit institutions, is crucial for the design of an effective credit policy. Only if the government knows why households use informal finance, appropriate instruments to improve the efficiency of formal financial markets can be developed. If informal and formal credit are complements, they fulfill different functions, and formal credit, if available, can never completely eliminate the role of informal credit. An increase in formal credit through a credit subsidy program instead leads to an increase in demand for informal credit, which raises the informal credit interest rate and can adversely affect farmers. Alternatively, if informal and formal credit are substitutes, an increase in access to formal credit will decrease demand for informal credit, lower the informal credit rate, and thus benefit farmers. In general, a better understanding of how formal and informal credit markets interact can lead to credit policies that better support the agricultural sector.

This study therefore tests whether formal and informal loans are substitutes or complements. We focus on formal and informal credit for market-oriented farmers in central Chile. The Chilean agricultural sector provides a good setting for studying this interaction, because both formal and informal credit sectors have a long tradition in the deregulated Chilean economy. The countryside in Chile also has been transformed dramatically by an agro-export boom and the entry of new financial intermediaries and product market traders, which have offered various financing options and contract forms. Monitored loans that rely on contracted farm arrangements, as offered by exporting firms and agro-industry traders, also grew from a relatively small base to become the dominant mode of financing by the mid-1990s (Conning and Udry, 2007).

As a unique feature, our study empirically identifies whether formal and informal loans are complements or substitutes by taking into account the possible endogeneity of formal credit constraints. To explain the use of informal credit, researchers have applied different methods empirically to identify the interactions between formal and informal lenders (Kochar, 1997; Conning, 2001). For example, Guirkinger (2008) uses panel data to estimate why the informal sector persists but fails to take endogeneity problems into account. Giné (2010) uses structural models of credit supply in formal and informal lending, which solves for unobserved heterogeneity and endogeneity problems, and Kihanga et al. (2010) use a structural model to estimate supply and demand for trade credit. Our study extends these prior works by incorporating individual unobservable heterogeneity in the estimation. More specifically, we use a maximum likelihood estimator which allows to estimate an endogenous switching binary variable (in our case credit constraints) in a panel context.

Our analysis suggests that controlling for the possible endogeneity of credit constraints is highly important. If credit constraints are incorrectly assumed to be exogenous, our results suggest that the demand for informal finance is not affected by formal credit

constraints. However, if we control for the endogeneity of credit constraints, our results indicate a complementary relationship between formal and informal credit. This is in contrast to the study by Guirkinger (2008), who, using a model that does not control for endogeneity, finds that formal and informal credit in Peru are substitutes.

The remainder of this chapter is organized as follows. Section 2 contains a literature review of the theories and explanations of the interaction between formal and informal lenders. In section 3, we explain the formal and informal credit sector in Chile, followed by a description of our data in section 4. We then explain the empirical methodology and present our results. Finally, section 7 offers some conclusions and implications.

3.2 Theories on the interaction between formal and informal lenders

The ongoing debate about the relationship between formal and informal credit institutions began with Floro and Ray (1997), who noted that formal and informal credit institutions may be complements or substitutes. If they are substitutes, formal sector banks compete directly with informal lenders, such as traders and input supplier companies, and borrowers first try to obtain a loan from the formal market, but their excess demand spills over into the informal market. That excess demand, assuming formal and informal loans are substitutes, can be explained in three ways (Guirkinger, 2008).

First, firms with insufficient collateral that are involuntarily excluded from the formal credit market may obtain an informal loan, because informal lenders rely on information-intensive screening and monitoring instead of collateral. Therefore, firms that lack access to formal credit should exhibit a higher demand for informal credit (Bell et al., 1997b; Kochar, 1997; Peterson and Rajan, 1997; Nilsen, 2002; Huyghebaert, 2006), whereas firms with such access exert less demand for informal credit (Howorth and Reber, 2003). According to this theory, informal sources are the lenders of last resort (Giné, 2010).

Second, informal lenders may have a comparative advantage over banks with regard to their offer of low-cost credit, because they can better manage client information (Jain, 1999; Conning, 2001), which reduces their moral hazard (Aaronson et al., 2004; Giannetti et al., 2004) and enables them to enforce contracts. Therefore, informal lenders actually are preferable to formal lenders, because their informal loans may be cheaper than formal ones (Chung, 1995; Mushinski, 1999). This theory also suggests that high transaction costs related to loan applications in the formal sector may discourage farmers from taking formal loans. If the transaction costs associated with informal credit are lower, suppliers and customers seek informal credit.

Third, informal loans may be preferable to formal loans because of a difference in risk. That is, informal lenders often have better information about farmers' activities and characteristics, so they can write contracts that ignore collateral and are less risky for borrowers. For most farmers, land is the most valuable asset they own, and they are not willing to pledge it as collateral. They may prefer instead to avoid formal loans and seek informal ones.

However, the relationship between formal and informal lenders also could be vertical (complementary). In this case, informal lenders have access to formal sources of lending, and they simply relend funds they borrow. A market for informal credit exists because the supply of formal credit is inadequate in terms of repayment or because formal credit is not available in particular instances, such as at the beginning of the crop cycle (Gupta and Chaudhuri, 1997). Such a complementary relationship is justified if informal and formal credit are available at different times. The expenditure of inputs required in the initial phases of the production process then can be met by the use of informal credit, but the costs of inputs needed in later stages can be financed by formal credit. If inputs in different stages involve a

technically complementary relationship, the desired production function should reveal a complementary relation between formal and informal credit.

Several examples feature such an outcome. First, in a lean season, informal credit may be used to finance consumption, whereas formal credit is reserved for production loans. In this case, an increase in the amount of formal credit raises the farmer's income and thus demand for a consumption loan in the next season. Second, some wage costs might be met in advance, before the crop starts, and financed by informal credit. Then, formal credit serves to finance the cost of non-labor inputs. In this case, the complementary relationship between labor and non-labor input establishes a similar relationship between formal and informal credit. Finally, a complementary relationship may occur when formal financial institutions have rigid terms of repayment that do not correspond with agro-project cash flows. Most formal lenders require fixed monthly payments that do not align with the needs and cash flows of most of the farmers, who have concentrated cash flows only during harvest periods.

3.3 The rural financial market in Chile

Before empirically testing the relationship between formal and informal credit, we provide some background information about these financial sectors in the specific context of Chile.

3.3.1 Formal financial sector

As do many developing countries, Chile contains both formal and informal lenders. The formal sector provides credit and mobilizes saving under the direct supervision of the National Regulatory Agency of Banks and Financial Institutions, the agency that controls commercial banks, state banks, and non-bank financial institutions, such as investment houses, insurance companies, financing companies, and security markets. The banking sector consists of 20 commercial banks: 12 foreign-owned, 7 Chilean-owned, and 1 state-owned.

Table 3.1: Loans in the Chilean Agriculture Sector by Banks, 2000-2007 (in million US)

BANK	Year 2000	2001	2002	2003	2004	2005	2006	2007
Scotiabank Sud Americano	36.701	47.680	43.753	18.463	67.759	91.480	10.459	130.964
Banco Chile	661.617	630.089	643.454	662.517	792.148	726.838	76.858	979.733
Banco Itaú Chile	3.503	9.344	8.320	9.045	18.709	30.277	77.872	139.359
Banco Estado	297.835	278.464	222.236	144.670	111.588	105.163	188.010	280.774
Banco Bice	105.133	101.578	79.286	88.515	107.813	142.144	212.088	289.132
Banco Del Desarrollo	138.301	130.089	134.893	142.329	178.037	219.992	263.895	297.410
Banco Bilbao, Vizcaya	39.821	32.713	34.033	12.559	12.889	177.923	244.526	775.137
Corpbanca	230.536	221.462	191.242	147.909	252.376	318.454	338.493	398.999
BCI	217.832	241.898	251.944	30.848	413.673	476.453	64.709	822.778
Santander Santiago Chile	447.903	4.591	483.673	488.622	583.684	789.898	1163.259	1243.409
TOTAL	**2179.182**	**1697.910**	**2092.832**	**1745.474**	**2538.676**	**3078.622**	**2640.167**	**5357.697**

Source: SBIF (SBIF, 2009)

As Table 3.1 shows, the most important agricultural credit provider is Banco Santander (foreign bank), followed by Banco Chile (Chilean bank), Banco Bilbao (foreign bank), and Banco BCI (Chilean bank).

3.3.2 Informal financial sector

The term "informal" refers to financial services that are not regulated by banking laws. Informal financial institutions obtain credit from formal financial institutions, then redistribute it to farmers, households, or traders (Moll, 1989). The recipients may be eligible for a direct loan from formal institutions, but they prefer to use informal channels for reasons related to transaction costs, financing advantages, or marketing.

The informal financial sector in rural areas in Chile mainly comprises contract farming and input supplier firms. Moneylenders and relatives or friends are relatively less important as a source of informal credit in central Chile. Therefore, we refer to contract farming firms and input supplier firms in our analysis of the informal financial sector.

Contract farming firms. Contract farming firms provide in-kind or monetary short-term credit advances. Usually the loan is tied to transactions on other markets, such as credit advances provided by fruit trading companies or agro-industry traders. In such arrangements,

farmers obtain heavily monitored production financing, tied to the provision of technical assistance and crop inputs, in exchange for a promise to market all or a part of their harvest through the trader at agreed-on terms. This type of credit primarily finances fresh fruit production, with few exceptions for crops such as sugar beets, tobacco, tomatoes, and certain types of horticultural production (Conning and Udry, 2007).

In the case of fruit production, installments offered at the beginning of the season get paid back upon the harvest. Trading companies may visit the farmers' field at harvest time or for important decisions. Therefore, this kind of credit is known as monitored credit. Interlinked credit contracts provide means to alleviate screening, incentive, and enforcement problems (Hoff, Braveman et al., 1993). Furthermore, the 19 largest exporting companies process 50% of Chile's total fresh fruit and vegetable exports and play a fundamental role in marketing Chilean products (ODEPA, 2005). These companies frequently contract with farmers to market or process their harvests in exchange for credit and other services, such as technical assistance and farm input sales (Conning and Udry, 2007).

Input supplier firms. Input supplier firms provide in-kind, short-term credit, usually payable at harvest. They tend to operate in a restricted geographic area or specific section of the market. These firms sell inputs such as seeds, fertilizers, or farm machinery. The in-kind product is both the form of credit and the avenue for active monitoring, in that this type of credit cannot be diverted to other private uses. The input supplier sector consists of 18 companies that generate a combined overall turnover of US$ 1,000 million annually.

Together input supplier firms and contract farming firms provide a wide supply of short-term credit with convenient contract terms, including flexible repayment and credit delivery at the beginning of the crop cycle for farmers in Chile. Informal lenders can extend those flexible loans to farmers because they actively monitor their clients through visits, interlinked credit contracts, or in-kind product delivery. In contrast, formal credit is inflexible

in contract conditions but provides long-term funding. Accordingly, formal and informal loans appear to be complements, as we test formally next.

3.4 Empirical approach

To determine whether formal and informal loans are substitutes or complements, we follow Guirkinger (2008), who uses an empirical model in which the different categories of credit constraints provide explanatory variables related to the demand for informal credit. The main difference between our model and Guirkinger's is that we control for endogeneity in our estimation procedure. Guirkinger's broader definition of credit constraints includes not only traditional pure credit constraints (Jaffee and Stiglitz, 1990a), but also transaction costs and risk-rationed borrowers (Boucher, Guirkinger et al., 2009). As Boucher et al. (2009) explain, transaction cost–rationed farmers have a positive demand for credit but no effective demand because the transaction costs are too high. Similarly, risk-rationed farmers prefer the lower return from a specific reservation activity (e.g., renting out land) to taking out a loan. Guirkinger's model indicates:

$$y_{it}^{*} = \alpha_1 + \alpha_2 QR_{it} + \alpha_3 TCR_{it} + \alpha_4 RR_{it} + x_{it}'\beta + \delta_i + \mu_{it} \qquad \textbf{(3.1)}$$

where y_{it} is a dummy variable for whether informal credit is used; QR_{it}, TCR_{it}, and RR_{it} are dummy variables that indicate the three rationing categories; subscripts i denote individual (i = 1, …, N) and subscripts t denote time periods (t = 1, …, T); the δ_t term is a time-invariant, individual-specific unobservable effect; μ_{it} is the error term; and x_{it} is a vector of control variables that affect informal loan supply and demand. We are interested mainly in the significance and signs of the coefficients for the dummy variables that indicate the rationing categories: If they are positive, formal and informal credit are substitutes, and if they are negative, formal and informal loans are complements.

Guirkinger (2008) also assumes that all independent variables are exogenous. However, the credit constraint dummies are likely to be endogenous (Conning and Udry, 2007; Giné, 2010), as demand for formal and informal credit is likely affected by the same set of unobserved factors. Farmers with more entrepreneurial ability are likely to be less constrained and also have less demand for informal loans; similarly, farmers who own more land are likely to be less constrained and have greater demand for informal loans. In contrast, farmers with less land should be credit constrained and have less demand for informal credit.

We therefore control for the potential endogeneity of the credit-constrained variables by using the following endogenous switching framework (Miranda and Rabe-Hesketh, 2006), adjusted for the panel structure[15]:

$$y_{it}^{*} = \alpha_1 + \alpha_2 CC_{it} + x_{it}'\beta + \delta_i + \lambda\zeta_{it} + \mu_{1it} \quad \textbf{(3.2)}$$

such that

$$y_{it} = 1 \text{ if } y_{it}^{*} > 0, \text{ and}$$

$$y_{it} = 0 \text{ if } y_{it}^{*} \leq 0,$$

where x_{it} represents $K \times 1$ vector of explanatory variables affecting loan supply and demand in the informal sector; CC_{it} is a dummy variable indicating all credit constraint categories from formal institutions, which we assume to be endogenous; δ_i is a time-invariant, individual-specific random effect. Finally the error term has been discomposed into two terms: ζ_{it} is a shared random effect to induce dependence between a dummy variable indicating whether informal credit is used and an endogenous dummy variable CC_{it}, and μ_{1it} which is a random error term specific for the informal credit equation. λ captures the correlation between equation (3.2) above and equation (3.3) below. The coefficients α and β are the parameters to be estimated. Similarly, the endogenous variable CC_{it} depends on a

[15] The adjustment of the endogenous switching model for the panel structure is based on guidelines provided by the STATA meeting Rabe-Hesketh, S. (2002) Multilevel selection models using gllamm, Stata Users Group .

$L \times 1$ vector of explanatory variables z_{it}. We specify a similar latent response model for the endogenous dummy:

$$CC_{it}^{*} = z_{it}'\gamma + \tau_i + \zeta_{it} + \mu_{2it} \quad \textbf{(3.3)}$$

such that

$$CC_{it} = 1 \text{ if } CC_{it}^{*} > 0, \text{ and}$$

$$CC_{it} = 0 \text{ if } CC_{it}^{*} \leq 0,$$

where CC^{*}_{it} represents a latent continuous variable, γ represents an $L \times 1$ vector of parameters and τ_i is a time-invariant, individual-specific random effect for the endogenous dummy equation. Again ζ_{it} and μ_{2it} represent the residual term. For identification alternatives see Appendix 5.

3.5 Data

The data we use are derived from a survey of a random sample of farms in central Chile, recorded by the Natural Resources Information Center (CIREN). We only consider market-oriented farmers, that is, farmers who manage a minimum of 10 productive hectares and sell their crops to a third party (market). We exclude subsistence, non-cultivated, and recreational farms, because formal financial institutions do not target these farmers, and because market-oriented farmers are the main players in the Chilean agricultural sector. We choose 10 hectares as the minimum productive area because it represents the minimum size required to support a family in Chile[16].

Table 3.2 provides the descriptive characteristics of the farms in the sample, separated by year. The mean farm size is 78 and 76 hectares for 2006 and 2008, respectively. This large size reveals that most of the farmers in our sample own land. Even though the Chilean judicial system works efficiently and it is possible to enforce contracts for larger loans, most commercial banks require land titles as backing for their loans.

[16] See Chapter 1 to see details on data (section 1.4) and Appendix 1 to see questions applied in the survey.

Table 3.2: Sample statistics by year (n = 177, each year)

		2006		2008	
Variable	**Definition**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
FORMAL DEBT	Average loan size from formal lenders (MM$)	44,12	113,89	49,86	118,31
INFORMAL DEBT	Average loan size from informal lenders	12,03	30,84	11,48	33,17
NO_PROGRAM	Binary dummy, equal to 1 if the firm had neither an employee-training program nor a GAP certification, 0 otherwise	0,26	0,44	0,20	0,40
CLUSTER	Number of firms connected with the firm as a cluster	1,27	0,66	1,56	0,88
HECTARES	Owned land (hectares)	77,57	95,44	76,02	93,77
INSURANCE	Binary dummy, equal to 1 if the firm used insurance instruments, 0 otherwise	0,03	0,18	0,03	0,18
WINE_GRAPE	Binary dummy, equal to 1 if the farm's main product was wine grapes, 0 otherwise	0,06	0,24	0,06	0,24
TABLE GRAPE	Binary dummy, equal to 1 if the farm's main product was table grapes, 0 otherwise	0,30	0,46	0,29	0,46
CHERRY	Binary dummy, equal to 1 if the farm's main product was cherries, 0 otherwise	0,06	0,23	0,06	0,23
AVOCADO	Binary dummy, equal to 1 if the farm's main product was avocados, 0 otherwise	0,07	0,26	0,07	0,26
ALMOND	Binary dummy, equal to 1 if the farm's main product was almonds, 0 otherwise	0,05	0,21	0,05	0,21
CANNED PEACH	Binary dummy, equal to 1 if the farm's main product was canned peaches, 0 otherwise	0,06	0,23	0,06	0,23

Notes: $1,000 Chilean = $1.58 US

In Table 3.3 we list the characteristics of borrowers from the formal and informal sectors. According to this table, the most important source of credit is the formal sector (banks), for which 29% and 17% of the farmers use long-term and short term-credit, respectively, closely followed by exporting and input supplier firms with 34% and 14% of the market, respectively. However, if we consider loan size, formal credit (long- and short-term credit) accounts for 80% of the market, a greater total percentage than the informal sector.

That is, despite the expansion of formal credit, market-oriented farmers continue to do loan business with informal lenders.

Table 3.3: Characteristics of borrowers from formal and informal sectors in Chile (pooled sample)

Credit Source	Farmers[(1)] Number (%)	Average debt (MM$)	Total debt (MM$)	Loan market participation (%)
Banks, long term credit	103 (29)	115.30	11,875.90	57%
Banks, short-term credit	60 (17)	79.81	4,788.60	23%
Exporting Firms	121 (34)	27.49	3,326.29	16%
Input supplier firms	48 (14)	17.39	834.72	4%
Total Sample	354	58.83	20,825.51	100%

Notes: $1,000 Chilean = $1.58 US.
[(1)]These percentages may sum up more than 100 because some farmers have more than one source of funding.

We reveal the structure of credit market participation according to the use of one or several sources of credit in Table 3.4: 46% of sampled farmers use only one source of credit, and 22% use mixed sources. The remaining 32% do not use any source of credit. These figures aside, banks and exporting firms are the most important exclusive sources of credit; formal and exporting firms are the most important mixed sources. These results illustrate the interconnections between sources. Formal credit meets the demand for long-term credit, but exporting firms provide short-term credit, mostly for working capital.

Wealthier farmers also appear to use input suppliers as an exclusive source of credit. Apparently they have enough capital to self-finance their long-term investments, and they use input supplier firms simply as an easy way to finance their fertilizer, seed, and machinery purchases, then repay those costs at the end of the season. In contrast, less wealthy farmers rely on both banks and exporting firms, which suggests two potential explanations. They may feel credit constrained and redirect their demand to informal sources, or they could demand both long-term credit for fixed assets and working capital to support their investments, but use informal lenders also as a source of working capital. We test this latter hypothesis.

Table 3.4: Single and multiple credit sources and characteristics of farmers (pooled sample)

Credit sources	Farmers, numbers and characteristics					
	Number	Average Owned Hectares	Average Long-Term Debt (MM$) [(1)]	Average Short-Term Debt (MM$) [(1)]	Average Assets (MM$)	Average Gross Income (MM$)
Banks only	71	76.53	(46) 116.88	(34) 77.65	1216.05	384.58
Exporting firms only	65	82.87	0.00	31.12	1449.87	423.03
Input supplier firms only	26	92.78	0.00	15.77	1771.07	343.21
Banks and Exporting firms	55	67.58	(43) 127.10 0.00	(17) 49.64 (55) 23.23	1204.72	335.76
Banks and input supplier firms	21	87.86	(14) 73.86 0.00	(8) 91.22 (21) 17.84	1534.83	540.94
Banks and exporting and input supplier firms	1	55	0.00 0.00 0.00	15.00 25.00 50.00	674.86	125.10
Total/average	354	76.80	(103) 115.30	(202) 41.53	1328.96	358.32

Notes: $1,000 Chilean = $1.58 US.
[(1)] Numbers of farmers appear in parentheses.

With Table 3.5 we report the frequency of formal sector rationing categories and the percentage of farmers who use informal loans in each category. All categories of farmers use informal lenders, especially the transaction cost–rationed farmers (83%).

Table 3.5: Informal loan use by formal sector rationing categories and type of informal lender (pooled sample)

Formal sector rationing categories	Exporting Firms		Input Supplier Firms		Total Informal Credit		Total sample
	Sample size	%	Sample size	%	Sample size	%	*Sample size*
Borrowers	43	36.4	18	15.3	61	51.7	118
Nonborrowers	54	29.3	26	14.1	80	43.5	184
Quantity rationed	14	38.9	3	8.3	17	47.2	36
Transaction cost rationed	5	83.3	0	0.0	5	83.3	6
Risk rationed	4	40.0	0	0.0	4	40.0	10
Subtotal of Credit-Constrained Categories	**23**	**44.2**	**3**	**5.8**	**26**	**50.0**	**52**
Total	**121**	**29.9**	**48**	**13.6**	**168**	**47.5**	**354**

We also observe from Table 3.5 that the number of farmers who are transaction cost or risk rationed is very low.

3.6 Are formal and informal loans substitutes or complements?

We now present the estimation results for the model we outlined in section 3.4. We are mainly interested in the sign of the coefficients for the credit constraint dummies, which can indicate whether formal and informal credit are substitutes or complements. We include some control variables in the model, including variables that proxy for farmer management skills, such as the farmer's participation in a training or certification program. The definitions and means of all the variables appear in Table 3.2. In addition, we include control variables indicating farm activity, which may reflect competition in a particular sector. If competition increases, input suppliers and contracting firms should offer more informal credit. For example, because the table grape market has grown more competitive as a result of cooperation between exporting companies and grape growers, we expect a positive coefficient for this variable. However, we expect negative coefficients for the cherry and wine grape sectors, because cherry growers are relatively new to Chilean agriculture, and wine grape farmers face an oligopolistic market in which demand comes from just a few buyers.

We present two sets of estimation results, using different estimation techniques. We start by estimating the model with a random effects probit model, which does not control for endogeneity. Table 3.6 contains these results. We use a random effects instead of fixed effects model, because our panel contains only two years, which reduces the possibility of obtaining time-variant variables. In the random effects model, we incorporate the individual effect into our estimators and also include time-invariant variables.

We therefore estimate three models of the random effects probit model that differ in terms of their specification of the credit constraint variable. The first model includes three different dummy variables that account for quantity, risk, and transaction cost rationing, in line with Guirkinger (2008). As the first column of Table 3.6 indicates, none of the credit-rationed variables is statistically different from 0 at the 5% level.

Recall from Table 3.5 that the number of farmers who are transaction cost or risk rationed is very low. Therefore, we estimate a model in which we only include a dummy for quantity rationed, and another model for which we use a dummy for the merger of the three categories of credit constraints. For the model with only the dummy for quantity constraints, the coefficients again are not statistically significant. The third estimation, with just one overall credit-rationing category, also shows an insignificant coefficient of credit-rationed farmers.

Table 3.6: Parameter estimates: Informal loan regression with random effect probit model

	Three credit-rationed categories	Quantity-rationed category	Pooled credit-rationed categories
QUANTITY RATIONED (A)	-0.564	-0.576	
	[0.346]	[0.344]	
RISK RATIONED (B)	-0.499		
	[0.601]		
TRANSACTION COST RATIONED (C)	1.100		
	[0.450]		
T. COST AND RISK RATIONED (B+C)			
RATIONED (A+B+C)			-0.370
			[0.446]
NO_PROGRAM	-1.461**	-1.464**	-1.480**
	[0.011]	[0.012]	[0.011]
WINE_GRAPE	-1.271	-1.312	-1.349
	[0.238]	[0.235]	[0.221]
TABLE_GRAPE	1.044*	1.048*	1.041*
	[0.069]	[0.078]	[0.079]
CHERRY	-1.267	-1.325	-1.337
	[0.264]	[0.255]	[0.250]
CLUSTER	1.061***	1.058***	1.035***
	[0.000]	[0.000]	[0.000]
Constant	-1.536***	-1.532***	-1.496***
	[0.002]	[0.002]	[0.003]
N	354	354	354
Log likelihood	-172.9	-173.4	-173.5
Individual	177	177	177
Wald Test	25.45***	24.51***	24.42***

Notes: *p*-values in brackets; *, ** and * indicate 1%, 5% and 10% levels of significance respectively; Wald test for the significance of all regressors but the constant.**

All these results suggest that formal credit rationing does not affect demand for informal credit. However, we caution that these results may be biased, because credit constraints likely are endogenous. For example, wealthier farmers are both more likely to demand informal credit and less likely to be quantity rationed. Therefore, we next perform a set of estimates using an endogenous switching approach that controls for the endogeneity of credit constraints.

To estimate the endogenous switching model, we must specify equations (3.2) and (3.3), that is, one equation for the demand for informal credit and another that explains credit constraints. For equation (3.2), we use the same specification as in the random effects model, whereas for equation (3.3), we also include variables that do not appear in the equation for the demand for informal credit. The endogenous switching model is formally identified through its functional form (Heckman, 1978; Wilde, 2000; Miranda and Rabe-Hesketh, 2006).

Nevertheless, to achieve an economic identification, at least one variable affecting credit constraint status must be excluded from informal credit use. In our model, we include an indicator of the number of owned hectares. Furthermore, because a model with an exogenous switching variable is nested within the endogenous switching model, we can perform the test for the endogeneity of *CC* in equation (3.2) using a simple likelihood ratio test for $\rho = 0$.

Our econometric model also enables us to distinguish among some alternative hypotheses regarding the effect of credit constraint categories on the use of informal sources. In particular, we distinguish four situations:

1) The correlation coefficient ρ is not statistically different from 0 and the coefficient for credit constraint status in the informal credit use equation is statistically significant. Therefore, credit constraint status is exogenous with respect to informal credit use, and its effect is causal.

2) The correlation coefficient ρ is statistically significant but the coefficient for credit constraints in the informal credit use equation is not. In this case, the credit constraint status is endogenous with respect to informal credit use, and the correlation between *CC* and informal credit use is driven by unobserved heterogeneity.
3) Both the correlation coefficient ρ and the coefficient on *CC* in the informal credit use equation are significant. Although *CC* thus is endogenous with informal credit use, it also has a causal impact on informal credit use.
4) The correlation coefficient and coefficient on *CC* in the informal credit use equation are both insignificant, and our analysis does not support any of the hypotheses outlined in the literature review.

To avoid further complications in the estimation procedure (because we have so few transaction cost– or risk-constrained farmers), we only estimate two variants of the model: one with a dummy for credit constraints based on the merger of the three individual rationing categories, and one with a dummy for credit constraints based only on quantity-rationed farmers. To estimate both models, we use generalized linear latent and mixed models (Rabe-Hesketh et al., 2002).[17]

The results in Table 3.7 indicate a significant negative effect of credit constraints on the use of informal credit, and a significant positive correlation between unobservable heterogeneity in informal use and credit constraint equations in both models. These results

[17] This model is estimated using maximum likelihood, and the convergence of the negative of the inverse of the Hessian matrix provides an estimator of the covariance matrix. Robust standard errors can be obtained as usual. To evaluate the likelihood function, we must integrate out the random term μ_{it}, for which we use adaptive quadrature Rabe-Hesketh, S., A. Skrondal and A. Pickles (2002) Reliable estimation of generalized linear mixed models using adaptive quadrature. *Stata Journal,* 2(1), pp. 1-21. Adaptive quadrature is a numerical integration technique that, at each iteration, updates the location and weights of the Gauss-Hermite quadrature points using the posterior distribution of μ_{it}. After the update, the locations center around the posterior mean and spread out equally according to the posterior standard deviation. Adaptive quadrature achieves higher accuracy with fewer integration points than ordinary Gauss-Hermite quadrature.

provide evidence that credit constraints have a causal impact on the use of informal credit and that credit constraints are endogenous with respect to the informal use of credit. If credit constraints are randomly distributed across market-oriented farmers, their effect on the use of informal credit is significantly negative. Therefore, formal and informal loans are complements. Formal credit appears useful for funding investments, but informal credit can fund working capital. This explanation is in line with our preceding descriptive analysis. It is noteworthy that our result is also in line with Karlan and Zinman (2009). Using a randomized controlled experiment, they e.g. examine the relationship between formal (micro) credit and informal finance for micro-entrepreneurs in Manila, and find that credit complements informal finance.

Table 3.7: Parameter estimates: Informal loan regression with an endogenous switching dummy variable model

Informal Loan Model	Model 1	Model 2
CREDIT_CONSTRAINT [A+B+C)		-0.400**
		[0.038]
QUANTITY_CONSTRAINT	-0.753***	
	[0.010]	
NO_PROGRAM	-0.533**	-0.393**
	[0.018]	[0.045]
CLUSTER	0.402***	0.285***
	[0.000]	[0.000]
WINE_GRAPE	-0.420	-0.440*
	[0.354]	[0.091]
TABLE_GRAPE	0.335	0.790***
	[0.121]	[0.000]
CHERRY	-0.521	0.228
	[0.306]	[0.614]
Constant	-0.504***	-0.670***
	[0.008]	[0.000]
ENDOGENOUS DUMMY MODEL	QUANTITY_CONSTRAINT	CREDIT_CONSTRAINT Model
HECTARES	-0.009***	-0.006***
	[0.003]	[0.001]
CLUSTER	0.204*	0.065
	[0.099]	[0.548]
INSURANCE	2.071***	2.234***
	[0.001]	[0.000]
NO_PROGRAM	0.410*	0.266
	[0.053]	[0.126]
AVOCADO	0.658	0.981***
	[0.132]	[0.005]
ALMOND	0.868*	0.806**
	[0.056]	[0.047]
WINE_GRAPE	0.875**	0.572
	[0.043]	[0.141]
CANNED PEACH	0.732*	0.389
	[0.082]	[0.321]
Constant	-1.599***	-1.182***
	[0.000]	[0.000]
Random Effect Individual level		
σ_{δ}^{2}	32.494	72.557
	[0.602]	[0.717]
σ_{τ}^{2}	4.447	1.845
	[0.102]	[0.110]
$\sigma_{\delta\tau}$	3.584	1.651
	[0.444]	[0.631]
$CORR(\delta\tau)$	0.298	0.142
	[0.202]	[0.476]

Random Effect Observation level		
$\rho(\delta_i + \lambda\zeta_{it} + \mu_{1it}, \tau_i + \zeta_{it} + \mu_{2it})$	0.649***	0.645***
	[0.000]	[0.000]
Observations	354	354
Individuals	177	177
Log likelihood	-258.407	-292.704
LR Test	88.756***	80.801***
Wald-test	59.75***	118.52***

Notes: *p*-values in brackets; *, ** and * indicate 1%, 5% and 10% levels of significance respectively; both models are estimated by maximum likelihood with 12 quadrature points, adding extra quadrature points did not produce important changes in coefficients and/or standards errors; σ_δ^2 and σ_τ^2 refer to the unexplained variance at the individual level for the informal credit use and the endogenous variable equations respectively; Likelihood ratio test (LR test) compares the exogenous (H_0) with the endogenous model (H_a) and Wald test for the significance of all regressors but the constant.**

3.7 Conclusions

With this study, we attempt to gain a better understanding of the relationship between formal and informal loans for farmers in rural central Chile. In particular, we are interested in whether formal and informal loans are complements or substitutes. As a key innovation in our study, we use a panel endogenous switching binary model, which controls for unobserved heterogeneity and endogeneity problems.

Although formal lenders are the most important source of credit in volume, a high percentage (48%) of market-oriented farmers in Chile still use informal sources of credit. Farmers use informal loans for working capital and formal loans for both working capital and long-term investment.

We find evidence in support of our hypothesis that credit constraints are endogenous. In addition, our results suggest that an increase in formal credit constraints reduces the demand for informal credit. This outcome strongly suggests that formal and informal loans are complements. Thus, our results further support the hypothesis that in the Chilean context, formal and informal institutions complement each other in their provision of credit to farmers.

Traditional development programs have focused on encouraging rural financial institutions to solve problems of access to credit and reduce the dependence on expensive informal finance. Our study suggests that these policies will not end the existence of the informal credit market. It is even more likely that better access to formal credit will stimulate the demand for informal credit, with possible negative multiplier effects in terms of changes in the costs of informal finance if the supply of informal finance lags behind demand. The analysis shows that the formal and informal credit sectors complement each other, since they fulfill different tasks.

Policies which aim to abolish the informal credit market are therefore questionable. It may even turn out to be beneficial to explore how informal lenders can be stimulated to provide other services, such as long-term credit or even co-signing bank loans with customers. In addition, the complementarity implies that the negative effects of formal credit market imperfections will and probably cannot be undone by an increase in lending from informal lenders. This seems to even increase the importance of government policies that improve access to formal credit markets. Hence, our study suggests that both the formal and informal credit markets are important and needed to improve performance of market-oriented farmers in Chile.

Chapter 4

Impact of Access to Credit on Farm Productivity of Fruit and Vegetable Growers[18]

Abstract

The objective of this chapter is to analyze the factors that determine productivity of fruit and vegetable growers in central Chile, focusing especially on the effect of short-term credit on farm output production for market-oriented farmers. We explicitly test for possible selection bias using a panel data set from a survey conducted in 2006 and 2008 with 177 farmers. Our results indicate that short-term credit does not have an impact on farm productivity, while other factors as education and the type of activity do.

4.1 Introduction

It is frequently argued in economic studies that rural development should be accompanied by agricultural credit reforms. After the financial structural adjustment of the 1980s which adversely affected the intricate system of public agencies that provide farmers with access to land, credit, insurance, and inputs, farmer organizations in developing countries started demanding an institutional reconstruction of parts of the agriculture support system such as rural development banks (World Bank, 2007). They claim that financial crises aggravated the lack of financial services, even for market-oriented farmers.

Rural development and, in particular, farm productivity, can be influenced by several factors; one is access to credit. Access to credit may affect farm productivity because farmers

[18] This chapter is based on: Reyes, A., R. Lensink, A. Kuyvenhoven, and H. A. J. Moll. Impact of Access to Credit on Farm Productivity of Fruit and Vegetable Growers in Central Chile. Paper under development.

facing binding capital constraints would tend to use lower levels of inputs in their production activities compared to those not constrained (Feder, Lau et al., 1989; Petrick, 2004b). Improved access to credit may therefore facilitate optimal input use and have a major impact on productivity. Thus, access to credit allows farmers to satisfy their cash needs induced by the agricultural production cycle and consumption requirements.

Other factors such as the pre-existing household resource endowment, its demographic characteristics, and the conditions of the surrounding physical, social and economic environment are significant factors in determining household income. Thus, farm productivity may be constrained because of other factors far removed from credit availability, and reform of other input markets may have a larger impact on farm income, and hence productivity.

The aim of this chapter is to analyze the factors that determine farm productivity in central Chile, focusing especially on the effect of short-term credit. Determining whether or not this variable is significant may help to provide evidence for the impact of credit on farm productivity. Most of the literature has found credit constraint to have a negative impact on farm investment (Carter and Olinto, 2003; Petrick, 2004a), farm output (Feder, Lau et al., 1990; Petrick, 2004b) farm profit (Carter, 1989; Foltz, 2004; Fletschner, Guirkinger et al., 2010) and farm productivity (Guirkinger and Boucher, 2008). In contrast, Kochar (1997) found credit to have no effect on efficiency. We hypothesize that, unlike most of the related studies and popular opinion in Chile, in a liberalized financial environment such as Chile's, credit availability is not an important variable in explaining farm productivity.

However, assessment of the expected productivity gain caused by credit availability is not trivial because the effect of credit is likely to differ between liquidity constrained and unconstrained credit farmers. This means that the marginal effect of credit may actually be zero for borrowers for whom liquidity is not a binding constraint. When liquidity is a binding constraint, the amount and combination of inputs used by a farmer will deviate from their

notional optimal level (the levels that would have been utilized if liquidity were not binding constraint). The marginal contribution of credit is therefore to bring input levels closer to optimal levels, thereby increasing output (Feder, Lau et al., 1990). Thus, measuring the difference of credit impact on unconstrained and constrained farmers must consider sample selection bias.

The contribution of this study is twofold. First, we empirically test the impact of credit on farm productivity in central Chile, one of the most competitive and deregulated markets in Latin America. In deregulated financial markets the expectations are that by removing state influence from financial markets, private actors would take over the financial market, reducing their costs, improving their quality, and eliminating favoritism to well-connected groups. Although the financial sector in Chile is not completely deregulated and a financial supervisory system does exist, this regulation attempts to reduce bank failures and helps to ensure an adequate level of bank solvency.

In addition, farmers in Chile can count on a well-spread network of informal lenders, namely input supplier and export firms. Informal lenders provide short-term credit usually payable at harvest with almost no requirements in collateral. Because informal lenders tend to rely less on collateral and more on monitoring to enforce repayments, informal loans became the dominant mode of finance by the mid 1990s (Foster and Valdes, 2006). An active informal sector may relax credit constrains that farmers face in the formal sector. Indeed, if the informal sector is a good substitute of an imperfect formal sector, then we would expect to find little differences in productivity of farmers that are constrained versus those who are unconstrained in the formal sector (Guirkinger and Boucher, 2008).

Secondly, this study utilizes a broad definition of credit constraints (Guirkinger, 2008; Guirkinger and Boucher, 2008; Boucher, Guirkinger et al., 2009; Fletschner, Guirkinger et al., 2010) to explain the influence of credit availability on farm productivity of credit-constrained

farmers in Chile. We include in our sample not only those farmers limited in their access to credit by banks, but also farmers who chose not to borrow as a result of high transaction costs or risk aversion. Moreover, we test not only for possible selection bias from credit-constrained farmers, but also for individual unobserved heterogeneity.

This chapter is organized as follows: Section 4.2 provides a literature review on the credit constraint impact on farm productivity; section 4.3 presents the data collection process and the surveyed sample; section 4.4 describes the empirical approach used in this study; section 4.5 discusses the results; and finally, section 4.6 summarizes the findings and discusses policy options.

4.2 Credit constraint and its impact on productivity

The most popular definition of a credit constraint comes from the seminal paper of Stiglitz and Weiss (1981). Under their definition certain individuals obtain loans while apparently identical individuals, who are willing to borrow at precisely the same terms, do not. Because lenders may take on risky project applications only at high interest rates, they refuse to raise the interest rate to eliminate excess demand and, consequently, may ration their supply for credit. This type of credit constraint is called quantity rationing (Guirkinger, 2008; Guirkinger and Boucher, 2008; Boucher, Guirkinger et al., 2009; Fletschner, Guirkinger et al., 2010), pure credit rationing (Jaffee and Stiglitz, 1990b), or simply credit rationing (Feder, Lau et al., 1990; Kochar, 1997; Petrick, 2004b). A quantity constraint is thus a supply-side credit restriction.

Several recent studies, however, have introduced two other forms of credit constraint (Guirkinger, 2008; Guirkinger and Boucher, 2008; Boucher, Guirkinger et al., 2009; Fletschner, Guirkinger et al., 2010). First, farmers may not seek a formal loan because the transaction costs associated with the loan application are too high. This may be the result of screening mechanisms that lenders use to guard against adverse selection and moral hazard

problems. While these actions may help lenders to avoid granting loans to undesirable clients and may provide borrowers with incentives to avoid undesirable actions, they also pose significant monetary and time costs for borrowers. This type of credit constraint is called transaction-cost rationing.

Secondly, farmers may not seek a loan because the risk implied by the available credit contract is too high. Perhaps this cost arises because lenders want to counteract the risk of imperfect information by asking for collateral. Collateral-based credit contracts may lead to quantity constraints but they may also lead risk-averse farmers to voluntarily exclude themselves from credit markets. This type of credit constraint is called risk rationing.

A common framework used to model the effects of credit constraints on farm output, and consequently, productivity, is a micro-economic agricultural household model where the utility maximization problem of a farmer depicts both the consumption and production decision of the farm household (Singh et al., 1986). In complete and competitive markets the consumption and production decisions of the farmers are separable, whereas in absent and non-competitive markets these decisions are not, meaning the product choice and factor productivities of the agricultural household are influenced by its preferences, characteristics, wealth, credit, and any other endowments. According to Benjamin (1992), this property of the independent household model can be used in empirical tests of market imperfections.

The recent empirical literature has tested for non-separability decision as being rooted in market imperfection, suggesting that non-separability should be applicable only to those farmers whose choices are constrained by the underlying market imperfections. If, for example, land, labor, or credit markets are completely absent and all farmers are constrained by their absence, then a common estimation test for all farmers is appropriate. But if only some of the farmers are constrained, then the non-separability should characterize only those constrained farmers.

In the case of a credit market imperfection, the non-separability decision needs to be tested for those farmers whose choices are constrained by it. As was explained before in this section, although pure credit rationing is the most frequently used definition of credit market imperfection, transaction cost and risk are two additional means by which asymmetric information may affect farmers' terms of access to the credit market and hence their resource allocation decisions (Guirkinger and Boucher, 2008). In all three categories of credit constraints, farmers have a demand for credit but they are limited in accessing credit by a limited capacity to provide collateral, high transaction costs of the credit contract, or a high level of risk associated with the credit contract. In other words, all three types of credit constraints can lead to an imperfect or even inexistent credit market.

Under this framework, Petrick (2004b) develops a two-period household model that allows an analysis of the effects of credit rationing with respect to short-term loans. In Petrick's model, a binding and pure concept of credit constraint results in a household-internal shadow interest rate that is above the market interest rate of a first best solution. Therefore, input use is reduced, which implies a drop in output, income, and productivity as compared with the first best. A further implication of the binding credit constraint is that it breaks the separability of consumption and production decisions.

4.3 Survey and data collection

At this point we introduce a methodological variation to the work of Petrick (2004b). To measure credit constraint on farmers, we include non-price demand-side restrictions as in Boucher et al. (2009). Thus, in addition to the typical demographic and production sections, we added to our survey core questions dealing with credit behavior including information on loan sources, loan applications, credit contracts, credit from suppliers, traders, and collateral[19].

[19]See Appendix 1 to see questions applied in the survey.

The survey was carried out in 2006 and 2008 and contains data on the 2005–2006 and 2007–2008 seasons, respectively. In the first wave of the survey, data consisted of a random sample of 200 farms located in six counties in the central region of Chile. During the second wave, we collected information from 200 farmers, 177 of which were in the first wave. The survey instrument was repeated with slight differences[20]. Table 4.1 provides descriptive characteristics of the farms taken in the sample.

Table 4.1: Sample statistics of surveyed farms (n=354, pooled sample)

Variable	Definition	Mean	Standard deviation
INCOME	Total farm output production (millions of Ch$)	358.32	424.37
HECTARES	Owned land (hectares)	76.80	111.22
SHORT- TERM CREDIT	Total outstanding short term credit from formal and informal lenders (millions of Ch$)	45.63	107.05
ASSETS NO HA	Total assets (machinery and facilities) net from hectares (millions of Ch$)	243.58	554.28
CLUSTER	Number of firms connected with the firm as a cluster	1.42	0.81
INSURANCE	1 if the firm use insurance instruments, 0 otherwise	0.03	0.18
YEAR ADM	Years farming (years)	22.90	12.34
NO PROGRAM	1 if the firm do not have neither employees-training program nor GAP certification, 0 otherwise	0.23	0.42
LOCATION 1 SB	1 if the farm is located in San Bernardo, 0 otherwise	0.25	0.43
LOCATION 2 LA	1 if the farm is located in Los Andes, 0 otherwise	0.18	0.39
LOCATION 3 CA	1 if the farm is located in Cachapoal, 0 otherwise	0.37	0.48
ALMOND	1 if the farm has Almond as a main production, 0 otherwise	0.05	0.21
CHERRY	1 if the farm has Cherry as a main production, 0 otherwise	0.06	0.23
TABLE GRAPE	1 if the farm has Table Grape as a main production, 0 otherwise	0.29	0.46
WINE GRAPE	1 if the farm has Wine Grape as a main production, 0 otherwise	0.06	0.24
SCANNE PEACH	1 if the farm has Scanned Peaches as a main production, 0 otherwise	0.06	0.23

Note: 1,000 Chilean$= 1.58 US$; n stands for sample size

[20] See Chapter 1 to see details on data (section 1.4).

Table 4.2 reports the number and average amount of short-term loans differentiated by formal sector rationing categories. Formal short-term credit is most used by unconstrained borrowers, while informal short-term credit is most used by risk and transaction-cost rationed farmers. In total, unconstrained borrowers together with risk and transaction-cost rationed farmers use more credit than those in the rest of the categories. It is important to note that risk and transaction cost categories use only informal credit. This situation arises because farmers in risk and transaction cost categories consider formal credit either to be more risky or to bear too much transaction cost. This suggests that these types of farmers prefer informal over formal credit, redirecting their demand for short-term credit from a formal to an informal sources of credit.

Table 4.2: Number and average of short-term loans from formal and informal institutions by formal sector rationing categories, pooled sample

Formal sector rationing categories	**Formal**		**Informal**		**Total short-term loans**		**Total sample**
Unconstrained	***N***	$\overline{X}$	***N***	$\overline{X}$	***N***	$\overline{X}$	***N***
Borrowers	41	83.901	62	24.581	86	57.139	118
Non-borrowers	0		80	22.243	80	22.243	184
Constrained							
Quantity rationed	20	41.935	17	17.111	27	41.818	36
Transaction cost rationed	0		5	60.680	5	60.680	6
Risk rationed	0		4	65.689	4	65.689	10
Subtotal	**20**	**41.935**	**26**	**32.963**	**36**	**47.090**	**52**
Credit Constrained Categories							
Total	**61**	**70.142**	**168**	**24.765**	**202**	**41.528**	**354**

Table 4.3 reports the characteristics of farmers classified by rationing categories from the formal credit sector. Unconstrained borrowers and transaction-cost rationed farmers own more hectares than those in the rest of the rationing categories, while quantity-rationed farmers have less titled land. Farm size appears a variable that affects a quantity constraint, the most important category of credit constraints: The 36 quantity-rationed farmers averaged just 40.6 owned hectares each, whereas the total average is 76.8 hectares per farmer.

Table 4.3: Farm characteristics by formal sector rationing categories, pooled sample

Formal sector rationing categories	***Average Owned hectares***	**Average assets**	***Average gross Income***	***Assets/ ha***	***Income/ ha***
	(Ha)	**(MM$)**	***(MM$)***	***(MM$ /ha)***	***(MM$/ ha)***
Unconstrained					
Borrowers (n=118)	82.181	206.868	418.940	2.517	5.098
Non-borrowers (n=184)	81.835	273.291	347.125	3.340	4.242
Constrained					
Quantity rationed (n=36)	40.636	273.893	253.156	6.786	6.272
Transaction cost rationed (n=6)	83.283	31.306	376.067	0.376	4.516
Risk rationed (n=10)	46.800	148.477	216.992	3.390	4.954
Subtotal	46.742	221.783	260.383	4.745	5.571
Credit Constrained Categories (n=52)					
Total (n=354)	76.795	243.584	358.321	3.172	4.666

Note: n stands for sample size for each particular category and MM$ stands for Chilean peso in millions

The average value of assets per hectare is high for quantity-rationed farmers, which can be explained by their capacity to both invest and to acquire new equipment or by a negative relation between quantity rationing and farm size. On the other hand, the low value of assets per hectare for transaction-cost constrained farmers reveals either a low propensity to invest or a positive relation between transaction cost and farm size. Although investments are not the scope of this chapter, this latter idea has to be tested taking into consideration endogeneity problems which arise for the variable credit constraint. This is tested in this next chapter.

Unconstrained borrowers have the highest income. Although this may be related to access to credit, it may also be due to farm size. Unconstrained borrowers and non-borrowers as well as transaction-cost rationed farmers can be seen to have high levels of both farm size and income. Later we test to what extent farm size affects farm productivity.

4.4 Empirical model

4.4.1 Econometric specification: A model for the selection mechanism with panel data

In general a statistical model yields valid inferences only if the units, in this case farmers, are sampled at random. Selection bias may arise when the selection mechanism depends on unobservable variables correlated with the error term of the statistical model of interest. In our case, a farmer who operates at low productivity may have higher demand for credit as compared to more productive farmers. This may create selection bias in our estimators. A classic way to avoid the selection bias is to add an equation which explicitly models the selection mechanism (Heckman, 1979).

The sample selection model for farm productivity using panel data can be written as a system of equations for the substantive equation (productivity) and the selection equation (credit constraint). By treating the responses as repeated measurements nested within individuals, the sample selection model fits neatly into the multilevel framework (Skrondal and Rabe-Hesketh, 2004). Although there exist several other parametric (Wooldridge, 1995) and semi-parametric (Kyriazidou, 1997) techniques to deal with residual selection using panel data, we prefer to use multilevel analysis because it allows to use the entire set of data without using a subsample of farmers for which the constraint regime does not change across periods, as others techniques do. Let us label with y_{it} the output production for farmer i *(i=1,…, N)* at time *t (t=1,…,T)*. The binary variable CC^{*}_{2it} simply indicates the presence or absence of all three categories of credit constraints (quantity, transaction cost, and risk rationing). As was explained in section 4.2, non-separability should be tested for those farmers whose choices are constrained by credit market imperfections, either because of collateral, transaction cost, or risk. Then farm productivity can be observed only if a credit constraint ($CC^{*}_{2it} = 1$) is met. The joint model is thus defined by the following equations:

$$y_{1it} = x'_{it}\beta + \varepsilon_{1it} \quad \textbf{(4.1)}$$

$$CC^{*}_{2it} = z'_{it}\gamma + \varepsilon_{2it} \quad \textbf{(4.2)}$$

Where x_{it} and z_{it} represent the vectors of explanatory variables affecting output production and credit constraint status, respectively. The coefficients γ and β are the parameters to be estimated.

To take into account the panel data structure and induce the dependence between both residuals, the residual in equations (4.1) and (4.2) are discomposed as $\varepsilon_{1it} = \xi_{1i} + \lambda\delta_{it} + \mu_{1it}$ and $\varepsilon_{2it} = \xi_{2i} + \delta_{it} + \mu_{2it}$. The three terms capture the unobservable heterogeneity: ξ_{1i} and ξ_{2i} are the random intercepts for each individual, normally distributed with zero mean and variance, $\sigma^2_{\xi_{1i}}$ and $\sigma^2_{\xi_{2i}}$, respectively and covariance $\sigma^2_{\xi_{1i};\xi_{2i}}$; δ_{it} is a shared random effect to induce dependence between substantive and selection equation by the factor λ, normally distributed with zero mean and variance σ^2_{δ}; μ_{1it} and μ_{2it} represent random error specific for output production and credit constraint status, respectively, and are assumed to be normally distributed and independent of x_{it} and z_{it} with zero mean and variance $\sigma^2_{\mu_{1it}}$ and $\sigma^2_{\mu_{2it}}$, respectively. Therefore, $Var(\varepsilon_{1it}) = \sigma^2_{\xi_{1i}} + \lambda^2\sigma^2_{\delta_{it}} + \sigma^2_{\mu_{1it}}$, $Var(\varepsilon_{2it}) = \sigma^2_{\xi_{2i}} + \sigma^2_{\delta_{it}} + \sigma^2_{\mu_{2it}}$ and $Cov(\varepsilon_{1it}, \varepsilon_{2it}) = \lambda\sigma^2_{\delta} + \sigma^2_{\xi_{1i};\xi_{2i}}$. Equations (4.1) and 4.2) can now be rewritten as:

$$y_{1it} = x'_{it}\beta + \xi_{1i} + \lambda\delta_{it} + \mu_{1it} \quad \textbf{(4.3)}$$

$$CC^{*}_{2it} = z'_{it}\gamma + \xi_{2i} + \delta_{it} + \mu_{2it} \quad \textbf{(4.4)}$$

In the system of equations (4.3) and (4.4) there are six variance-covariance parameters, ($\sigma^2_{\xi_{1i}}, \sigma^2_{\xi_{2i}}, \sigma^2_{\mu_{1it}}, \sigma^2_{\mu_{2it}}, \sigma^2_{\delta_{it}}, \lambda$). However, there are only four quantities to estimate: the residual variance of y_{1it}, namely $\sigma^2_{\xi_{1i}} + \lambda^2\sigma^2_{\delta} + \sigma^2_{\mu_{1it}}$; the variance of ξ_{1i} and ξ_{2i}, identified through the intraclass correlation in the substantive and selection model respectively; and the correlation between the total residual of the two equations namely:

$$\rho(\varepsilon_{1it},\varepsilon_{2it}) = \frac{\lambda\sigma_{\delta}^{2} + \sigma_{\xi_{1i};\xi_{2i}}}{\sqrt{(\sigma_{\xi_{1i}}^{2} + \lambda^{2}\sigma_{\delta}^{2} + \sigma_{\mu_{1it}}^{2})(\sigma_{\xi_{2i}}^{2} + \sigma_{\delta}^{2} + \sigma_{\mu_{2it}}^{2})}} \quad \textbf{(4.5)}$$

Therefore, it is necessary to impose two restrictions. One restriction comes directly from the binary nature of the selection equation, so $\sigma_{\mu_{2it}}^{2}$ is implicitly fixed to a value determined in the model estimated in the selection equation (we use the probit model for the selection model, hence $\sigma_{\mu_{2it}}^{2} = 1$). The second restriction needed for identification must be stated explicitly: here we fixed the factor variance to one ($\sigma_{\delta}^{2} = 1$). For discussions and alternatives restrictions see Skrondal and Rabe-Hesketh (2004).

Thus the covariance matrix of the residual is given by:

$$\sum = \begin{pmatrix} \sigma_{\xi_{1i}}^{2} + \lambda^{2} + \sigma_{\mu_{1it}}^{2} & \lambda + \sigma_{\xi_{1i};\xi_{2i}} \\ \lambda + \sigma_{\xi_{1i};\xi_{2i}} & \sigma_{\xi_{2i}}^{2} + 2 \end{pmatrix} \quad \textbf{(4.6)}$$

And the correlation is

$$\rho = \frac{\lambda + \sigma_{\xi_{1i};\xi_{2i}}}{\sqrt{(\sigma_{\xi_{1i}}^{2} + \lambda^{2} + \sigma_{\mu_{1it}}^{2})(\sigma_{\xi_{2i}}^{2} + 2)}} \quad \textbf{(4.7)}$$

The estimation of ρ will be relevant in our model, because it gives statistical evidence of the sample selection bias in our model.

The estimation of this model is by maximum likelihood, with the likelihood function evaluated by the adaptive quadrature numerical technique shown by Rabe-Hesketh *et al*. (2005). This technique has shown to be superior to standard quadrature methods, particularly where the number of cross-sectional observations is large and/or the intra-class correlation is high. Maximization of the likelihood function over the set of parameters is achieved by the Newton-Ramhson algorithm. The productivity function is estimated as a Tobit model, which includes random effects for households-level heterogeneity (Rabe-Hesketh 2004).

4.4.2 Variable specification

The dependent variable in equations (4.3) is farm productivity, measured as the value of farm output production per hectare in Chilean pesos (Ch$)[21]. Due to the multiproduct farm households in central Chile, the value of farm production is an aggregate of fruit and horticultural crop production in 2006 and in 2008. The production is valued using prices declared by the household at the time of the household survey. In the case of exported products, we consider the average dollar (US$) value for each year to estimate total value of farm production in pesos.

The following independent variables are typically included to explain farm productivity (Feder, Lau et al., 1990; Moschini and Hennessy, 2001; Boucher, Guirkinger et al., 2009): short-term credit availability ($\overline{K}$), initial liquidity endowment (E), and household (z^h) and production (z^y) characteristics.

For credit available ($\overline{K}$) we consider the amount of credit borrowed from all available sources (formal and informal institutions). Because short-term credit is linked with liquidity available for current inputs and directly affects productivity, some authors state that short-term rather than long-term credit is the most appropriate variable for affecting productivity[22]. However, all credit available may also affect farm productivity as a result of continuous improvement in productivity by means of investments (Feder, Lau et al., 1990; Foltz, 2004; Guirkinger and Boucher, 2008). In addition, credit constraint variables consider both long- and short-term credit restrictions. From our data set, we cannot separate short-term from long-term credit restrictions. Although farmers from the survey are more likely to report long-term credit constraints, those constraints are not directly assessed in the survey. Nevertheless, to

[21] The exchange rate between the Chilean peso and the US dollar is 651 peso per dollar.

[22] It is important to note that we consider short-term credit as liquidity because households consider the allocation of resources at the beginning of the production period between current consumption, investment, and the purchase of variable inputs for current production (including labor and fertilizer). Variable inputs, in combination with land and existing capital, will produce this period's output. Because investment will not mature by the time this period's output is produced, investment in not considered as a factor in one-period production functions. It is just considered as initial capital. Thus long-term credit would not be a relevant variable for one-period production.

consider both arguments about the duration of the period pertinent to the outstanding credit variable and the possible mismatching of a period affecting credit constraint and outstanding credit variables, we estimate the switching regression model of farm productivity specified in equations (4.3) and (4.4) using two alternative variables proxying for credit variables: short-term and total credit availability. We define short-term credit as loans with a maximum maturity of 12 months because these types of loans are required to finance inputs or current consumption.

The credit variable will be relevant to indicate whether consumption and production decision are separated or not. If this variable is positively significant, there is evidence for non-separability, and farm productivity would be effectively constrained by lack of access to credit. If the credit variable is not significant, it would be not important to explain farm productivity, and credit is not a binding constraint limiting production.

The independent variable representing household characteristics (z^h) is education. The expectation is that the high-educated managers could have a positive impact on the farm's productivity. The household resource endowment (*E)* is represented by farm size because land is the most important asset that farmers have. The *a priori* expectation is that these factors have a positive influence on farm productivity. Production characteristics (z^y) are captured by the type of farm activity. We expect that for higher value crops such as avocados and grapes, the value of farm productivity is also higher.

The number of adult males or females in the household is not included in our analysis. Farmers in Chile do business as would a regular company. They hire workers for jobs and family members are normally not part of the farm's workforce. Instead, this study includes the characteristics of the owner and his or her abilities to take control of the business.

Thus, for farm productivity empirical model (equation 4.3), explanatory and observable variables are as follows (Table 4.4):

Table 4.4: Explanatory and observable variables explaining farm productivity

Explanatory Variables	Observable variables
Credit access (K)	Volume of outstanding credit (Ch$)
Endowment (Z)	Farm size (hectares)
Household characteristics (z^h)	Education
	Problems with export company
Production characteristics (z^y)	Specialization (type of fruit or vegetable)

In the credit constraint empirical model (equation 4.4), explanatory and observable variables are taken from previous studies (Foltz, 2004; Petrick, 2004b; Guirkinger and Boucher, 2008) that analyzed this stage in detail. In this chapter the model and independent variables used to determine credit constraint are as follows (Table 4.5):

Table 4.5: Explanatory and observable variables explaining credit constraint

Explanatory Variable	Observable variable
Initial wealth	Titled land (hectares)
Production characteristics	Specialization (type of fruit or vegetable)
Farmer's management skills	Problems with export company (0-1)
	Insurance
	No training and certification programs
	Education

4.5 Results

The primary objective of this chapter is to determine to what extent available credit affects farm productivity of credit constrained farmers. As explained in section 4.4.1, we estimate the switching regression model of farm productivity specified in equation (4.3) and (4.4) using two alternative variables proxying for credit variable: short-term and total credit availability.

As farm productivity is observable only for credit-constrained farmers and as there is a likely correlation between credit constraints and income, we need to control for a possible selection bias within the panel data structure using switching regression models (Miranda, 2006). Although we recognize that modeling unconstrained farmers may suffer from misspecification and endogeneity problems not captured by credit constraint variables, all two specifications for farm productivity are estimated separately for credit-constrained and unconstrained subsamples to compare the significance of the parameters in both subsamples.

The coefficients of the constrained sample selection model are estimated on 52 observations because only credit-constrained farmers are included. The rest of the observations (125) are used to estimate the unconstrained sample selection model.

Table 4.6 presents estimates of the two switching regression models of farm productivity for formal credit constrained and unconstrained farmers. All regressors from the productivity equation are regressors in the selection equation. However the selection equation has some variables excluded from the productivity equation to ensure identification of the model. The variables included in the selection equation and excluded from productivity equation are: whether use has made of insurance instruments, whether a training and a certification program has been completed, and a dummy for farm activities such as avocado and peach growing.

Before turning to the main results, we briefly comment on the parameter estimates of the selection equation representing the credit constraint (Equation 4.4). These parameters are reported in the first column of each model of Table 4.6. As expected, possession of land reduces the probability of being credit constrained in the two models. Titled land may be used as collateral which helps formal financial institutions overcome adverse selection and moral hazard problems. Another parameter that is significant and increases the probability of being credit constrained is the use of insurance. This result is in line with the Leland-Pyle model (Leland and Pyle, 1977). According to their model, poor organizations, or farms in this case, try to get full insurance, whereas good farms try to signal their quality by being only partially insured. This implies that farms that are insured are poorer-quality farms that will have a higher probability of being quantity rationed.

Finally, avocado and almond growers are more likely to be credit constrained. Two different reasons may explain this result: In the case of avocado growers, with a long tradition in Chilean agriculture, this result may reflect a situation where growers may reach a credit

ceiling, and banks are less willing to extend extra credit. In the case of almonds, which is not a typical crop in Chile, the constraint may suggest that less experienced bank officers are assessing almond projects, so that banks may be less willing to extend a loan to these lesser known entrepreneurial activities.

Table 4.6: Parameter estimates of Switching Selection Model for farm productivity under binding and no-binding credit constraint

Productivity	Model 1 CC	Prod Cons	Prod Uncons	Model 2: CC	Prod Cons	Prod Uncons
HECTARES	-0.008***	-0.00695	-0.00345	-0.007***	-0.00179	-0.00326
	[0.005]	[0.595]	[0.364]	[0.006]	[0.918]	[0.392]
ST CREDIT	0.002	0.00176	-0.00282			
	[0.222]	[0.769]	[0.484]			
TOTAL DEBT				0.001	-0.00272	0.00330
				[0.453]	[0.762]	[0.215]
EDUCATION	-0.040	3.159**	-2.264**	-0.040	3.204**	-2.449***
	[0.899]	[0.035]	[0.012]	[0.901]	[0.034]	[0.007]
TABLE GRAPES	0.220	6.930***	2.453***	0.255	6.980***	2.340***
	[0.534]	[0.000]	[0.003]	[0.463]	[0.000]	[0.005]
ALMOND	1.184**	9.036***	-0.862	1.186**	9.119***	-0.730
	[0.041]	[0.000]	[0.670]	[0.039]	[0.000]	[0.718]
WINE GRAPES	0.777	8.555***	0.710	0.752	8.672***	0.607
	[0.157]	[0.001]	[0.665]	[0.168]	[0.001]	[0.712]
CHERRY	-0.183	4.738	5.014***	-0.180	4.762	5.112***
	[0.802]	[0.265]	[0.002]	[0.803]	[0.263]	[0.001]
EXPORT_PROB	0.511	-1.981	-2.123**	0.506	-1.946	-2.196**
	[0.117]	[0.125]	[0.013]	[0.117]	[0.133]	[0.010]
INSURANCE	2.915***			2.898***		
	[0.001]			[0.001]		
NO PROGRAM	0.413			0.413		
	[0.180]			[0.181]		
AVOCADO	1.520***			1.501***		
	[0.002]			[0.002]		
SCANNED PEACH	0.555			0.594		
	[0.316]			[0.277]		
CONSTANT	-1.603***	3.802**	8.332***	-1.617***	3.694*	8.251***
	[0.000]	[0.049]	[0.000]	[0.000]	[0.055]	[0.000]

Random Effect				
Observation level				
$\text{Var}(\mu_{1it})$	5.215**	11.489***	5.208**	11.387***
	[0.015]	[0.000]	[0.015]	[0.000]
$\text{Var}(\mu_{2it})$	Fixed	fixed	fixed	fixed
Individual level				
$\sigma^2_{\xi_{1i}}$	12.401**	15.403***	12.449**	15.488***
	[0.011]	[0.000]	[0.011]	[0.000]
$\sigma^2_{\xi_{2i}}$	5.295	11.970	5.444	12.133*
	[0.169]	[0.101]	[0.167]	[0.100]
$\sigma_{\xi_{1i}\xi_{2i}}$	-4.057	1.040	-4.048	1.2016
	[0.264]	[0.770]	[0.270]	[0.736]
$\text{CORR}(\xi_{1i};\xi_{2i})$	-0.501	-0.077	-0.492	-0.088
	[0.185]	[0.769]	[0.189]	[0.775]
Observations	406	656	406	656
Individuals	52	125	52	125
Log likelihood	-257.8	-1013.9	-258.3	-1013.8
LR Test	7.08***	0.18	6.38***	0.13
Wald-test (21)	88.63***	70.18***	89.44***	71.98***

Notes: p-values in brackets; *, ** and * indicate 1%, 5% and 10% levels of significance respectively; both models are estimated by maximum likelihood with 12 quadrature points, adding extra quadrature points did not produce important changes in coefficients and/or standards errors; $\sigma^2_{\xi_{1i}}$ and $\sigma^2_{\xi_{2i}}$ refer to the unexplained variance at the individual level for the farm productivity model and the selection model respectively; Likelihood ratio test (LR test) compares the exogenous (H0) with the endogenous model (Ha) and Wald test for the significance of all regressors but the constant.**

We now turn to the primary results of the regressions in Table 4.6. The second and third columns give parameters estimates for constrained and unconstrained productivity equations for short-term credit specification while the fifth and sixth columns do for constrained and unconstrained productivity equations for total debt specification .

The regression results of the farm productivity equation under a binding credit constraint for the two specifications show that the following variables affect farm productivity: education of the manager of the farm, and being almond, wine grape and table grape growers. The most important result, however, is the insignificant effect of short-term and total credit on farm productivity for constrained farmers. This result also indicates that constrained farmers, most of them quantity rationed, can separate production and consumption decisions and thus optimally choose their levels of input so that farm productivity is not affected. Although farmers feel themselves credit constrained, credit is not actually limiting their farm productivity. In other words, although farmers perceive themselves to be credit constrained, production and input-use decisions are not linked to their outstanding credit.

As expected, productivity for unconstrained farmers is not influenced by the availability of short neither by total debt. Although some farmers are credit constrained from formal credit institutions, the outstanding credit does not limit their productivity because they either have short-term credit available from informal institutions and probably shift demand for credit to the informal sector, or they find other sources to fund working capital such as cash reserves or near liquid assets. Indeed, we find little difference in the impact of short-term credit allocation on productivity for farmers that are constrained versus those who are unconstrained in the formal sector, suggesting that in the short term the informal sector is a good substitute or complement for an imperfect formal one.

Analyzing our control variables, we see that education is one of the variables that has a positive significant influence on farm productivity. This is an indication that education increases farm productivity. Given their constrained access to credit, more educated managers have more skills and tools to improve productivity.

Finally, variables related to specific farm activities also positively affect farm productivity under a credit constraint. For instance, almond growers, compared to farmers of other crops apart from cherries and table and wine grapes, increase their productivity by Ch$ 9 million per hectare (see model 1). In the meantime wine and table grape growers, compared to farmers of other crops, increase their income by Ch$ 8.67 and Ch$ 6.9 million per hectare, respectively. Good prices for these products in recent seasons may have affected these results.

The switching regression model for farm productivity under a binding credit constraint for the two specifications reports that the parameter is statistically insignificant. However, the LR test for selection bias is significant, suggesting that the selection bias is relevant under binding credit, and the coefficients may differ from constrained and unconstrained samples.

Since both ρ parameters for constrained and unconstrained farmers are statistically insignificant, this result is not conclusive with respect to whether or not credit-constrained or unconstrained farmers are more or less productive than a random farmer.

4.6 Discussion and conclusions

The present work analyses farm productivity conditional on selection criteria for access to formal credit using a panel data structure for market-oriented farmers in Chile. The complexity arises from the panel structure of the data and from the need to adjust for a possible selection bias. In our results, neglecting sample selection problems lead to biased estimators, for example for the impact of credit on farm productivity.

Most comparable studies suggest that while the productivity of unconstrained farmers is independent of their endowments such as liquidity, the productivity of constrained farmers is linked with their endowments. Specifically Guikenger (2008) suggests that credit constraints have a negative impact on productivity on constrained farmers in Peru. Their study suggests that Peruvian farmers do not have other financing alternatives such as an informal sector, capable to fully meet the liquidity need for constrained farmers in the formal sector. Their results break the independence between farmer`s resource allocation and endowments, implying credit market failures.

However, the most important result of this chapter is that, despite some evidence of credit constraints due to asymmetric information and adverse selection prevalent in rural areas in Chile, the marginal effect of credit on farm productivity is nil across credit constrained and unconstrained farmers. Thus, access to credit does not seem to change farmers' production decisions for market-oriented farmers. The credit constraint condition is not binding, which implies that the available amount of credit does not restrict productivity and farmers do not need more credit to improve their income per hectare. A possible explanation for not finding significant effects for credit constrained firms in the formal sector is that informal credit institutions act as complement providers of credit, as it is shown in Chapter 3. An active informal sector may thus relax credit constraints that prevail due to asymmetric information as well as risk and transaction cost.

This finding is relevant in a country like Chile that is currently discussing the pertinence of an agricultural bank, specialized in agricultural credit. Our results suggest that an increase in the availability of short-term credit will not have an impact on farm productivity. Others factors may have a larger impact on farm productivity such as education and farm activities such as avocado and almond.

Chapter 5

Dynamics of Investment for Market-Oriented Farmers[23]

Abstract

Using panel data from a survey conducted in 2006 and 2008 of 177 market-oriented farmers in central Chile, we investigate investment under imperfect capital markets. Specifically we determine the impact of formal credit constraints on fixed investment. By controlling for endogeneity problems, we find credit constraints to have a significant negative impact on fixed investment. In addition, a time trend is significant, which we understand as evidence of the impact of the global financial crisis of 2007.

5.1 Introduction

An investment can be broadly defined as an outlay of cash in exchange for expected future cash returns (Barry and Robison, 2001: p.84), and it is possible to distinguish between capital investments and financial investments. The former is the purchase of capital goods (such as a machine or buildings) to produce goods for future consumption. The latter is the purchase of assets (such as securities, bank deposits) with a primary view to their financial return, either as income or capital gain; this form represents a means of saving. In this study we focus on the capital (or real) investment.

Market-oriented farmers need more capital for three main reasons: to invest in new technologies, to meet the requirements of international regulations on quality and food safety, and to obtain scale and scope economies. All these investments play an important role in increasing the productivity and efficiency of a firm.

[23] This chapter is based on: A. Reyes et al. Dynamics of Investment for Market-Oriented Farmers in Central Chile. Paper under development.

However, to invest in certain goods carry costs which farmers have to face. Changes in capital stock are associated with additional costs of machinery, administration and planning the capital expansion. All these costs are assumed by farmers if they expect higher prices and productivity. However, when expectations are uncertain, as in a global financial crisis period, these uncertainties lead to lower investments by risk-averse farmers.

The objective of this chapter is to explore the factors that influence the decision to invest in fixed capital for farmers in Chile. Specifically we focus on the impact of formal credit constraints on investment decisions. In doing so we also try to detect the time trend in a investment model. The panel data structure of our data base allows us to test differences in farmers' probability to invest during the years of our study, which were strongly influenced by the global financial crisis of 2007. Increasing volatility and uncertainty may cause higher interest rates in the financial market and may influence investment decisions (Demir, 2009). Then, irreversible fixed investment in the farming sector may be negatively affected by the uncertainty of the future.

Our contribution is two-fold: First, we empirically estimate the impact of credit constraints on investment in a developing country context, using a direct measure for capital constraints. Although investment studies under capital market imperfections are extensive, most of this literature is based on the idea that investment is only sensitive to internal funds if there are imperfect capital markets. Empirically these studies, first introduced by Fazzari et al. (1988), have been conducted by dividing the study sample according to an a priori measure of financing constraints, after which a variable that proxies for internal funds is compared in both subsamples. In some studies the variable that proxies for internal funds is cash flow.

Some authors, however, question the relevance of the use of cash flow as a measure of financial constraints. Kaplan and Zingales (1997) argue that investment-cash flow sensitivities do not provide useful evidence about the presence of financial constraints. Demir (2009)

shows that the availability of internal funds may be a necessary but not a sufficient condition for financing a real investment project. In addition, an a priori classification of financing constraints is problematic since the threshold used to classify firms in different groups is set arbitrarily (Bo et al., 2003). Some exceptions to the previous measurement of credit constraint methods are Petrick (2004a) and Feder (2001) who propose to proxy the credit constraint status by using results of a direct survey. In their survey farmers were directly asked about their perception of credit constraints. Both studies, conducted in Poland and China respectively, found that credit constraints negatively affect investment.

A completely different approach is used by Rajan and Zingales (1998) in trying to determine the impact of financial market imperfections on investment and growth. Specifically their study uses the interaction between industry`s dependence on external funds and financial market development in a country as indicator of financial market imperfections in the investment model. Their study suggests that financial development may play a particularly beneficial role in investment in new firms. If new firms are the source of new ideas, financial development can enhance innovation, and this, in turn, enhances growth in indirect ways. Although their approach partly solves the problems associated with the investment cash-flow estimates, it still does suffer from not using a direct measure for capital constraints.

To estimate investment decisions this study directly measures credit constraints based on a direct elicitation approach (Guirkinger, 2008; Boucher, Guirkinger et al., 2009) where the randomly selected farmers were asked about the perception of their formal credit constraint status. Although one drawback of directly asking responders about their borrowing experience is that such an approach relies only on an individual's subjective assessment of his situation, it is better than relying on an arbitrarily chosen variable that may not distinguish between credit-constrained and unconstrained farmers.

Second, we address the potential endogeneity problems of a credit constraint variable by using a discrete switching endogenous model (Miranda & Rabe-Hesketh, 2006). The endogeneity problems arise in a credit-market context because several unobserved characteristics may at the same time affect investments and the probability of becoming credit constrained. For instance, some farmers who are unknown to banks but who are very innovative may have a higher probability of being credit constrained, but they also may have more investments. In this case, not controlling for this "unobserved" factor will lead to an underestimation of the effect of credit constraints because the positive effect of innovation skills will also be picked up by the credit constraint variable which will, in and of itself, counteract the negative effect of credit constraints. On the other hand, farmers with poor entrepreneurial ability (an unobservable factor) are both less likely to invest in fixed capital and more likely to be limited in their access to credit. In this case, not controlling for endogeneity will lead to an overestimation of the effect of credit constraints.

The rest of the chapter is organized as follows. Section 5.2 provides an overview of empirical investment models applied in the literature. Section 5.3 presents the empirical approach used in this chapter based on an endogenous switching dummy variable model with state dependence. Section 5.4 describes the context of our study together with the data collection. Sections 5.5 shows the results of two different econometric strategies on an estimated investment model with potential endogeneity problems. Finally section 5.6 concludes and discusses the main findings.

5.2 Theoretical framework

In this section we explain the most relevant studies about how to empirically estimate investment under capital market imperfections[24]. Under the assumption of perfect capital

[24] For a complete survey on investment equations we referred to Lensink, R., H. Bo and E. Sterken (2001) *Investment, capital market imperfections, and uncertainty: Theory and empirical results* (Cheltenham, UK: Edward Elgar)., and Petrick, M. (2005) Empirical measurement of credit rationing in agriculture: a methodological survey. *Agricultural Economics,* 33(2), pp. 191-203.

markets with firms having equal and unlimited access to invest at an exogenously determined cost, financing decisions or the capital structure of a firm should not have any impact on private investment decisions (Modigliani and Miller, 1958). However, under imperfect capital markets related to asymmetric information problems, the Modigliani and Miller proposition no longer holds and liquidity variables, such as cash flow, has a significant effect on investment decisions.

The literature has been developed in several ways to empirically estimate the investment model under imperfect capital markets. Three basic types of models have been applied: the *q* model of investment (also called the flexible accelerator model or Tobin's *q* investment model), the structural investment model (also called the stochastic Euler equation) and the reduced form model.

First, the *q* model of investment proposed by Tobin (1969) states that all fluctuations in investment are related to the *q* indicator, which is the ratio of the market value of installed capital to the replacement cost of installed capital. An increase in Tobin's *q* should have a positive effect on investment. In this equation, variables that may say something about financial constraint are added to the basic reduced-form equation of investment. Based on the idea that investments are sensitive to internal funds in imperfect capital markets, it is common to include cash flow as a measure of internal sources.

On the other hand, since most firms (including farms) are likely to be financially constrained in some sense, the investment-cash flow sensitivity indicator would be positive for almost all firms. To get around this problem it is common to divide the sample into two groups where each may be more or less likely to be credit constrained and to compare the investment-cash flow sensitivity indicator for both subsamples. A greater investment-cash flow sensitivity coefficient is seen as an indicator of more severe capital restrictions. This approach is popularized by Fazzary, Hubbard and Petersen (Fazzari, Hubbard et al., 1988) and

is widely used in literature with different splitting criteria. A sample-splitting criteria that have been considered in literature include dividend payout ratios (Fazzari, Hubbard et al., 1988), firm size, age or growth (Devereux and Schiantarelli, 1990), the firm credit rating (Whited, 1992) the dispersion in the firm's share ownership (Schaller, 1993); whether the firm is affiliated to a larger corporate grouping (Hoshi et al., 1991; Hermes and Lensink, 1998); and the firm has a relationship with a particular bank (Elston, 1993).

However some criticism of this approach has arisen mainly because of the use of investment cash flow sensitivity as a measure of financial constraints and the *a priori* classification of firms into different groups. Kaplan and Zingles (1997) criticize Fazzary, Hubbard and Petersen's approach by pointing out that while constrained firms should be sensitive to internal cash flow and unconstrained firms may not need to be, it is not necessarily true that the magnitude of the sensibility increases with the degree of financing constraints. In particular, their results indicate that a higher sensitivity of investment to cash flow is not associated with more financially constrained firms.

In addition, two problems may arise from *a priori* classification of firms into different groups. Firstly, the threshold used to classify firms in different groups is set arbitrarily, and secondly, although it might be possible to identify constrained firms, it is quite often impossible to identify the years during which a firm is constrained. This makes it impossible to differentiate between firm-specific effects on investment and the effects of financing constraints (Kaplan and Zingales, 1997; Bo, Lensink et al., 2003).

The second approach to estimating an investment equation is the structural investment model approach, also called the Euler model of investment (Bond and Meghir, 1994). The idea of the structural investment model is to maximize the firm's present value subject to capital accumulation and external borrowing constraints. With this optimization problem the optimal path for investment is derived, which yields an empirical Euler equation under the

null hypothesis of no financial constraints. Like the previous model, the sample needs to be divided into two groups—credit constrained farmers and unconstrained farmers—in order to test the Euler equation. This Euler equation has a lagged investment variable which is most likely correlated with current investment. Then in estimating this equation, state dependency needs to be considered[25]. This approach does not necessarily need an explicit investment equation and, consequently, it is not necessary to estimate a Tobin's *q*, avoiding problems related to the measurement of Tobin's *q*. Some example of this approach are Whited (1992), Bond and Meghir, (1994), Hubbard (1995) Demir (2009).

However, the structural models of investment that have been proposed to date have not been successful in characterizing a dynamics process, possibly because they have neglected the potential importance of endogeneity and measurement errors in average *q* (Bond and Van Reenen, 2007). An intermediate possibility is to rely on dynamic econometric specifications that are not explicitly derived as optimal firm behavior, but address questions without fully specifying the nature of investment equations. A favorable interpretation of such reduced-form models is that they represent an empirical approximation to some complex underlying process that was generated by the data. However, a less favorable interpretation is that they compound the parameters adjustment process with parameters of the expectation-formation process in determining investment, causing identification problems. Fortunately, some possible solutions to the identification problems can be found. Models like this have been introduced into the investment literature by Bean (1981), Bond et al. (2003) and Petrick (2004a).

The model considered in this chapter follows the approach that use a reduce-form of dynamic investment decision model. These reduced-form investment models have the

[25] For lagged variables in a continuous model see Arellano and Bond Arellano, M. and S. Bond (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies,* 58(2), pp. 277-297. and for discrete lagged variables see Woodridge Wooldridge, J. M. (2005) Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity. *Journal of Applied Econometrics,* 20(1), pp. 39-54..

following implications (Petrick, 2004a): First, limited access to credit causes a lagged adjustment of capital stocks to a steady state. Second, optimal investment is dependent on the equity formation of the household in terms of the profit retention or savings, or more generally, on the availability of collateral. Finally, investment and credit demand are thus neither separable from consumption decisions nor independent of the equity position of the farm. These implications are followed in the empirical model used in this chapter.

In addition, three characteristics distinguish the model used in this chapter. First, we use a discrete instead of a continuous variable for investment in order to empirically estimate the impact of credit constraints on the probability of farmers to invest. Our interest is to study the variables that impact the decision whether to invest in fixed capital with two-year data set. In addition, for a continuous model of investment, at least a three-year data set is needed (Arellano and Bond, 1991). Thus, we need to limit our analysis to that covered in a dynamic investment decision model because we have less than three years of data. Second, we include a credit constraint variable, which allows us to test our primary question, the impact of credit constraint on investment. Instead of using a proxy for a credit constraint, we use a directly collected variable for a credit constraint which include a broader definition of credit constraints (Boucher, Guirkinger et al., 2009).

Finally, we include a lagged investment variable to retain the dynamic process of investment.

5.3 Empirical approach

To deal with the dynamic estimation of a discrete variable for investment and a possible endogenous credit constraint variable, this section sets out a statistical model that permits identification of state dependence, taking into account the potentially confounding effect of unobserved individual heterogeneity (Wooldridge, 2005).

Let us label with y^*_{it} the latent continuous variable representing investment decision for farmer i (i=1,…, N) at time t (t=1,…,T). The dynamic investment decision model is thus defined by the following equations:

$$y^*_{it} = x'_{it}\beta + \gamma y_{it-1} + \alpha_i + \varepsilon_{it} \quad \textbf{(5.1)}$$

With

$y_{it} = 1$ if $y^*_{it} > 0$

$y_{it} = 0$ if $y^*_{it} \leq 0$

Where x_{it} represents the vector of explanatory variables affecting the investment decision and y_{it-1} is the lagged investment decision variable. The coefficients γ and β are the parameters to be estimated. The term α_i captures unobserved heterogeneity and accounts for all time invariant unobserved individual characteristics that influence investment decision. This will include, for example, entrepreneurial abilities or capacities. The null hypothesis of no state dependence implies that $\gamma = 0$. The parameter γ should be interpreted as the average effect over the time period considered.

The model is dynamic in the sense that it allows the unobservable farmer's probability to invest to be a function of previous farmer investment. Defining a state as a realization of a stochastic process, we may think of state dependence in term of the actual investment pattern being dependent on the state of investment decision that was revealed for the previous investment of the same farmer.

However, equation (5.1) has two methodical problems related with its estimation: initial conditions and an endogeneity problem.

The initial condition problem arises in our estimation because α_i is an individual-specific term, which appears in every equation for the same individual over time. In particular, it will appear in the equation for y_{it} and also in the equation for y_{it-1}. Therefore in

the equation for y_{it} the regressor y_{it-1} is necessary correlated with the error component α_i. This will cause endogeneity problems of y_{it-1} and, if unaddressed, will tend to produce a bias in the coefficient estimate of y_{it-1}, which provides an estimate of state dependence. This is called "the initial condition problem". Intuitively, the problem is that the model describes a dynamic process, and we need to allow for it to start. The probability to invest in the current year depend on whether the farmer invested in the year before and the probability to invest in the year before depends on whether the farmer invested two years before, and so on. However information on whether the farmer invests in the first year is most of the time missing.

Fortunately, Wooldridge (2005) proposed a simple strategy to address this problem in dynamic nonlinear panel data models with unobserved heterogeneity. This paper suggests to model the distribution of the unobserved effect conditional on the initial value and any exogenous explanatory variables. On using this suggestion to estimate probit, ordered probit, tobit and poisson regressions, an auxiliary distribution can be chosen that leads to straightforward estimation, namely the introduction of the same time-invariant initial observation as a regressor in the equation for y_{it}. With this simple shortcut, partial effect on mean responses, averaged across the distribution of observables, are identified. Thus, equation (5.1) can be re-written as:

$$y_{it} = x'_{it}\beta + \gamma y_{it-1} + \varphi y_{i0} + \alpha_i + \varepsilon_{it} \qquad \textbf{(5.2)}$$

With

$y_{it} = 1$ if $y^*_{it} > 0$

$y_{it} = 0$ if $y^*_{it} = 0$

Where y_{i0} is the time-invariant initial condition of investment decision and φ is the regressor to be estimated. The term φ will also indicate the correlation between the initial and current investment decision.

In determining the effect of a credit constraint on probability to invest, another major problem is the possible endogeneity of a credit constraint in the sense that credit constraint status is correlated with unobservable heterogeneity. For instance, farmers with poor entrepreneurial ability (unobservable heterogeneity) are both less likely to invest in fixed capital and more likely to be limited in their access to credit.

To get around this problem, an endogenous switching binary variable for a dynamic investment decision model in panel data can be written as a system of equations for the substantive equation (investment equation) and the endogenous equation (credit constraint). By treating the responses as repeated measurements nested within individuals, the endogenous switching model fits neatly into a multilevel framework (Skrondal and Rabe-Hesketh, 2004). We keep the same specification of probability to invest (y_{it}) for farmer *i* (*i*=1,…, *N*) at time *t* (t=1,…,*T*). The binary variable CC_{2it}^{*} simply indicates presence or absence of a credit constraint. The joint model is thus defined by the following equations:

$$y_{1it}^{*} = x_{it}'\beta + \gamma y_{it-1} + \varphi y_{i0} + \phi CC + \varepsilon_{1it} \qquad \textbf{(5.3)}$$

With

$y_{it} = 1$ if $y_{it}^{*} > 0$

$y_{it} = 0$ if $y_{it}^{*} = 0$

And

$$CC_{2it}^{*} = z_{it}'\gamma + \varepsilon_{2it} \qquad \textbf{(5.4)}$$

With

$CC_{2it} = 1$ if $CC_{2it}^{*} > 0$

$CC_{2it} = 0$ if $CC_{2it}^{*} = 0$

Where x_{it} and z_{it} represent the vectors of explanatory variables affecting the decision to invest and credit constraint status, respectively. The coefficients γ and β are the parameters to be estimated.

To take into account the panel data structure and impose dependence between both residuals, the residuals in equations (5.3) and (5.4) are decomposed as $\varepsilon_{1it} = \alpha_{1i} + \lambda\delta_{it} + \mu_{1it}$ and $\varepsilon_{2it} = \alpha_{2i} + \delta_{it} + \mu_{2it}$. These three terms capture unobservable heterogeneity: α_{1i} and α_{2i} are the random intercepts for each individual normally distributed with zero mean and variance $\sigma^2_{\alpha 1}$ and $\sigma^2_{\alpha 2}$, respectively, and covariance $\sigma^2_{\alpha 1;\alpha 2}$; δ_{it} is a shared random effect to induce dependence between substantive and endogenous equation by the factor λ, normally distributed with zero mean and variance $\sigma^2_{\delta_{it}}$; μ_{1it} and μ_{2it} represent the random error specific for output production and credit constraint status, respectively, and are assumed to be normally distributed and independent of x_{it} and z_{it} with zero mean and variance $\sigma^2_{\mu_{1it}}$ and $\sigma^2_{\mu_{2it}}$, respectively. Therefore, $Var(\varepsilon_{1it}) = \sigma^2_{\alpha_{1i}} + \lambda^2\sigma^2_{\delta_{it}} + \sigma^2_{\mu_{1it}}$, $Var(\varepsilon_{2it}) = \sigma^2_{\alpha_{2i}} + \sigma^2_{\delta_{it}} + \sigma^2_{\mu_{2it}}$ and $Cov(\varepsilon_{1it}, \varepsilon_{2it}) = \lambda\sigma^2_{\delta_{it}} + \sigma^2_{\alpha_{1i};\alpha_{2i}}$. Then equations (5.3) and (5.4) are now;

$$y^*_{1it} = x'_{it}\beta + \gamma y_{it-1} + \varphi y_{i0} + \phi CC + \alpha_{1i} + \lambda\delta_{it} + \mu_{1it} \qquad \textbf{(5.5)}$$

With

$y_{it} = 1$ if $y^*_{it} > 0$

$y_{it} = 0$ if $y^*_{it} = 0$

And

$$CC^*_{2it} = z'_{it}\gamma + \alpha_{2i} + \delta_{it} + \mu_{2it} \qquad \textbf{(5.6)}^{26}$$

With

$CC_{2it} = 1$ if $CC^*_{2it} > 0$

$CC_{2it} = 0$ if $CC^*_{2it} = 0$

[26] See Appendix 6 for details about identification problem.

5.4 The survey

The data we use derives from a survey of a random sample of farms in central Chile, recorded by the Natural Resources Information Center (CIREN). We only consider market-oriented farmers, that is, farmers who manage a minimum of 10 productive hectares and sell their crops to a third party (market). We exclude subsistence, non-cultivated, and recreational farms, because formal financial institutions do not target these farmers, and because market-oriented farmers are the main players in the Chilean agricultural sector. We choose 10 hectares as the minimum productive area because it represents the minimum size required to support a family in Chile.

The survey was carried out in 2006 and 2008 and contains data on the 2005–2006 and 2007–2008 seasons, respectively. In the first wave of the survey, data consisted of a random sample of 200 farms located in six counties in the central region of Chile. During the second wave, we collected information from 205 farmers, 177 of which were in the first wave. The survey instrument was repeated with slight differences[27]. Table 5.1 provides descriptive characteristics of the farms taken in the sample.

[27] See Chapter 1 to see details on data (section 1.4) and Appendix 1 to see questions applied in the survey.

Table 5.1:Sample statistics of surveyed farms (n=354, pooled sample)

Variable	Definition	Mean	Standard deviation
HECTARES	Farm size (hectares)	76.80	111.22
ASSETS NO HA	Total assets (machinery and facilities) net from hectares (millions of Chilean$)	243.58	554.28
INV	Binary dummy with a 1 if the farmer decided to invest in the current season	0.53	0.50
LAGGED INV	Binary dummy with a 1 if the farmer decided to invest in the past season	0.69	0.46
INI INV	Binary dummy with a 1 if the farmer decided to invest in the season 2003-2004	0.72	0.45
CREDIT CONSTRAINT	Binary dummy with a 1 if farmer is either quantity, risk or transaction-cost constraint	0.15	0.35
INSURANCE	Binary dummy with a 1 if the firm use insurance instruments, 0 otherwise	0.03	0.18
CLUSTER	Number of relationships that a firm has with export and/or input supplier firms.	1.42	0.81
YEAR ADM	Years farming (years)	22.90	12.34
NO PROGRAM	1 if the firm do not have neither employees-training program nor GAP certification, 0 otherwise	0.23	0.42
ALMOND	1 if the farm has Almond as a main production, 0 otherwise	0.04	0.21
AVOCADO	1 if the farm has Avocado as a main production, 0 otherwise	0.07	0.26
WINE GRAPE	1 if the farm has Wine Grape as a main production, 0 otherwise	0.06	0.24

Notes: 1,000 Chilean $= 1.58 US

Table 5.2 shows the investment activity by farmers in different years. Investment refers to the gross investment made during the current and previous calendar year because investment occurs across a longer period than one year (e.g., plantation and irrigation systems). The 2006 survey shows investments from 2005 to 2006, while the survey made in 2008 collected information on investments from 2007 to 2008. In addition, during the first round in 2006, farmers were required to recall investments made from 2003 to 2004. As illustrated in Table 5.2, investment decreased from a total of $39 million in 2003 and 2004 to

$15 million in 2007 and 2008. This can be explained by the uncertainty caused by the financial crisis in 2008. It is commonly known that in uncertain economic environments, entrepreneurs invest less (Demir, 2009). In addition, only 40% of our sample invested in 2007 and 2008, in contrast to the 70% who decided to invest in 2003 and 2004.

Table 5.2: Investment behavior by farmers, 2003-2008

	2003-2004	2005-2006	2007-2008
Investment (million Ch$) [(1)]	38.74	38.08	14.83
Percentage of farmers investing	72	66	40
Number of farmers	177	177	177

[(1)]Investment in million Chilean pesos; 1,000 Chilean$= 1.58 US$

In the context of investment decision models, firms will be financially constrained if external sources of finance (for example, from new share issues or borrowing) are assumed to be more expensive than internal sources of finance (for, example, from retained earnings) Bond (2007). Under this context, the three categories of credit constraints (quantity, risk and transaction cost) introduced by Boucher (2009) may be relevant in determining the impact of credit constraint on investment decision[28]. In all three categories of credit constraints, farmers have a demand for credit but they are constrained in accessing credit by a limited capacity to provide collateral, high transaction costs of the credit contract, or a high level of risk associated with the credit contract. In other words, all three types of credit constraints can lead to an imperfect or even inexistent credit market and, thus, both sources of finance, internal and external, are not perfect substitute.

Table 5.3 shows that on average 53% of farmers in our sample invested (pooled sample), with higher investment activities for borrowers (59%) and transaction-cost rationed farmers (67%). Quantity-rationed farmers are those who invested less with only 47% investing in fixed capital. On the other hand, unconstrained borrowers and nonborrowers seemed to be wealthier farmers with larger holdings than quantity- and risk-rationed farmers.

[28] See Chapter 1 to see details on Boucher's categories of credit constraints and questions applied in the survey (section 1.4.3)

From our results it seems that investment decision is driven by credit status, with the exception of transaction-cost rationed credit constraint. However, farm size and endowment seems to be correlated with credit status as well. This may cause endogeneity problems in trying to explain the investment decision process.

We also observe in Table 5.3 that the number of farmers who were transaction-cost and risk-rationed was very low (6 and 10, respectively). We therefore merge the two categories in the remainder of this chapter.

Table 5.3: Investments by farmers classified according to credit constraint status, pooled sample 2006 and 2008

Credit Constraint Status	**Investment per farm**		**Land size**	**Assets**	**Total sample**
Unconstrained	**Volume (million Ch$)**	**Proportion of farmers investing (%)**	**(ha)**	**Volume (million Ch$)**	***Sample size***
Borrowers	36.6	59	82	1336	118
Non-borrowers	21.2	49	82	1463	184
Sub-total	27.2	53	82	1413	302
Formal sector credit constrained					
Quantity rationed	12.7	47	41	836	36
Transaction cost rationed	55.1	67	83	863	6
Risk rationed	34.7	50	47	840	10
Sub-total	**21.9**	**50**	**47**	840	**52**
Total	**26.4**	**53**	**77**	**1329**	**354**

5.5 Are investments influenced by a credit constraint?

We now present the estimation results for the dynamic investment decision model without considering endogeneity problems for credit constraint variable, presented in section 5.3 in equation (5.2). As our model is dynamic, we include a two-period lagged investment decision as a variable to capture state dependence. We also include the initial investment decision as a regressor in order to avoid initial condition problems (Wooldridge, 2005).

In addition, we include some control variables in the model, including variables that proxy for credit constraints, existing capital stock, for observable farm(er)-specific effects and

for a time trend. The credit constraint variable indicate presence or absence of credit constraint, considering as credit constraint all three forms of formal credit rationing: quantity, risk and transaction cost (see note 5). The proxy for existing capital stock is the amount of assets, measured as the valued total of farm assets including land, machinery and facilities (in logs). All assets are priced using market prices. The effect of the amount of assets on the probability to invest depends on the size of the capital stock or farm size. A negative sign of the amount of assets implies that large farms have less probability to invest, meaning that the farm size decrease over time, whereas a positive sign implies an increasing farm size.

The proxies for observable farm(er)-specific characteristics are years of farming experience (in logs), farmer participation in a training or certification program, and farm activity. From prior observations the expectation was that the experience of the household head could have a positive impact on the probability to invest because skilled farmers tend to invest more (Petrick, 2004). Production characteristics of farm activity are captured by variables related to specialization in a particular fruit or horticulture product. The expectation is that specialization in a higher-value crop such as almonds or avocados tends to result in a higher probability to invest. Finally, we expect a negative sign for the time trend. This is because the 2008 global financial crisis affected investment decisions.

Table 5.4 presents the results of the dynamic investment model if we deny endogeneity problems. We first estimate the model without considering the lagged investment and the initial condition variables (model 1). Then, in model 2 these variables are included. Finally, model 3 keeps all statistically significant variables at a level of 20%[29], with two exceptions. The initial investment variable is maintained to avoid the initial condition problems explained in section 5.2, and the credit constraint dummy variable. We include this variable to be able to compare this result with the later analysis.

[29] We chose 20% as a level of significance to avoid any omitted variable problems in non-lineal estimations. In this case omitted variables could cause biased estimators.

Table 5.4 shows that the total amount of assets and time trend are statistically significant in all models. This preliminary result means that having a larger number of assets has a positive effect on the probability to invest, suggesting that on average farm size in Chile is growing. However, we will return to this analysis in the next table where endogeneity problems are considered. In addition, the time trend indicates that there is a strong negative relation between the time trend and investment. The financial crisis that affected the world in 2008 may be the explanation of this result. This crisis may have affected the investment decisions of farmers who decided to postpone investment in no urgent assets to later years when they hoped to find a less uncertain environment. Finally, Table 5.4 shows that the credit constraint dummy variable is insignificant in all specifications, suggesting as primary result that rural financial market are efficient in Chile.

Since the random intercept is shared between each observation for the same individual, intraclass correlation explains the proportion of the total variance that is explained by individuals. In our case the proportion of the total variance explained by individuals is very low in all models. This is because explaining variables, specially the time trend and the amount of assets, capture most of the variance explained by individuals.

Although Table 5.4 shows that the level of state dependence is not significant, we can see differences in the unobservable heterogeneity between both models. In model 1, 7.5% of the unexplained variation is captured by the individual effect. In contrast, the unobservable heterogeneity practically disappears in model 2. This may be due to the fact that we have explicitly taken into account the presence of state dependence by means of the lagged investment variable.

Table 5.4: Parameter estimates from the dynamic investment decision model

	Model 1	Model 2	Model 3
LAGGED INVESTMENT		0.261	0.268
		[0.154]	[0.140]
INITIAL INVESTMENT		0.115	0.111
		[0.542]	[0.555]
LN (YEAR FARM+1)	0.0909	0.0809	
	[0.411]	[0.446]	
NO_PROGRAMME	0.0144	0.0394	
	[0.935]	[0.815]	
AVOCADO	-0.0846	-0.0689	
	[0.762]	[0.797]	
ALMOND	-0.458	-0.539	-0.520
	[0.220]	[0.134]	[0.141]
LN[ASSETS]	0.157**	0.139*	0.128*
	[0.045]	[0.060]	[0.078]
TIME TREND	-0.749***	-0.711***	-0.705***
	[0.000]	[0.000]	[0.000]
CREDIT CONSTRAINT	-0.0164	-0.0443	-0.0488
	[0.939]	[0.829]	[0.809]
Constant	-0.102	-0.272	0.0420
	[0.882]	[0.681]	[0.936]
N	354	354	354
Log likelihood	-228.5	-226.2	-226.6
Individual	177	177	177
Wald Test	28.12***	35.09***	34.53***
Intraclass correlation	0.076	0.000	0.000

Notes: *p*-values in brackets; *, ** and * indicate 1%, 5% and 10% levels of significance respectively; all models are estimated using probit models; Wald test for the significance of all regressors but the constant; Continuous variables such as assets and years farming are measured in logarithms to avoid possible heterogeneity problems.**

We now move to determine to what extent formal credit constraints affect the investment decision-making process for market-oriented farmers in central Chile taking into account endogeneity problems. Because there is likely a dependence between a credit constraint and investment, we need to prevent a possible endogenous credit constraint variable within the panel data structure. In addition, because investment is a dynamic decision process we need to take state dependence into account.

As we saw in section 5.3, to estimate investment equation (5.5) and endogenous switching credit constraint equation (5.6), we use a multilevel approach (Rabe-Hesketh, Skrondal et al., 2005). We start using model 3 investment specification for investment

equation. For the credit constraint switching variable we include variables that do not appear in the investment equation and that correlate with credit constraint status. These variables are the number of clusters that the firm belongs to, whether or not the farmer uses insurance, farmer participation in a training and certification program, and variables related to farm activity such as avocado and wine-grapes. Although the endogenous switching model is formally identified through its functional form (Wilde, 2000), we keep some variables as exclusion restriction in the endogenous switching equation in order to maintain an economic identification (Miranda and Rabe-Hesketh, 2006).

Because a model with an exogenous switching variable is nested within the endogenous switching model, the test for the endogeneity of credit constraint *(CC)* in equation (5.5) can be performed on the basis of a simple likelihood ratio test for correlation between investment decision and credit constraint equation at the observation level ($\rho = 0$).

The econometric model will enable to distinguish some alternative hypotheses regarding the effect of credit constraint categories on the probability to invest for market-oriented farmers in Chile. In particular, we will be able to distinguish four different situations:

1) The correlation coefficient ρ is not statistically different from zero, and the coefficient on credit constraint status in the probability to invest equation is statistically significant. In this case the credit constraint status is exogenous with respect to probability to invest and its effect is causal.

2) The correlation coefficient ρ is statistically significant while the coefficient for credit constraints in the probability to invest equation is not. In this case the credit constraint status is endogenous with respect to probability to invest, and the correlation between *CC* and probability to invest is driven by unobserved heterogeneity.

3) Both the correlation coefficient ρ and the coefficient on *CC* in the probability to invest equation are significant. In this case, although *CC* is endogenous with probability to invest, it also has a causal impact on probability to invest.

4) The correlation coefficient and the coefficient on *CC* in the probability to invest equation are both insignificant. In this case our analysis will not support any of the hypotheses outlined in the literature review.

We estimate two models: The panel data investment model considers a dummy endogenous variable for credit constraint, with (model 4) and without (model 5) considering the state dependence (Table 5.5). The parameter estimates show two outstanding results in both models: a significant positive correlation between unobservable heterogeneity in the investment and credit constraint equations, and a significant negative effect of credit constraints on investment decisions.

First, the likelihood ratio test (LR Test) which compares the exogenous against the endogenous model is statistically different from zero at the 5% level in both models. This evidence is in favor of endogenous credit constraint. Even if the LR test for endogenous bias has low power, endogeneity of credit constraint is confirmed as we see differences in the parameter estimates from model 3 (Table 5.4) and model 5 (Table 5.5). The endogenous adjustment does cause a significant change in two of the output estimators: assets and credit constraint. Thus, neglecting the potential endogeneity of credit constraint variable on estimating farmer's probability to invest may result in a serious bias. In this case the bias changes the coefficient from insignificant to negatively significant[30].

Second, the estimation results provide evidence that credit constraints have a causal impact on investment, and that a credit constraint condition is endogenous with respect to

[30] Note that the correlation between the error in the probability to invest equation and credit constraint equation is positive and statically significant at 1%. Hence, unobservable heterogeneity in investment equation is positive correlated with the one in credit constraint. In this context, the positive ρ can be associated to the exclusion of the other relevant variables. This can be explained by, for instance, farmers with highly- return risky project. These farmers are more likely to be credit constraint and more willing to invest.

investment. In other words, when credit constraint treatment is randomly distributed among market-oriented farmers, the effect of credit constraints on investment decision is significantly negative.

As we can see from model 4 in Table 5.5, the coefficient of lagged investment fails to be statistically significant, suggesting no state dependence in the probability to invest equation. This result is confirmed by the Bayesian Information Criterion (BIC) and Akaike's Information Criterion (AIC), which favors model 5.

Again the unobservable heterogeneity from individuals is very low. Only 7.1% (model 4) and 14.5% (model 5) of the unexplained variation is captured by the individual effect. The difference between the unobservable heterogeneity from individuals in models 4 and 5 may be due to the fact that we have explicitly taken into account the presence of state dependence by means of the lagged investment in model 4.

Another variable that remains significant is the time trend. This variable is believed to measure the effect of the financial crisis on investment. On the other hand, the significance of the variable on the total amount of assets changed compared with the previous analysis. Taking endogeneity into account, the coefficient for total assets is not statistically significant.

Other than in the previous section, the variable assets (in logs) is not statistically significant. Its coefficient goes from positive and significant in the probit model to insignificant in the endogenous switching model. This result indicates that unobservable factors that influence both credit constraint status and probability to invest also affect assets. Removing this effect by considering endogeneity problems of the credit constraint variable shows that the value of assets does not affect the probability to invest. Thus, it is incorrect to state that large farmers invest more.

The coefficients for the variables included in the credit constraint model for models 4 and 5 show that they are strong predictors of credit-constrained farmers (Table 5.5).

Table 5.5: Parameter estimates from the dynamic investment decision model with an endogenous switching binary variable

Investment equation	Model 4	Model 5
LAGGED INVESTMENT	0.250	
	[0.196]	
INITIAL INVESTMENT	0.140	
	[0.464]	
ALMOND	-0.246	-0.193
	[0.482]	[0.604]
LN[ASSETS]	0.046	0.069
	[0.531]	[0.399]
TIME TREND	-0.685***	-0.698***
	[0.000]	[0.000]
CREDIT CONSTRAINT	-1.051***	-0.912**
	[0.000]	[0.042]
Constant	0.670	0.798
	[0.213]	[0.164]
ENDOGENOUS CREDIT CONSTRAINT MODEL		
LAGGED INVESTMENT	0.329	
	[0.243]	
INITIAL INVESTMENT	-0.241	
	[0.396]	
ALMOND	0.850*	0,828*
	[0.061]	[0,061]
LN[ASSETS]	-0.436***	-0,429***
	[0.000]	[0,000]
TIME TREND	-0.116	-0,130
	[0.453]	[0,409]
CLUSTER	0.049	0,060
	[0.664]	[0,595]
INSURANCE	2.009***	1,988***
	[0.000]	[0,000]
NO_PROGRAMME	0.224	0,243
	[0.172]	[0,143]
AVOCADO	0.835***	0,783**
	[0.007]	[0,010]
WINE GRAPE	0.953**	0,876**
	[0.011]	[0,018]
Constant	1.463**	1,495**
	[0.049]	[0,045]
Random Effect		
Observation level		
$Var\left(\lambda\delta_{it}+\mu_{1it}\right)$	6.098	1.680163
	[0.645]	[0.379]
$Var\left(\delta_{it}+\mu_{2it}\right)$	2	2
$\rho\ \left(\alpha_{1i}+\lambda\delta_{it}+\mu_{1it};\alpha_{2i}+\delta_{it}+\mu_{2it}\right)$	0.647***	0.450
	[0.000]	[0.232]

Individual level		
$\sigma^2_{\alpha_{1i}}$	0.462	0.284
	[0.712]	[0.579]
$\sigma^2_{\alpha_{2i}}$	2.120*	2.128*
	[0.090]	[0.089]
$\sigma_{\alpha_{1i}\alpha_{2i}}$	0.990	0.748
	[0.482]	[0.198]
CORR ($\alpha_{1i}\alpha_{2i}$)	1.000	0.963
	[0.000]***	[0.063]*
Intraclass correlation	0.0705	0.1446
Observations	354	354
Individuals	177	177
Log likelihood	-339.632	-342.696
LR Test	3.756*	4.586**
Wald-test	198.45***	189.85***
AIC	723.26	721.39
BIC	823.63	803.51

Notes: *p*-values in brackets; *, ** and * indicate 1%, 5% and 10% levels of significance respectively; both models are estimated by maximum likelihood with 12 quadrature points, adding extra quadrature points did not produce important changes in coefficients and/or standards errors; $\sigma^2_{\alpha_{1i}}$ and $\sigma^2_{\alpha_{1i}}$ refer to the unexplained variance at the individual level for the investment model and the endogenous variable equations respectively; Likelihood ratio test (LR test) compares the exogenous (H_0) with the endogenous model (H_a) and Wald test for the significance of all regressors but the constant; BIC and AIC stand for Bayesian Information Criterion and Akaike's Information Criterion, respectively; The continuous asset variable is measured in logarithms to avoid possible heterogeneity problems.**

Since model 5 is preferred over model 4, the analysis continues by retaining the model 5 estimations reported in Table 5.5. Thus, Table 5.6 shows the odds ratios of model 5 on the probability to invest for the two variables we focus on: credit constraint and time trend. Comparing farmers with and without a constraint, with all other variables unchanged, the odds of investment are 2.5 times as high for farmers who do not face a credit constraint compared to farmers who do.

Table 5.6: Odds ratios for investment equation

Variable	Odds ratios	Standard error	95% CI	
Restricted	2.49	1.12	1.03	5.99
Time trend	2.01	0.26	1.55	2.60

To better understand the effect of a credit constraint on investment, we need to explore the potential difference between constrained and unconstrained farmers for different levels of assets. To do so, we plot an unconstrained farmer's predicted probability to invest as a function of an extended range of values of total assets (in logs), and compare the results with constrained ones. The outcome can be seen in Figure 5.1. The range of total assets (in logs) actually observed in the data lies approximately between the two vertical lines.

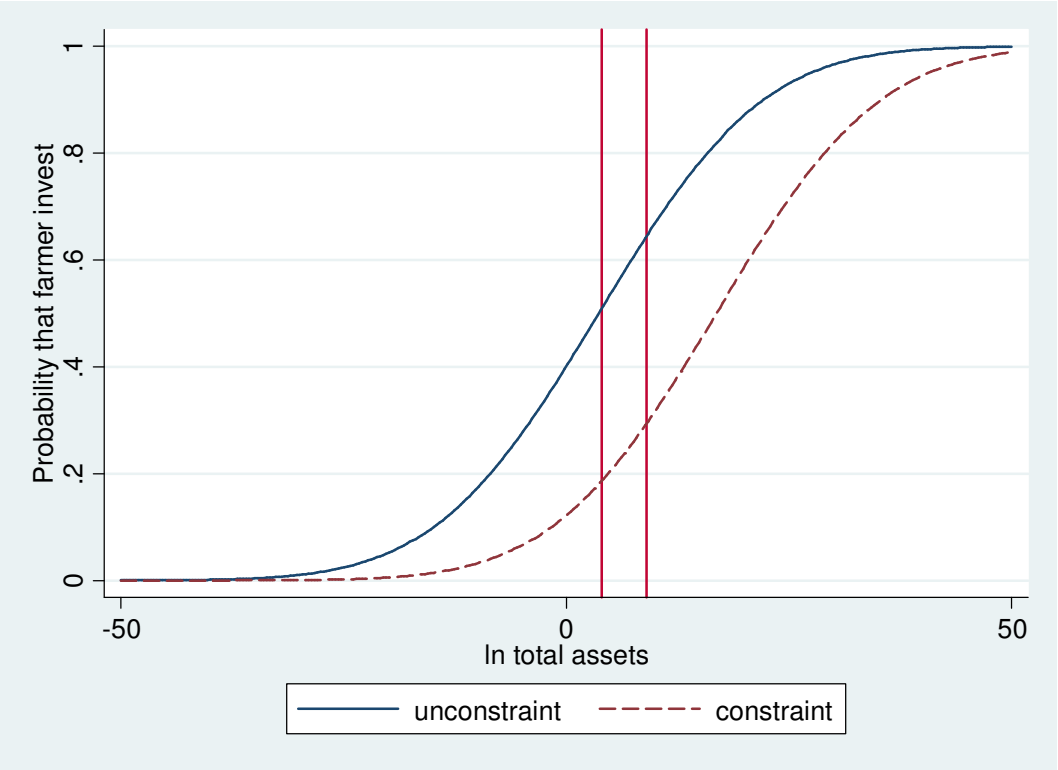


Figure 5.1: Predicted probabilities by total asset

As expected, the probability to invest increases with a farmer's wealth. As was shown for the odds rations, the probability to invest for unconstrained farmers is about 2.5 times more than for constrained farmers in the same range of total assets.

Next, comparing farmers' probability to invest in 2006 to 2008 shown in Table 5.6 with all other variables remaining the same, the odds of investment are 2.0 times as high for farmers who invested in 2006 compared to farmers who did so in 2008.

5.6 Discussion

The present work estimates the impact of credit constraint on investment for market-oriented farmers in central Chile. Specifically we estimate a dynamic investment model that takes into account endogenous problems arising from credit constraint variables. The results show that credit constraint is an endogenous variable in determining investment decision. This means that if we estimate investment without taking into account the endogenous determination of credit constraint, we would have biased estimators. Second, it can be assumed that there is not state dependence in the investment equation.

In our study, investment is observed to depend on credit constraint status. It can be interpreted as evidence of imperfect capital markets because constrained farmers, most of them quantity rationed, cannot separate investment and financing decisions. Based on an endogenous switching modeling framework, unconstrained farmers invest more than 2.5 times that of credit constrained farmers in Chile. Although not tested in this chapter, this situation can be explained because the only providers of long-term credit are commercial banks for whom lending in the long term is more risky. In addition, agricultural projects can be complex, making their assessment difficult. Variation in market price and weather conditions and foreign exchange fluctuations make farming projects often more uncertain than other projects. Under these circumstances. banks can be hesitant to extend credit to agricultural activities.

This study also reveals the negative impact of time trend on investment decisions. In our sample, roughly 70% of the farmers invested in fixed capital before the 2007 financial

crisis. By contrast, 40% of them made investments during 2007-2008. We hypothesize that this may be an effect of the impact of the global financial crisis of 2007.

A few policy recommendations can be derived from our findings. As providing credit for long-term investment is risky for banks under asymmetric information, more information is needed about the creditworthiness of farmers. Policies to improve information about the position of farmers in the credit market is therefore needed. For instance, for farmers it would be important to have well audited balance sheets and income statements to document their reputation as an entrepreneur. In this way farmers can assure banks of the quality of their farming projects as investments and obtain better lending conditions. In addition, other mechanisms to improve information in rural financial markets would be for banks to have risk evaluation departments specialized in agricultural projects. Bank officers well-trained in assessing agro-projects may help in discriminating between good and bad projects. Finally, other instruments need to be explored to avoid asymmetric information like co-signed long-term credit by business cluster member; venture capital to provide financial capital to early-stage, high potential projects; or insurance to control the risk derived from output and prices uncertainties.

Chapter 6

Discussion and Conclusions

6.1 Overview

Rural financial markets have been extensively studied in the past. In most cases these markets are characterized by strong credit constraints, even for commercial, market-oriented farmers. Some characteristics of the agricultural sector that make it more likely to face credit constraints include remote location of farms where access to bank officers is difficult; long gestation lags between investment and harvest, implying that long periods need to be bridged with working capital; high asset specificity, for which funding is more expensive and difficult; and a large number of small-scale farms with relatively limited repayment capacity. In addition, in developing countries problems of credit access can be even worse because of formal financial institutions' lack of information to discriminate between bad and good borrowers.

Some of these problems, however, can be overcome as in the case of Chile where particular characteristics confine problems of access to credit to a small number of farmers. Large average land size, long-standing bank-farm relationships, and widespread informal lending make Chile a country with specific lending conditions. However, rigorous empirical studies about credit constraints in Chile are very limited.

This study investigates the credit-rationing status of Chilean farmers and its effect on productivity and investment. In so doing, this research contributes to (1) new knowledge on the impact of credit constraints in the context of developing countries and (2) methodological approaches in estimating models in panel data context. Thus, a broad definition of being credit constrained is used that includes rationing mechanisms operating through risk and

transaction costs. In addition, multilevel analysis approach is used to deal with unobservable heterogeneity due to individual characteristics.

In the reminder of this chapter four issues are presented. In section 6.2 the contributions and the main findings of this study are discussed. Next, given the use in all empirical chapters, a brief explanation of multilevel analysis is presented in section 6.3. In section 6.4 directions for further research are identified. Finally, in section 6.5 policy implications of this study are derived.

6.2 Are market-oriented farmers credit constrained?

This study makes a contribution to measuring credit constraints and empirically determining the effects of credit constraints on productivity and investment for market-oriented farmers. More specifically, the first aim of this study is to identify the main factors that influence access to credit for market-oriented farmers, which are addressed in Chapter 2. The second aim is to determine whether informal financial institutions act as complements to or substitutes for farmers' strategies for funding, and this is considered in Chapter 3. Chapter 4 is concerned with the third aim, which is to determine the effect of credit constraints by formal financial institutions on farm productivity. Finally, Chapter 5 addresses the fourth aim, which is to identify the factors that limit farm investment.

Using data from two surveys conducted in 2006 and 2008 with 177 farmers, Chapter 2 applies three definitions of credit constraints used in literature. In line with Guirkinger (2008), Boucher et al. (2009) and Fletschner et al. (2010), we explicitly differentiate between credit constraints due to high transaction cost, risk aversion and quantity constraints. This implies that we measure in our sample not only those farmers limited in their access to bank credit, but also farmers who chose not to borrow as a result of high transaction costs or risk aversion. We find for central Chile that 16.4% and 13.6% of the sample felt credit constrained in 2006 and 2008 respectively, with most farmers being quantity rationed (10.7% and 9.6%,

respectively) and a much lower share for farmers constrained by risk (2.8% and 3.4%, respectively) and transaction cost (2.8% and 0.6%, respectively). The most important variable explaining quantity rationing is found to be land size. The negative and significant impact of land size supports the fact that titled land can be used as collateral and is able to overcome adverse selection and moral hazard problems. On the other hand, the insignificant effect of the length of the relationship between the bank and a farm may indicate that a long-term relationship not only improves information about the farm, but also that this information can be used by banks for calculating a credit ceiling. As both effects work in opposite directions, the combined effect is indeterminate.

However, both relationship variables, namely the number of relationships that a farm has with export and/or input supplier firms, and the length of the farm-bank relationship, reduce the probability that a farmer would be risk and transaction-cost rationed. This may indicate that higher social capital reduces the transaction cost and risk associated with credit contracts.

A comparable study, Boucher et al. (2009), finds evidence for the importance of credit constraints in Peru. Their study suggests that the fraction of households that are credit constrained is about 50%, higher than our result of 15%. One possible explanation of this difference is that unlike Peru, Chile has a financial sector that is highly competitive and deregulated, which may mitigate financial market imperfections.

Although the results in Chapter 2 show some degree of market imperfection in Chile, the study is not conclusive here in that it cannot quantify the severity of credit rationing for rural financial markets in Chile. Chapters 4 and 5 try to address this question and extend the analysis given in Chapter 2 by testing two theories that would explain financial market imperfections.

In Chapter 3 we identify the relation between formal lenders (mainly banks) and informal lenders (such as export and input supplier firms) by determining whether formal and informal loans act as complements or substitutes in rural financial markets. If they are substitutes, the relationship between formal and informal financial institutions is horizontal (Floro and Ray, 1997), so the formal sector compete directly with informal providers of funds. Borrowers then should try to obtain loans first from the formal market, and then their excess demand spills over into the informal market. Accordingly, borrowers who are confronted with greater credit constraints from formal lenders should increase their borrowing from informal lenders.

If informal and formal loans are complements, the informal and formal financial sectors exhibit a vertical relationship (Floro and Ray, 1997). For example, in agricultural markets a complementary relationship might emerge because informal credit is the only type available at the beginning of the crop cycle, whereas formal credit becomes available later (Gupta and Chaudhuri, 1997). Inputs needed at the beginning of the production process then get financed by informal credit, but later inputs can be financed by formal credit. Such a complementary relationship also implies a positive relationship between informal and formal credit, such that an increase in formal credit constraints decreases demand for informal credit.

As a special feature, the study explores the determinants that influence access to informal credit using a panel probit model that controls for the endogeneity of credit constraints. When controlling for endogeneity, the analysis suggests that formal and informal credit are complementary due to their distinct uses: formal credit funds investments, whereas informal credit funds working capital. If farmers invest less because they are credit constrained by formal institutions, they need less working capital, so their demand for informal credit also declines. This results is in contrast to the study by Guirkinger (2008)

who, using a model that does not control for endogeneity, finds that formal and informal credit in Peru are substitutes for one another.

In Chapter 4 we empirically test the impact of formal credit on farm productivity in central Chile by using the hypothesis of non-separability of consumption and production decisions. If credit availability affects production and, consequently, productivity, that would be evidence for supporting non-separability of consumption and production decisions and thus, financial market failures. Otherwise, the financial market for short-term credit would not limit production and would allow separation of consumption and production decisions. However, in testing the effect of credit on farm productivity, causality problems can emerge. This is because less productive farmers may be more likely to pursue a loan than highly productive farmers. If true, credit constrained farmers may be correlated with those who have lower productivity. These endogeneity problems are addressed by using a subsample of constrained farmers where the decision to provide a loan was externally chosen. A drawback of this sample selection procedure is the selectivity that might introduce biased estimates. We tested for this bias by using a sample selection model for panel data.

Although comparable studies suggest that credit constraints have a negative impact on farm investments (Carter and Olinto, 2003; Petrick, 2004a), farm output (Feder, Lau et al., 1990; Petrick, 2004b), farm profit (Carter, 1989; Foltz, 2004; Fletschner, Guirkinger et al., 2010) and farm productivity (Guirkinger and Boucher, 2008), the most important result of this chapter is that the marginal effect of credit on farm productivity is nil across both credit-constrained and unconstrained farmers. This result implies that although farmers may be credit constrained, this condition does not limit their productivity. A possible explanation for not finding significant effects for credit constrained firms in the formal sector is that informal credit institutions act as complement providers of short-term credit, as it is shown in Chapter

3. The active informal sector in Chile may thus relax credit constraints that prevail due to asymmetric information and to risk and transaction cost in short-term decision process.

In Chapter 5 we search for the determinants of the probability to invest, focusing on the impact of credit constraints. In testing the effect of credit availability on investment, two considerations are important. First, we need to take into account the dynamic process of investment, because current investment is influenced by past investment decisions. It is likely that farmers who invested in the past also invest in the present for reasons other than farmer characteristics. For instance, investment decisions may be influenced by conditions such as an economic boom or a crisis. However, introducing a lagged investment variable may cause correlation with the error term in the panel data structure.

Second, the effect of credit constraints on investment decision may suffer again from endogeneity problems. Farmers who are more likely to invest are also often the ones more likely to pursue a loan. Both problems are addressed in Chapter 5 by using initial conditions (Wooldridge, 2005) and endogenous switching modeling (Miranda and Rabe-Hesketh, 2006). Although it would be convenient to estimate a continuous variable for investment, three rounds of farm-level survey data are needed to estimate Bond-Arellano estimators (Bond and Meghir, 1994). Thus, the two rounds of data collected allows just enough information to estimate a discrete-dependent variable. Then, the probability to invest was chosen as dependent variable.

Results show that credit constraint status has a negative impact on investment decision, reducing the probability to invest for farmers in central Chile by a factor 2.5. This outcome reveals long-term financial market imperfections, most probably because the only providers of long-term credit are commercial banks for whom long-term lending is considered risky. To evaluate risk in farming projects, the bank officer's experience in assessing farming projects is very important. Agricultural projects have complexities that make assessing

difficult. Variable market prices and weather conditions as well as exchange rate fluctuations make farming projects more uncertain than most other activities. If a bank does not have well-versed officers capable of assessing the risk of the farming project, it will be less willing to extend a loan to an agricultural project compared to other, better-known projects.

The other variable that limits the investment decision is the time trend. This result shows that farmers' probability to invest decreased from 2006 to 2008, revealing the negative effect of the 2007's global financial crises on investment.

The results in Chapters 4 and 5 are supported by those in Chapter 3. One of the explanations for formal credit not having an effect on productivity is that formal and informal sources of credit have either a substitutive or complementary relationship. If formal and informal lenders have a substitutive relationship to one another, then credit-constrained farmers in the formal sector could switch from formal to informal loans, either in the short- or long-term, without having an impact on both long-term investment and short-term productivity. Alternatively, if this relation is complementary, farmers would use informal loans for working capital and formal loans for long-term investment, not having an impact on productivity where both sources of credit can be used, and having an impact on investment only where formal credit is available. This is the case for the results in Chapters 4 and 5, respectively. Similarly, a significant and negative effect of formal credit constraints on the use of informal credit is found in Chapter 3. This provides evidence that a credit constraint has a causal impact on the use of informal credit, and indicates that formal and informal loans are complements.

6.3 Using multilevel analysis

Multilevel analysis applies to situations where unit observations fall into groups or clusters. For instance, observations could be nested in firms, families, hospitals, or schools. Panel data also consist of clusters of observations made at different occasions for the same individual.

In many economic studies one cannot hope to explain all variability between clusters (between individuals for instance) using observable variables. There are some variables like entrepreneurial ability, risk aversion, or motivations, that are difficult to measure. Therefore, there is unobservable heterogeneity (or unexplained variability) between clusters. This means that two observations in the same cluster are correlated and more similar than are observations in a different cluster. By using multilevel analysis it is possible to deal with unobservable heterogeneity for different types of responses, including continuous, count, dichotomous, ordered, and multinomial (unordered) responses (Skrondal and Rabe-Hesketh, 2004).

Stressing multilevel analysis tools, Chapter 2 uses an approach where a multinomial model with random effects is estimated using multilevel techniques. In other studies, a simple multinomial model is used. The most important characteristic of multilevel analysis approach in estimating multinomial logit model in panel data context is that multilevel analyses allows to fit de model with random effects and correlated intercept for each category (alternative-specific intercepts). It accounts for the fact that each individual is classified in one of the categories which cannot be assumed to be independent. Probability of each category for repeated observations on the same individual share the same unobservable random effects and are assumed to be correlated. Allowing correlation between alternatives, the estimations do not suffer from Independence of Irrelevant Alternatives (Skrondal and Rabe-Hesketh, 2003). Specifically in Chapter 2 a multinomial logit model with random effect is applied to quantify determinants and probabilities for farmers to be in one of the four distinct credit access and

constraint categories: borrowers, non-borrowers, quantity rationed, and risk and transaction-cost rationed farmers.

In addition, multilevel analysis also allows for modeling situations where endogeneity and sample selection problems are present. In general, sample selection bias refers to problems where the dependent variable is observed for a restricted, non-random sample. Endogeneity problems refer to the fact that an independent variable included in the model is potentially a choice variable, correlated with unobservable variables relegated to the error term. The dependent variable, however, is observed for all observations in the data. In either case, problems arise because standard regression techniques result in biased and inconsistent estimators if unobservable variables affecting the dependent variable are correlated with unobservable factors affecting the endogenous or selection variable.

For strictly continuous outcome variables, simple two-stage regression strategies have been developed to address these problems (Heckman, 1979). For binary responses, straightforward programs have recently been developed (Miranda, 2006). However, for the case of continuous and discrete responses, accounting for sample selection and endogenous problems in panel data contexts has rarely been developed. Although non-parametric two-stage procedures analogous to the Heckman (1979) methods are implemented in some studies (Wooldridge, 1995; Kyriazidou, 1997), they are only approximate procedures, and no appropriated distribution results for the estimators are available. Chapters 3 and 5 apply a novel methodology for modeling discrete response accounting for endogeneity in a panel data context, using an endogenous switching framework (Miranda, 2006) adjusted for panel data structure (Rabe-Hesketh, Skrondal et al., 2002). Chapter 4 uses a similar model but for sample selection problems.

Although the natural methods for this analysis would have been randomized experiments, multilevel analysis is used because of the observational nature of the data

available. In contrast to randomized studies, a major problem in estimating a dichotomous variable effect from observational studies is that the dichotomous variable is often an endogenous variable in the sense that this variable is correlated with unobserved heterogeneity. However, an endogenous switching framework tackles this problem, allowing randomization of the units to the dichotomous variable, and making the dichotomous variable exogenous because the dichotomous variable would become independent of the unobservable heterogeneity. Thus valid inferences regarding the regressors can be obtained from the main response.

6.4 Suggestions for further research

As was mentioned before, the literature about access to credit and credit constraints is vast. However, there is still room for empirical research on new topics such as (1) other variables that may influence a credit constraint, (2) database requirements to measure productivity and investment in the agricultural sector, (3) measurement errors involved in using survey data to measure and make inferences about borrowing, and (4) identification problems in estimating credit constraint effects.

First, the results in Chapter 2 highlight the effect of social capital variables on the probability for farmers to be classified as risk and transaction-cost rationed as well as on entitled land as a determinant of quantity-constrained farmers. However, the links among access to credit, bank performance, and the sustainability of bank lending are not studied. For example, it may be the case that banks were lending to successful farmers only, hence loans were fully serviced or repaid, and banks could expand lending. As a result of the lending expansion of the bank sector, less successful farmers are granted a loan, fewer farms are credit constrained now, and the sector performed well. The link between access to credit and bank performance can be studied in a dynamic model which incorporates bank performance variables.

In addition, further research needs to be done on the reasons why farmers do not invest. Although Chapter 4 highlights the impact of the global financial crisis, before the crisis just 40% of farmers claimed to invest in fixed capital. This level is considered to be low. Further research needs to be done to explain this low level as well as the high level of farmers who decide not to borrow.

Second, although a two-round survey to estimate the probability to invest was used in this study, at least a three-round dataset is needed to estimate the variables explaining the amount to invest, which include variables that determine the farmer's profile for investing. With a three-round dataset it would be possible to estimate, for example, Arellano-Bond estimators in a dynamic context for continuous investment dependent variable. As explained in section 1.3, limited data available in the agricultural sector in Chile currently limits further research. Field surveys with a larger number of respondents are needed to address issues such as modeling dynamic investment and productivity.

Third, there is a growing body of literature about measurement issues involved in using survey data to measure and make inferences about borrowing. A drawback of directly asking responders about their borrowing experience is that such an approach relies only on an individual's subjective assessment of his or her situation. It is admittedly better than relying on an arbitrarily chosen variable that may not distinguish between credit-constrained and unconstrained farmers. However, more research is needed to eliminate probable measurement errors in these surveys.

Finally, because studies that consider credit constraints involve endogeneity problems, other techniques may be tested to improve accuracy in modeling. Experimental economics is a flourishing field, but the work done in rural financial markets in developing countries is rather limited compared to work in other countries and disciplines. For instance, as a randomized experiment is difficult to set up, other econometrics techniques can also be

applied in observational data. A very interesting application of modeling with endogeneity problems is given in Gine (2010) and Miranda (2010) who consider a simultaneous equation in panel data structure. Employing multiple strategies may help to check the robustness of such methods used.

6.5 Policy implications

When attempting to generalize the results of this study, it is important to consider the particular conditions of the Chilean case. Although Chile can be considered a good case study because of its solid and longstanding open trade policy, the labor intensity and land concentration characteristics of non-traditional crops are particularities not common to all developing countries. In different environments and regions, different results for agricultural development may therefore emerge (Valdes and Jara, 2008).

However, three policy implications can be derived from this study: First, this study shows that although to some extent a credit constraint was found, it is not generally prevalent in the Chilean rural financial market. This has probably to do with the result of the economic liberalization in both financial and trade markets which took place in the 1970s. However, the Chilean context suggests that to get the benefit of liberation policies, it is important to develop some degree of coordination in the market by, for example, clusters. Long-term relationships between banks and farmers and the formation of clusters ensure more and better information between banks and farmers, and consequently more trust. In the case of Chile, cluster formations and long-term relationships were organized by private parties who saw an economic interest in cluster formations. Policies may help in cluster formation by facilitating the interaction between a cluster coordinator and farms. For instance, state development agencies may put effort into creating programs that facilitate business connections between small-scale farmers and agro-processing/export firms.

Second, results in Chapter 5 find imperfections in long-term credit markets as illustrated by the significant and negative impact of long-term credit on investments. This imperfection is caused by the higher requirements banks require for evaluating long-term credit because these loans are more risky. Banks assess these kinds of loans more carefully and reject more clients. In addition, no alternative lenders provide long-term credit, making the situation worse.

Policies may aim to improve information about farmers in the credit market. For instance, for farmers it would be important to have well-audited balance sheets, income statements and accounting systems to ensure their reliability as an entrepreneur. This may also enhance the quality of their investment projects submitted for funding to the banks and enable them to obtain better conditions in their loan contracts. An illustrative policy proposal could be to provide accounting management service to farmers adopting accounting management practices. Other mechanisms to improve information in rural financial markets would be for banks to have risk evaluation departments specialized in agricultural projects. Bank officers well-trained in assessing agro-projects may help in discriminating between good and bad projects.

Finally, an important other finding in this study is that formal and informal lenders complement each other in providing credit to farmers. This finding suggests that instead of policies that try to abolish informal lenders by encouraging formal lenders, policies may be more productive if they explore how informal lenders can be stimulated to provide other services such as long-term credit.

References

Aaronson, D., R. W. Bostic, P. Huck and R. Townsend (2004) Supplier relationships and small business use of trade credit. *Journal of Urban Economics,* 55(1), pp. 46-67.

Arellano, M. and S. Bond (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies,* 58(2), pp. 277-297.

Baas, T. and M. Schrooten (2006) Relationship banking and SMEs: A theoretical analysis. *Small Business Economics,* 27(2), pp. 127-137.

Banco Central de Chile (2010) Sintesis de Estadisticas de Chile 2005-2009, Banco Central de Chile

Barrientos, S. (1997) The hidden ingredient: Female labour in Chilean fruit exports. *Bulletin of Latin American Research,* 16(1), pp. 71-81.

Barry, P. J. and L. J. Robison. (2001). Agricultural finance: Credit, credit constraints, and consequences, in B. L. Gardner and G. C. Rausser (eds), *Handbook of Agricultural Economics* (Amsterdam: Elsevier), pp. 513-571.

Barslund, M. and F. Tarp (2008) Formal and informal rural credit in four provinces of Vietnam. *Journal of Development Studies,* 44(4), pp. 485 - 503.

Bean, C. R. (1981) An econometric model of manufacturing investment in the UK. *Economic Journal,* 91 pp. 106-121.

Bell, C., T. N. Srinivasan and C. Udry (1997a) Rationing, spillover, and interlinking in credit markets: The case of rural Punjab. *Oxford Economic Papers-New Series,* 49(4), pp. 557-585.

Bell, C., T. N. Srinivasan and C. Udry (1997b) Rationing, Spillover, and Interlinking in Credit Markets: The Case of Rural Punjab. *Oxford Economic Papers,* 49(4), pp. 557-585.

Benjamin, D. (1992) Household Composition, Labor Markets, and Labor Demand: Testing for Separation in Agricultural Household Models. *Econometrica,* 60(2), pp. 287-322.

Berglof, E. and T. von Ernst-Ludwig (1994) Short-term versus long-term interests: Capital structure with multiple investors. *The Quarterly Journal of Economics,* 109(4), pp. 1055-1084.

Bester, H. (1985) Screening vs rationing in credit markets with imperfect information. *American Economic Review,* 75(4), pp. 850-855.

Bo, H., R. Lensink and E. Sterken (2003) Uncertainty and financing constraints. *European Finance Review,* 7 pp. 297-321.

Bond, S., J. A. Elston, J. Mairesse and B. t. Mulkay (2003) Financial factors and investment in Belgium, France, Germany, and the United Kingdom: A comparison using company panel data. *Review of Economics and Statistics,* 85(1), pp. 153-165.

Bond, S. and C. Meghir (1994) Dynamic investment models and the firm's financial policy. *Review of Economic Studies,* 61(2), pp. 197-222.

Bond, S. and J. Van Reenen. (2007). Chapter 65 Microeconometric models of investment and employment, in J. Heckman and E. Leamer (eds), *Handbook of Econometrics* (Elsevier), pp. 4417-4498.

Boot, A. W. A. and A. V. Thakor (1994) Moral hazard and secured lending in an infinitely repeated credit market game. *International Economic Review,* 35(4), pp. 899-920.

Boucher, S. R., C. Guirkinger and C. Trivelli (2009) Direct elicitation of credit constraints: Conceptual and practical issues with an application to Peruvian agriculture. *Economic Development and Cultural Change,* 57(4), pp. 609-640.

Bowles, S. and H. Gintis (2002) Social capital and community governance. *The Economic Journal,* 112(483), pp. F419-F436.

Brown, M., T. Jappelli and M. Pagano (2009) Information sharing and credit: Firm-level evidence from transition countries. *Journal of Financial Intermediation,* 18(2), pp. 151-172.

Carter, M. R. (1988) Equilibrium credit rationing of small farm agriculture. *Journal of Development Economics,* 28(1), pp. 83-103.

Carter, M. R. (1989) The impact of credit on peasant productivity and differentiation in Nicaragua. *Journal of Development Economics,* 31(1), pp. 13-36.

Carter, M. R. and P. Olinto (2003) Getting Institutions "Right" for Whom? Credit Constraints and the Impact of Property Rights on the Quantity and Composition of Investment. *American Journal of Agricultural Economics,* 85(1), pp. 173-186.

Conning, J. (2001) Mixing and Matching Loans: Complementarity and Competition amongst lenders in a Rural Credit Market in Chile.

Conning, J. and C. Udry. (2007). Rural financial markets in developing countries, in R. Evenson and P. Pingali (eds), *Handbook of Agricultural Economics* (Elsevier), pp. 2857-2908.

Crane, L. and D. Leatham (1995) External equity financing in agriculture via profit and loss sharing contracts: A proposed financial innovation. *Agribusiness,* 11(3), pp. 223-233.

Cuevas, C. E. and D. H. Graham. (1986). Rationing agricultural credit in developing countries: The role and determinants of transaction cost for borrowers, in A. H. Maunder and U. Renborg (eds), *Agriculture in a Turbulent World Economy: A survey of the 19th International Conference of Agricultural Economists, Malaga, Spain, 26 August-4 September, 1985*, pp. 249-262.

Chemmanur, T. J. and P. Fulghieri (1994) Reputation, renegotiation, and the choice between bank loans and publicly traded debt. *The Review of Financial Studies,* 7(3), pp. 475-506.

Chung, I. (1995) Market choice and effective demand for credit: The roles of borrower transaction costs and rationing constraints. *Journal of Economic Development,* 20(2), pp. 23-44.

Decofrut (2008) *Expordata yearbook 2008* (Santiago, Chile: Decofrut).

Degryse, H. and S. Ongena (2005) Distance, lending relationships, and competition. *The Journal of Finance,* 60(1), pp. 231-266.

Demir, F. (2009) Capital market imperfections and financialization of real sectors in emerging markets: Private investment and cash flow relationship revisited. *World Development,* 37(5), pp. 953-964.

Devereux, M. and F. Schiantarelli. (1990). Investment, financial factors, and cash flow: Evidence from U.K. panel data, in R. G. Hubbard (ed), *Asymmetric Information, Corporate Finance, and Investment* (University of Chicago Press).

Diagne, A. (1999) Determinants of household access to and participation in formal and informal credit markets in Malawi. Food Consumption and Nutrition Divition (FCND) discussion paper 67, IFPRI. Washington, DC.

Diagne, A., M. Zeller and M. Sharma (2000) Empirical measurements of households' access to credit and credit constraints in developing countries: Methodological issues and evidence. Food Consumption and Nutrition Divition (FCND) discussion paper 90, IFPRI. Washington, DC .

Diamond, D. W. (1991) Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt. *Journal of Political Economy,* 99(4), pp. 689.

Durlauf, S. N. (2002) On The empirics of social capital. *The Economic Journal,* 112(483), pp. F459-F479.

Elston, J. (1993) Firm ownership structure and investment: theory and evidence from German manufacturing. WZB Discussion Paper no. FS IV.

Fazzari, S., R. G. Hubbard and B. C. Petersen (1988) Financing constraints and corporate investment. *National Bureau of Economic Research Working Paper Series,* No. 2387.

Feder, G., L. J. Lau, J. Y. Lin and X. Luo (1990) The Relationship between credit and productivity in Chinese agriculture: A microeconomic model of disequilibrium. *American Journal of Agricultural Economics,* 72(5), pp. 1151-1157.

Feder, G., L. J. Lau, J. Y. Lin and L. Xiaopeng (1989) Agricultural credit and farm performance in China. *Journal of Comparative Economics,* 13(4), pp. 508-526.

Fleming, D. A., D. G. Abler and S. J. Goetz (2010) Agricultural trade and poverty in Chile: a spatial analysis of product tradability. *Agricultural Economics,* in press.

Fletschner, D., C. Guirkinger and S. Boucher (2010) Risk, credit constraints and financial efficiency in Peruvian agriculture. *Journal of Development Studies,* 46(6), pp. 981-1002.

Floro, M. S. and D. Ray (1997) Vertical Links between Formal and Informal Financial Institutions. *Review of Development Economics,* 1(1), pp. 34-56.

Foltz, J. D. (2004) Credit market access and profitability in Tunisian agriculture. *Agricultural Economics,* 30(3), pp. 229-240.

Foster, W. and A. Valdes (2006) Chilean Agriculture and major economic reforms: Growth, trade, poverty and the environment. *Région et développement* 23 pp. 187-214.

Freixas, X. and J.-C. Rochet (1997) *Microeconomics of banking* (Cambridge: The MIT press).

Fry, M. J. (1994) *Money, interest, and banking in economic development* (London: Johns Hopkins University Press).

Fuentes, R. and M. Vergara (2003) Explaining bank efficiency: bank size or ownership structure? Proceedings of the VIII Meeting of the Research Network of Central Banks of the Americas. Caracas,Venezuela

Fukuyama, F. (1995) *Trust: The social virtues and the creation of prosperity.* (New York: The Free Press Paperbacks).

Gallego, F. and N. Loayza. (2004). Financial structure in Chile: Macroeconomic developments and microeconomic effects, in A. Demirgüç-Kunt and R. Levine (eds), *Financial Structure and Economic Growth: A Cross-Country Comparison of Banks, Markets, and Development* (Cambridge: The MIT press), pp. 299-346.

Giannetti, M., M. Burkart and T. Ellingsen (2004) What You Sell is What You Lend? Explaining Trade Credit Contracts, C.E.P.R. Discussion Papers

Giné, X. (2010) Access to capital in rural Thailand: An estimated model of formal vs. informal credit. *Journal of Development Economics,* In Press, Corrected Proof.

Glaeser, E. L., D. Laibson and B. Sacerdote (2002) An economic approach to social capital. *The Economic Journal,* 112(483), pp. F437-F458.

Guirkinger, C. (2008) Understanding the Coexistence of Formal and Informal Credit Markets in Piura, Peru. *World Development,* 36(8), pp. 1436-1452.

Guirkinger, C. and S. R. Boucher (2008) Credit constraints and productivity in Peruvian agriculture. *Agricultural Economics,* 39(3), pp. 295-308.

Gupta, M. R. and S. Chaudhuri (1997) Formal Credit, Corruption and the Informal Credit Market in Agriculture: A Theoretical Analysis. *Economica,* 64(254), pp. 331-343.

Gwynne, R. N. (2003) Transnational capitalism and local transformation in Chile. *Tijdschrift voor economische en sociale geografie,* 94(3), pp. 310-321.

Gwynne, R. N. and J. Ortiz (1997) Export growth and development to poor rural regions: A meso-scale analysis of the upper Limari. *Bulletin of Latin American Research,* 16(1), pp. 25-41.

Heckman, J. J. (1978) Dummy Endogenous Variables in a Simultaneous Equation System. *Econometrica,* 46(4), pp. 931-959.

Heckman, J. J. (1979) Sample Selection Bias as a Specification Error. *Econometrica,* 47(1), pp. 153-161.

Hermes, N. and R. Lensink. (1998). Regulatory change and the allocation of finance: The role of business conglomerates in Chile, 1983-1992 in J. Doukas and C. Wihlborg (eds), *Financial Sector Reform and Privatization in Transition Economies* (Amsterdam: Elsevier Science Publishers).

Hernandez, L. and F. Parro (2004) Sistema financiero y crecimiento economico en Chile, Central Bank of Chile. Working Paper No. 291

Hoff, K., A. Braveman and J. E. Stiglitz (1993) *The economics of rural organization: Theory, practice and policy* (Oxford; New York; Toronto and Melbourne: Oxford University Press).

Hoff, K. and J. E. Stiglitz (1990) Introduction: Imperfect information and rural credit markets--Puzzles and policy perspectives. *World Bank Econ Rev,* 4(3), pp. 235-250.

Hole, A. R. (2007) Fitting mixed logit models by using maximum simulated likelihood. *The Stata Journal,* 7(3), pp. 388-401.

Hoshi, T., A. Kashyap and D. Scharfstein (1991) Corporate structure, liquidity, and investment: Evidence from Japanese industrial groups. *The Quarterly Journal of Economics,* 106(1), pp. 33-60.

Howorth, C. and B. Reber (2003) Habitual Late Payment of Trade Credit: An Empirical Examination of UK Small Firms. *Managerial and Decision Economics,* 24(6/7), pp. 471-482.

Hubbard, R. G., A. K. Kashyap and T. M. Whited (1995) Internal finance and firm investment. *National Bureau of Economic Research Working Paper Series,* No. 4392.

Huyghebaert, N. (2006) On the Determinants and Dynamics of Trade Credit Use: Empirical Evidence from Business Start-ups. *Journal of Business Finance & Accounting, Vol. 33, No. 1-2, pp. 305-328, January/March 2006*.

Instituto Nacional de Estadisticas (2007) VII National Agriculture Census. INE, Instituto Nacional de Estadisticas

Jaffee, D. and J. E. Stiglitz. (1990a). Credit Rationing, in B. M. Friedman and F. H. Hahn (eds), *Handbook of Monetary Economics* (Amsterdam: Elsevier B.V.), pp. 8378-8888.

Jaffee, D. and J. E. Stiglitz. (1990b). Credit rationing, in B. M. Friedman and F. H. Hahn (eds), *Handbook of Monetary Economics* (Amsterdam: Elsevier B.V.), pp. 8378-8888.

Jain, S. (1999) Symbiosis vs. crowding-out: the interaction of formal and informal credit markets in developing countries. *Journal of Development Economics,* 59(2), pp. 419-444.

Jappelli, T. (1990) Who is credit constrained in the U.S. economy? *The Quarterly Journal of Economics,* 105(1), pp. 219-234.

Kaplan, S. N. and L. Zingales (1997) Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints? *The Quarterly Journal of Economics,* 112(1), pp. 169-215.

Karcz, Z. (1998). Agricultural credit in Poland in the period of transformation, in K. Frohberg and W. R. Poganietz (eds), *The Importance of Institutions for the Transition in Central and Eastern Europe* (Wissenschaftsverlag, Vauk, Kiel: Studies on the Agricultural and Food Sector in Central and Eastern Europe), pp. 94-97.

Karlan, D. S. and J. Zinman (2009) Expanding Microenterprise Credit Access: Using Randomized Supply Decisions to Estimate the Impacts in Manila. *SSRN eLibrary*.

Khandker, S. R. and R. R. Faruqee (2003) The impact of farm credit in Pakistan. *Agricultural Economics,* 28(3), pp. 197-213.

Kihanga, E., R. Lensink, C. Lutz and N. Hermes (2010) Determinants of Trade Credit Demand and Supply in the Tanzanian Rice Market: A Structural Modelling Approach. *SSRN eLibrary*.

Kochar, A. (1997) An empirical investigation of rationing constraints in rural credit markets in India. *Journal of Development Economics,* 53(2), pp. 339-371.

Kondonassis, A. J., A. G. Malliaris and T. O. Okediji (2000) Swings of the pendulum: A review of theory and practice in development economics. *The American Economist,* 44 pp. 17-23.

Kyriazidou, E. (1997) Estimation of a Panel Data Sample Selection Model. *Econometrica,* 65(6), pp. 1335-1364.

Leland, H. E. and D. H. Pyle (1977) Informational Asymmetries, financial structure, and financial intermediation. *The Journal of Finance,* 32(2), pp. 371-387.

Lensink, R., H. Bo and E. Sterken (2001) *Investment, capital market imperfections, and uncertainty: Theory and empirical results* (Cheltenham, UK: Edward Elgar).

Meyer, R. L. and C. E. Cuevas. (1992). Reduction of transaction costs of financial intermediation: theory and innovations, in Department of International Economic and Social Affairs (ed), *Savings and Credit for Development. Report of the International Conference on Savings and Credit for Development* (New York: United Nations), pp. 285–317.

Miranda, A. and S. Rabe-Hesketh (2006) Maximum likelihood estimation of endogenous switching and sample selection models for binary, ordinal, and count variables. *Stata Journal,* 6(3), pp. 285-308.

Modigliani, F. and M. H. Miller (1958) The cost of capital, corporation finance and the theory of investment. *The American Economic Review,* 48(3), pp. 261-297.

Moll, H. A. J. (1989) Farmers and finance: Experience with institutional savings and credit in West Java, Wageningen Economic Studies. Wageningen

Moll, H. A. J. (2005) Microfinance and rural development: A long-term perspective. *Journal of Microfinance,* 7(2), pp. 13-31.

Moll, H. A. J., R. Ruben, E. Mol and A. Sanders (2000) Exploring segmentation in rural financial markets: An application in El Salvador. *Savings and development,* 1(24), pp. 33-54.

Moschini, G. and D. A. Hennessy. (2001). Uncertainty, risk aversion, and risk management for agricultural producers, in B. L. Gardner and G. C. Rausser (eds), *Handbook of Agricultural Economics* (Amsterdam: Elsevier), pp. 88-153.

Mushinski, D. W. (1999) An analysis of offer functions of banks and credit unions in Guatemala. *Journal of Development Studies,* 36(2), pp. 88 - 112.

Nilsen, J. H. (2002) Trade Credit and the Bank Lending Channel. *Journal of Money, Credit and Banking,* 34(1), pp. 226-253.
ODEPA (2005) Chilean agriculture overview, Oficina de Estudios y Politicas Agrarias (ODEPA). Santiago, Chile
ODEPA (2010) Colocaciones de credito en el sector silvoagropecuario, Oficina de Estudios y Politicas Agrarias (ODEPA)
Ongena, S. and D. C. Smith (2001) The duration of bank relationships. *Journal of Financial Economics,* 61(3), pp. 449-475.
Padilla, A. J. and M. Pagano (2000) Sharing default information as a borrower discipline device. *European Economic Review,* 44(10), pp. 1951-1980.
Pagano, M. and T. Jappelli (1993) Information sharing in credit markets. *The Journal of Finance,* 48(5), pp. 1693-1718.
Peterson, M. A. and R. G. Rajan (1997) Trade Credit: Theories and Evidence. *The Review of Financial Studies,* 10(3), pp. 661-691.
Petrick, M. (2004a) Farm investment, credit rationing, and governmentally promoted credit access in Poland: a cross-sectional analysis. *Food Policy,* 29(3), pp. 275-294.
Petrick, M. (2004b) A microeconometric analysis of credit rationing in the Polish farm sector. *European Review of Agricultural Economics,* 31(1), pp. 77-101.
Petrick, M. (2005) Empirical measurement of credit rationing in agriculture: a methodological survey. *Agricultural Economics,* 33(2), pp. 191-203.
Putnam, R. (2000) *Bowling alone: The collapse and revival of American community* (New York: Simon and Schuster).
Qualitas Agroconsultores (2009) Estudio de caracterizacion de la pequeña agricultura a partir del VII Censo Nacional Agropecuario y Forestal. Odepa, Odepa pp. 53. Santiago
Rabe-Hesketh, S. (2002) Multilevel selection models using gllamm, Stata Users Group
Rabe-Hesketh, S., A. Skrondal and A. Pickles (2002) Reliable estimation of generalized linear mixed models using adaptive quadrature. *Stata Journal,* 2(1), pp. 1-21.
Rabe-Hesketh, S., A. Skrondal and A. Pickles (2005) Maximum likelihood estimation of limited and discrete dependent variable models with nested random effects. *Journal of Econometrics,* 128(2), pp. 301-323.
Rajan, R. G. (1992) Insiders and outsiders: The choice between informed and arm's-length debt. *The Journal of Finance,* 47(4), pp. 1367-1400.
Rajan, R. G. and L. Zingales (1998) Financial dependence and growth. *The American Economic Review,* 88(3), pp. 559-586.
SBIF (2009) Estados de situación por institución financiera, Superintendencia de Bancos e Instituciones Financieras. Santiago, Chile
Schæfer, D. (2003) The new basel accord and its impact on small and medium-sized companies. *German Institute for Economic Research - Economic Bulletin* 40 pp. 209-221.
Schaller, H. (1993) Asymmetric information, liquidity constraints, and Canadian investment. *The Canadian Journal of Economics / Revue canadienne d'Economique,* 26(3), pp. 552-574.
Singh, I., L. Squire and J. Strauss, Eds. (1986). *Agricultural Household Models: Extensions, Applications and Policy* (Baltimore
Johns Hopkins University Press).
Skrondal, A. and S. Rabe-Hesketh (2003) Multilevel logistic regression for polytomous data and rankings. *Psychometrika,* 68(2), pp. 267-287.
Skrondal, A. and S. Rabe-Hesketh (2004) *Generalized Latent Variable Modeling: Multilevel, Longitudinal and Structural Equation Models* (Boca Raton, FL: Chapman & Hall/ CRC Press.).
Slack, N., S. Chambers, C. Harland, A. Harrison and R. Johnston (1995) *Operations management* (London: Pitman Publishing).
Stiglitz, J. E. and A. Weiss (1981) Credit rationing in markets with imperfect information. *American Economic Review,* 71(3), pp. 393-410.
Tobin, J. (1969) A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking,* 1(1), pp. 15-29.
Train, K. (2003) *Discrete choice models with simulation* (Cambridge: Cambridge University Press).

Valdes, A. and E. Jara. (2008). Chile, in K. Anderson and A. Valdes (eds), *Distortions to Agricultural Incentives in Latin America* (Washington DC: World Bank), pp. 119-158.
von Thadden, E. L. (1995) Long-term contracts, short-term investment and monitoring. *The Review of Economic Studies,* 62(4), pp. 557-575.
Whited, T. M. (1992) Debt, Liquidity Constraints, and Corporate Investment: Evidence from Panel Data. *The Journal of Finance,* 47(4), pp. 1425-1460.
Wilde, J. (2000) Identification of multiple equation probit models with endogenous dummy regressors. *Economics Letters,* 69(3), pp. 309-312.
Wooldridge, J. M. (1995) Selection corrections for panel data models under conditional mean independence assumptions. *Journal of Econometrics,* 68(1), pp. 115-132.
Wooldridge, J. M. (2005) Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity. *Journal of Applied Econometrics,* 20(1), pp. 39-54.
World Bank (2007) World Development Report 2008: Agriculture and Development, The World Bank. Washington D.C.
World Bank (2010) Development and climate change: World Development Report 2010. W. Bank, World Bank. Washington D.C.
Zeller, M. and M. Sharma. (2002). Credit constraints and loan demand in rural Bangladesh, in M. Zeller and R. L. Meyer (eds), *The Triangle of Microfinance. Financial Sustainability, Outreach, and Impact* (Baltimore: Johns Hopkins University Press), pp. 96-116.

Appendix 1

QUESTIONNAIRE

Name of firm	
Code	
Name of manager	
Address	
Phone	
County	
Fax	
Email	

SECTION 1: GENERAL INFORMATION

Name of the manager (who makes decisions in the firm)
_____

VARIABLE	POSSIBLE ANSWERS	NAME OF VARIABLE	ANSWER
Manager			
• Highest completed education level	1 Primary School 2 Secondary School 3 Technical degree 4 Professional degree 5 Graduate degree	EDU	_____
• Specialization	1 Fruit plantations 2 Crops 3 Livestock 4 Annual crops 5 Management 6 Engineering 7 Other	ESP	_____
• Age	Number (10-100)	AGE	_____
• Years managing	Number of years	YEAR_ADM	_____

Firm

- Year the firm started

YEAR_CO _____

- Main activity of the farm (considering total income):

1 Fruits ACT _____
2 Annual crops
3 Livestock
4 Food processing
5 Commercial activity
6 Tourism
7 Construction
8 Other

- Is this farm the main activity of the owners?

1 Yes ACT_PRIN _____
2 No

If the answer is no, which of the following is the main activity? (mining, tourism, services, construction)

_____

- Stage of the firm's life-cycle:

01 Star-up stage CYCLE _____
02 Expansion stage
03 Mature stage
04 Exit stage

- Does the firm have certification for good agricultural practice?

1 No CERT_01 _____
2 Yes,

- Which one?

1 EUREP GAP CERT_02 _____
2 USA GAP
3 CHILE GAP
4 HACCP
5 BPM
6 Others?

SECTION 2: CREDIT

CR 1 What type of financial services does the firm use?:

1. Credit — CR1 _____
2. Insurance
3. Option or future contracts
4. Trade credit
5. Factoring
6. Leasing
7. Owned capital

CR 2 If pertinent, what type of insurance does the firm use?

1. Fire insurance
2. Life insurance
3. Crop insurance
4. Other_____ — CR2 _____

CR 3 What is the shortest distance from the firm to a bank office?

CR 3 _____

CR 4 Does the firm work with commercial banks?

1 No, please skip to question CR 6 — CR4 _____
2 Yes

CR 5 For how many years has the firm worked with the bank?

CR 5 _____

CR6 Did the firm receive any loans from export or input supplying firms within the past 3 years?

1 No, CR6 _____
2 Yes, please fill out the next table

Name of the lender	What was the value of the loan?	Did the firm want a larger loan at this same interest rate?	What was the interest rate?	How much did the firm pay in each monthly installment?	When did the firm receive this loan?	When will the firm finish paying it off?	What was the loan used for?	How many years do has the firm worked with this institution?

CR7 Did you receive any loans from commercial banks within the past 3 years?

1 No, please skip to question CR9 CR7 _____
2 Yes, please fill out the next table

Name of the lender	What was the value of the loan?	Did the firm want a larger loan at this same interest rate?	What was the interest rate?	How much did the firm pay in each monthly installment?	When did the firm receive this loan?	When will the firm finish paying it off?	What was the loan used for?	How many years has the firm worked with this institution?

CR 8 Would the firm wish to receive a loan from another institution besides the one from which it has already received a loan?

1 No CR8 _____

2 Yes, please fill out the table

Name of the lender	How much would the firm have liked to receive?

(Skip to the next section)

CR 9 Did the firm apply for a loan within the past three years?

1 No, please skip to question CR 10

CR9 _____

2 Yes, please fill out the next table and skip to section 2

Name of the lender	Year	Why did the credit institution reject the application?

CR10 If the firm had applied, would a formal credit institution have accepted the application?

1 No, skip to question CR 13 CR10 _____

2 Yes,

CR 11 Why did the firm not apply for a loan?

1	The loan was not needed.
2	The interest rate was too high.
3	Farming does not give the firm enough profit to repay the debt.
4	The firm did not want to risk its land holdings.
5	Worry and/or fear.
6	Formal lenders are too strict; they are not as flexible as informal ones.
7	Formal lenders do not offer refinancing.
8	The bank branch was too far away.
9	Banks require too much paper work associated with the application.

CR 12 What aspect would you improve from formal credit contracts to which the firm is able to apply?

1. Collateral requirements CR12 _____
2. Long-term credit
3. Annual payment
4. Paperwork
5. Other_____

(skip to the next section)

CR 13 If the firm had applied, why wouldn't a formal credit institution have accepted the application?

1. Lack of collateral CR13 _____
2. Lack of revenues
3. Lack of accountability
4. The firm is small
5. The agricultural activity is risky
6. Other_____

CR 14 If the firm had been certain that a commercial bank would approve its application, would it have applied?

1 No, CR14 _____
2 Yes, skip to the next section

CR 15 Why did the firm not apply for a loan if a commercial bank likely would have approved the application?

CR15
_____

1	The loan was not needed.
2	The interest rate was too high.
3	Farming does not give the firm enough profit to repay the debt.
4	The firm did not want to risk its land holdings.
5	Worry and/or fear.
6	Formal lenders are too strict; they are not as flexible as informal ones.
7	Formal lenders do not offer refinancing.
8	The bank branch was too far away.
9	Banks require too much paper work associated with the application.

CR 16 What aspect would you improve from formal credit contracts to which the firm is able to apply?

6. Collateral requirements CR16 _____
7. Long-term credit
8. Annual payment
9. Paperwork
10. Other_____

(skip to the next section)

SECTION 3: LAND USE

FRUIT PLANTATION	VARIATY	YEAR OF PLANTING	SEASON 2005-2006				
			SUP (HAS)	YIELD	UNIT	PRICE	Was changed from last year (Yes/no)

SUB-TOTAL (A)

ANNUAL CROPS	VARIATY	SEASON 2005-2006				
		SUP (HAS)	YIELD	UNIT	PRICE	Was changed from last year (Yes/no)
SUB – TOTAL						

(B)

(C)

SECTION 4: INFRAESTRUCTURE

Please specify assets belonging to the farm such as a residential house, stables, barns, greenhouses, cooling houses, and so on.

Buildings				
Type	Size (m2)	Year of construction	Good or bad condition	**Is this building a change from the previous year? (Yes/no)**

Please specify farm machinery, equipment, and vehicles such as tractor, truck, etc.

Machinery, equipment and vehicles				
Type	Brand	Year of manufacturing	Condition (G/B)	**Was changed from last year (Yes/no)**

- Do you consider the use of machinery in the farm to be

  1 Underused MAQ_NI _____
  2 Sufficiently used
  3 Overused

- Apart from the owned machinery, does the firm rent machinery?

  1 Never MAQ_CON _____
  2 A few times a year
  3 Monthly
  4 Weekly

SECTION 5: COMMUNICATION SYSTEMS

What is the quality of the service of the following communication systems in the firm?

- Radio system COM_RA _____
  1 No problems
  2 Some problems
  3 Not available
- PHONE COM_TEL _____
  1 No problems
  2 Some problems
  3 Not available
- FAX COM_FAX _____
  1 No problems
  2 Some problems
  3 Not available
- INTERNET COM_INT _____
  1 No problems
  2 Some problems
  3 Not available

SECTION 6: ACCOUNTING AND TAX PAYMENT SYSTEM

- The tax payment system is calculated by
  1 Simplified balance sheet TRI_EMP _____
  2 Effective balance sheet

- How often does the firm use the Sence training program (the government agency for training)?
  1 Never TRI_SEN _____
  2 A few times a year
  3 Monthly
  4 Weekly

- How would you categorize the quality of the firm's accounting system?
  1 Excellent TRI_CON _____
  2 Good
  3 Regular
  4 Bad

- What accounting software does the firm use?
  1 MS Excel TRI_UTILIZA _____
  2 Softland
  3 Don Juan
  4 Other_____

SECTION 7: LABOR FORCE

Hired Labor

Position	Number	Observations

Temporal labor

Position	Number	Months

SECTION 8: SALES CHANNELS

Which export firm does your firm work with and what percentage of the firm's total income does that work represent?

- First export company EXP_FS _____
  EXP_FS_PERC _____
- Second EXP_SC _____
  EXP_SC_PERC _____
- Third EXP_TR _____
  EXP_TR_PERC _____

1 DOLE CHILE S.A.
2 UNIFRUTTI TRADERS LTDA.
3 DEL MONTE FRESH PRODUCE(CHILE) S.A
4 DAVID DEL CURTO S.A.
5 RIO BLANCO LTDA.
6 CHIQUITA ENZA CHILE LTDA.
7 COPEFRUT S.A.
8 RUCARAY S.A
9 COM.AGRICOM LTDA.
10 FRUTERA SAN FERNANDO S.A.
11 VERFRUT LTDA.
12 SUBSOLE S.A
13 AGUA STA.
14 QUILLOTA S.A.
15 FRUTAM S.A.
16 GEOFRUT S.A.
17 STA. CRUZ
18 ACONCAGUA LTDA
19 FRUTEXPORT S.A.
20 EXSER LTDA
21 COMPANIA FRUTERA DEL NORTE S.A
22 GREENWICH S.A.
23 GESTION DE EXP.FRUTICOLA S.A.
24 C Y D INTERNACIONAL S.A.
25 HORTIFRUT S.A.
26 TRINIDAD EXPORTS S.A.
27 AGRO FRIO S.A.
28 VICONTO S.A..
29 VITAL BERRY MARKETING
30 SERGIO RUIZ TAGLE HUMERES
31 CONOSUR LTDA.
32 CABILFRUT S.A.
33 SAN CLEMENTE LTDA
34 ATLAS S.A.
35 BEN DAVID LTDA
36 STA. ELENA S.A.
37 FRUCENTRO S.A.
38 FRUTERA EUROAMERICA S.A.
39 CORPORA AGRICOLA S.A.
40 CONTADOR FRUTOS S.A.
41 Other

Has the firm had any problems with the export company it works with?

1 No PROB_EXE _____
2 If yes, which one?
2.1 Unclear price information
2.2 Unclear price charged for the service
2.3 Delayed payments
2.4 Technical assistance
2.5 Other

Please mark the service of your exporting companies your firm works with:

	1	2	3	4	5	6	7
First							
Second							
Third							

What is the main sales channel?:

EXPORT_MEDIO _____

1. Exporting company
2. Supermarket
3. Wholesaler
4. Processing company
5. Retail shop
6. Others

SECTION 9: PROBLEMS

Which is the most important problem in limiting the firm's economic performance?

- First option PROB_FS _____
- Second option PROB_SC _____
- Third option PROB_TR _____

Available answers

1 Credit: The firm does not have access to credit. 2 Taxes: The firm paid too much in taxes. 3 Labor: The firm does not have labor available. 4 Water: The firm does not have water available. 5 Price information. 6 Monopoly power of wholesalers (supermarkets and export firms) 7 State regulations and norms. 8 New varieties and crops. 9 Climate factors. 10 Commercialization. 11 Dollar price. 12 Other, please specify.
Comments

SECTION 10: INVESTMENT

Specify the investment made during the current season

INVESTMENTS	Amount (M$)	Source of fund (M$)			
		CREDIT S.T.	CREDIT L.T.	Owned capital	Other
TOTAL INVESTMENT					

Observations_____

_____

_____

Specify the investment made during the last 3 years

INVESTMENTS	Amount (M$)	Source of fund (M$)			
		CREDIT S.T.	CREDIT L.T.	Owned capital	Other
TOTAL INVESTMENT					

Observations_____

_____

Specify the future investments projected

INVESTMENTS	Amount (M$)	Source of fund (M$)			
		CREDIT S.T.	CREDIT L.T.	Owned capital	Other
TOTAL INVESTMENT					

Observations_____

_____

SECTION 10: QUESTIONS FOR THE ENUMERATOR

What is the degree of co-operation and interest of the interviewed person?

Appendix 2

Direct elicitation method

The following qualitative questions are included in the questionnaire to collect information on different sources of credit rationing.

Question 1

Did you receive a loan in the past three years from a formal credit institution?

If so, we asked several questions with respect to the debt contract characteristics, such as the loan amount, the interest rate, and the loan period. In order to identify quantity rationing, we also asked whether the firm had received the desired amount. In addition, we asked whether the firm had received a loan from another financial institution, or if it would like to receive a loan from another credit institution. This information allowed us to identify cross constraints from different types of formal credit institutions.

If the answer to question 1 was no, we continued with question 2

Question 2

Did you apply for a loan in the past three years?

If so, we asked why the credit institution decided to reject the application.

If the answer to question 2 was no, we continued with question 3.

Question 3

If you had applied, would a formal credit institution have accepted your application?

If so, we asked why he/she did not apply for a loan. Table A2.1 provides possible answers and the associated rationing category.

If the answer to question 3 was no, we continued with question 4.

Question 4

If you were certain that a commercial bank would approve you application, would you apply?

If the answer was yes, the firm was classified as quantity-constrained.

If the answer was no, we asked why they would not apply for a loan. Again Table A2.1 shows possible answers and the rationing category associated.

Table A2.1: Common answers to qualitative questions

Answers	Associated question	Constraint Status
I received the desired loan from formal lenders in the past three years.	Question 1	Unconstrained (Borrowers)
I do not need a loan.	Question 3, 4	Unconstrained (Nonborrowers)
Interest rate is too high.	Question 3, 4	
Farming does not give me enough to repay a debt.	Question 3, 4	
I received a loan from formal lenders in the past three years, but not the desired amount.	Question 1	Constrained (Quantity Rationed)
I applied for a loan in the past three years but my application was rejected.	Question 2	
I did not apply for a loan because I did not think the formal institution would accept my application.	Question 4	
I did not want to risk my land.	Question 3, 4	Constrained (Risk Rationed)
I did not want to be worried/ I was afraid.	Question 3, 4	
Formal lenders are too strict; they are not as flexible as informal ones.	Question 3, 4	
Formal lenders do not offer refinancing.	Question 3, 4	
The bank branch was too far away.	Question 3, 4	Constrained (Transaction-cost Rationed)
Banks require too much paper work associated with application.	Question 3, 4	

Appendix 3

The multinominal logit model with random effects used in Chapter 2

Let *j* index the *J* possible categories of the multiresponse variable, *n* index the *N* responders, and *t* index the *T* waves of the panel. The utility that responder *n* derives from choosing alternative *j* on choice occasion *t* is $U_{njt} = \alpha_j + \beta_j' x_{nt} + \mu_{nj} + \varepsilon_{njt}$, where β_j is the vector of the alternative-specific coefficient, x_{njt} is a vector of observed attributes related to individual *n* and alternative *j* on wave *t*, α_{nj} is unobservable random effects for each category and individual, and ε_{njt} is a random term assumed to be independently and identically distributed. The probability that individual *n* will be classified in the *j* category of credit rationing on wave *t* is

$$L_{njt} = prob(y_{nt} = j) = \frac{\exp(\alpha_j + \beta_j X_{nt} + \mu_{nj})}{\sum_{k=1}^{J} \exp(\alpha_k + \beta_k X_{nt} + \mu_{nk})} \text{ , for } j = 1,\ldots, J. \qquad (1)$$

To estimate Equation 1, we use the mixlogit command from Stata 9.1, which uses maximum simulated likelihood estimations (Train, 2003; Hole, 2007) to implement the multinomial logit model with unobserved heterogeneity. Other commands, such as gllamm,[31] help us estimate alternative-specific random intercepts by approximating the analytical solution of the maximization of the log-likelihood function, using simulation methods.

Hole (2007) shows that the probability of the observed sequences of alternatives, conditional on knowing β_j, is given by $S_j(\beta_j) = \prod_{t=1}^{T} L_{njt}(\beta_j)$. The density for β_j is denoted $f(\beta|\theta)$, where θ are the parameters of the distribution. The unconditional probability of the observed sequences of alternatives is the conditional probability, integrated over the

[31] We also estimate our model using Generalized Linear Latent and Mixed Models (GLLAMMs) and we obtain similar results.

distribution of β: $P_n(\theta) = \int S_n(\beta) f(\beta|\theta) d\beta$. The log likelihood for the model is given by $LL(\theta) = \sum_{n=1}^{N} \ln P_n(\theta)$, which cannot be solved analytically and it is therefore approximated using simulation methods (Train 2003). The simulated log-likelihood is:

$$SLL(\theta) = \sum_{n=1}^{N} \ln \left\{ \frac{1}{R} \sum_{r=1}^{R} S_n(\beta^r) \right\}, \qquad (2)$$

where R is the number of replications, and β^r is the r[th] draw from $f(\beta|\theta)$. The maximum simulated likelihood estimator (MSLE) is the value of θ that maximizes SLL. The maximization of equation 2 estimates all parameters in Equation 1. Equation 1 estimates the probability that a market-oriented farmer is associated with one of the remaining four mutually exclusive borrower categories. In turn, *X* refers to a vector of explanatory variables. The linear predictor includes individual-specific variables (X_{nt}) and a random intercept for each category. Thus, there are three random effects, μ_{n2}, μ_{n3}, μ_{n4}, for alternatives two, three, and four. We assume the random effects are correlated[32].

[32] As random effects are assumed to be correlated, this model does not suffer from Independence of Irrelevant Alternatives. For details see Skrondal, A. and S. Rabe-Hesketh (2003) Multilevel logistic regression for polytomous data and rankings. *Psychometrika,* 68(2), pp. 267-287.

Appendix 4

Alternative models compared in Chapter 2

Table A4.1. Coefficients of regressors on different categories of credit access (multinomial logit model without random effects)

Variable	Unconstrained Non-borrowers	Constrained Quantity Rationed	Constrained Transaction Cost and Risk Rationed
Relationship variables:			
CLUSTER	-0.829***	0.125	-0.0209
	[0.000]	[0.554]	[0.958]
Ln(1+LENGTH)	0.0920	0.0633	-1.006***
	[0.548]	[0.803]	[0.009]
Control variables			
HECTARES	0.00109	-0.0134**	-0.00489
	[0.549]	[0.013]	[0.289]
YEAR_ADM	0.0214	0.0145	0.0255
	[0.112]	[0.384]	[0.174]
INSURANCE	0.538	5.016***	4.174**
	[0.614]	[0.002]	[0.012]
NO_PROGRAM	0.466	1.211**	0.798
	[0.254]	[0.015]	[0.195]
ALMOND	1.496	2.574**	2.816
	[0.184]	[0.024]	[0.143]
AVOCADO	-0.919	0.556	1.779*
	[0.110]	[0.618]	[0.074]
CONSTANT S	0.760	-1.875**	-1.068
	[0.109]	[0.029]	[0.289]
Test			
ROC	0.695	0.788	0.757
LR Test	78.79***		
Log-Likelihood	-327.5		
Number of observations	354		

Notes: *p*-values in brackets; ***, ** and * indicate 1%, 5% and 10% levels of significance respectively; LR test is for test of joint significance of all regressors.

Table A4.2. Coefficient of regressors on different categories of credit access compared with unconstrained borrowers (multinomial logit model with random effect, adding distance to the closest bank office and different farm locations as control variables)

Variable	Unconstrained Non-borrowers	Constrained Quantity Rationed	Constrained Transaction Cost and Risk Rationed
Relationship variables:			
CLUSTER	-1.386***	0.649	-8.698**
	[0.002]	[0.236]	[0.022]
Ln(1+LENGTH)	-0.310	-0.165	-25.57**
	[0.437]	[0.763]	[0.036]
Control variables			
HECTARES	0.0060	-0.0552**	-0.0396*
	[0.256]	[0.025]	[0.058]
YEAR_ADM	0.0772**	-0.0142	0.786**
	[0.035]	[0.710]	[0.028]
INSURANCE	-0.707	15.80**	63.136
	[0.762]	[0.023]	[0.031]**
NO_PROGRAM	0.0276	2.265**	2.870**
	[0.973]	[0.024]	[0.033]
DISTANCE	-0.0444	-0.0335	-1.318**
	[0.490]	[0.572]	[0.011]
ALMOND	1.558	5.594	9.276**
	[0.383]	[0.116]	[0.019]
AVOCADO	-1.541	1.586	57.88**
	[0.375]	[0.253]	[0.035]
LOCATION 1 SB	3.877**	-0.760	13.91**
	[0.034]	[0.589]	[0.039]
LOCATION 2 LA	-2.682	0.540	7.635*
	[0.121]	[0.685]	[0.073]
LOCATION3 CA	0.596	-0.810	-37.57**
	[0.685]	[0.517]	[0.033]
CONSTANT	1.032	-2.044	-49.78**
	[0.548]	[0.212]	[0.044]
Random effects			
Var (μ_{nj})	3.742***	2.863*	60.62**
	[0.000]	[0.055]	[0.030]
Corr (μ_{j2}, μ_{j3})	-1.037		
	[0.239]		
Corr (μ_{j3}, μ_{j4})	-0.298		
	[0.468]		
Corr (μ_{j2}, μ_{j4})	-3.031		
	[0.305]		
Test			
Wald test(39)	86.27***		
Log-Likelihood	-263.96		
Number of observations	354		
Number of individuals	177		
BIC	792.03		
AIC	617.92		

Notes: *p*-values in brackets; ***, ** and * indicate 1%, 5% and 10% levels of significance respectively; All variables are estimated using robust standards errors based on the White's heteroskedasticity consistent estimators of variance; Wald test is for test of joint significance of all regressors; BIC stands for Bayesian Information Criterion and AIC for Akaike's Information Criterion (AIC).

Table A4.3. Coefficient of regressors on different categories of credit access compared with unconstrained borrowers (multinomial logit model with random effect, adding distance to closest bank office and total assets net from debt as control variables)

Variable	Unconstrained Non-borrowers	Constrained Quantity Rationed	Constrained Transaction Cost and Risk Rationed
Relationship variables:			
CLUSTER	-1.678***	0.556	-10.11**
	[0.002]	[0.329]	[0.028]
Ln(1+LENGTH)	-0.504	-0.0994	-20.14**
	[0.326]	[0.851]	[0.018]
Control variables			
HECTARES	-0.00170	-0.0580***	-0.105**
	[0.781]	[0.008]	[0.015]
YEAR_ADM	0.0769**	-0.0103	0.817***
	[0.050]	[0.765]	[0.003]
INSURANCE	-0.296	16.29**	59.98***
	[0.896]	[0.021]	[0.006]
NO_PROGRAM	0.807	2.065**	-3.421
	[0.360]	[0.019]	[0.222]
DISTANCE	-0.0256	-0.0596	-0.420***
	[0.654]	[0.242]	[0.001]
ALMOND	2.137	5.087**	2.953
	[0.211]	[0.037]	[0.354]
AVOCADO	-2.234	2.346	65.59**
	[0.169]	[0.124]	[0.023]
NET_ASSETS	0.00381**	0.00276	0.00642*
	[0.027]	[0.106]	[0.053]
CONSTANT	2.557	-2.580*	-55.87**
	[0.135]	[0.063]	[0.018]
Random effects			
Var (μ_{nj})	4.709***	3.114***	59.48**
	[0.000]	[0.008]	[0.018]
Corr (μ_{j2}, μ_{j3})	-1.156		
	[0.195]		
Corr (μ_{j3}, μ_{j4})	-0.0978		
	[0.904]		
Corr (μ_{j2}, μ_{j4})	-1.964		
	[0.567]		
Test			
Wald Test	76.41***		
Log-Likelihood	-273.9		
Number of observations	354		
Number of individuals	177		
BIC	776.75		
AIC	625.85		

Notes: *p*-values in brackets; ***, ** and * indicate 1%, 5% and 10% levels of significance respectively; All variables are estimated using robust standards errors based on the White's heteroskedasticity consistent estimators of variance; Wald test is for test of joint significance of all regressors; BIC stands for Bayesian Information Criterion and AIC for Akaike's Information Criterion (AIC).

Appendix 5

Identification alternative for endogenous switching model used in Chapter 3

In the system of equations (3.2) and (3.3) there are six variance-covariance parameters, ($\sigma^2_{\delta_i}, \sigma^2_{\tau_i}, \sigma^2_{\mu_{1it}}, \sigma^2_{\mu_{2it}}, \sigma^2_{\zeta_{it}}, \lambda$). However, there are only three quantities to estimate: the variances of δ_i and τ_i identified through the intraclass correlation in the substantive and endogenous dummy variable model respectively; and the correlation between the total residual of the two equations (ρ).

Therefore, it is necessary to impose three restrictions. Two restrictions come directly from the binary nature of the substantive and endogenous equation, so μ_{1it} and μ_{2it} are implicitly fixed to a value determined in the model estimated in both equations (here we used the probit model for the substantive and endogenous models, then $\sigma^2_{\mu_{1it}} = \sigma^2_{\mu_{2it}} = 1$). The third restriction needed for identification must be stated explicitly: here we fixed the factor variance to one ($\sigma^2_{\zeta_{it}} = 1$). For discussions and alternatives restrictions see Skrondal and Rabe-Hesketh (2004).

Thus the covariance matrix of the residual is given by:

$$\sum = \begin{pmatrix} \sigma^2_{\delta_i} + \lambda^2 + 1 & \lambda + \sigma_{\delta_i;\tau_i} \\ \lambda + \sigma_{\delta_i;\tau_i} & \sigma^2_{\tau_i} + 2 \end{pmatrix}$$

And the correlation at observation level is

$$\rho = \frac{\lambda + \sigma_{\delta_i;\tau_i}}{\sqrt{(\sigma^2_{\delta_i} + \lambda^2 + 1)(\sigma^2_{\tau_i} + 2)}}$$

The estimation of ρ will be relevant in our model, because it gives statistical evidence of endogenous bias in our model.

The estimation of this model is by maximum likelihood, with the likelihood function evaluated by the adaptive quadrature numerical technique shown by Rabe-Hesketh *et al*.

(2005). This technique has shown to be superior to standard quadrature methods, particularly where the number of cross-sectional observations is large and/or the intraclass correlation is high. Maximization of the likelihood function over the set of parameters is achieved by the Newton-Ramhson algorithm.

Appendix 6

Identification alternative for endogenous switching model used in Chapter 5

In the system of equations (5.5) and (5.6) there are six variance-covariance parameters, ($\sigma^2_{\alpha_{1i}}, \sigma^2_{\alpha_{2i}}, \sigma^2_{\mu_{1it}}, \sigma^2_{\mu_{2it}}, \sigma^2_{\delta_{it}}, \lambda$). However, there are only three quantities to estimate: the variance of α_{1i} and α_{2i} identified through the intraclass correlation in the substantive and endogenous model respectively; and the correlation between the total residual of the two equations (ρ).

Therefore, it is necessary to impose three restrictions. Two restrictions directly comes from the binary nature of the substantive and endogenous equation, so $\sigma^2_{\mu_{1it}}$ and $\sigma^2_{\mu_{2it}}$ are implicitly fixed to a value determined in the model estimated in both equations (here we use the probit model for the investment decision and endogenous credit constraint equations, then $\sigma^2_{\mu_{2it}} = \sigma^2_{\mu_{2it}} = 1$). The third restriction needed for identification must be stated explicitly: here we fix the factor variance to one ($\sigma^2_{\delta_{it}} = 1$). For discussions and alternatives restrictions see Skrondal and Rabe-Hesketh, (2004).

Thus the covariance matrix of the residual is given by:

$$\sum = \begin{pmatrix} \sigma^2_{\alpha_{1i}} + \lambda^2 + 1 & \lambda + \sigma_{\alpha_{1i};\alpha_{2i}} \\ \lambda + \sigma_{\alpha_{1i};\alpha_{2i}} & \sigma^2_{\alpha_{2i}} + 2 \end{pmatrix}$$

And the correlation is

$$\rho = \frac{\lambda + \sigma_{\alpha_{1i};\alpha_{2i}}}{\sqrt{(\sigma^2_{\alpha_{1i}} + \lambda^2 + 1)(\sigma^2_{\alpha_{2i}} + 2)}}$$

The estimation of ρ will be relevant in our model, because it gives statistical evidence of endogenous bias in our model.

The estimation of this model is by maximum likelihood, with the likelihood function evaluated by the adaptative quadrature numerical technique shown by Rabe-Hesketh et al.

(2005). to be superior to standard quadrature methods, particularly where the number of cross-sectional observations is large and/or the intraclass correlation is high. Maximization of the likehood function over the set of parameters is achieved by the Newton-Ramhson algorithm.

Summary

Rural development needs to be accompanied by farmers' access to credit. If farmers are unconstrained, production and consumption decisions are separated. As such, credit-unconstrained farmers can choose optimal levels of inputs for their production processes. In such a situation, the optimal decision does not depend on credit. However, if farmers are credit constrained, investment decisions will depend on credit availability. Then, access to credit facilitates investments which can improve economic performance of the farmer by reducing costs through the adoption of better technology or by increasing income through adapting production to new challenges posed by phenomena such as global warming and changing customer preferences.

However, existing empirical literature on access to credit for a country such as Chile is very limited. This issue still awaits rigorous empirical examination in measuring credit constraints, in determining the effect of informal credit institutions on credit constraints, and in determining the credit constraint effect on production and investment patterns.

The aim of the research presented in this study is to measure access to credit and to empirically determine the effects of credit constraints on investment and production for market-oriented farmers in central Chile. More specifically, four issues are dealt with: (1) to identify the main factors that influence access to credit for market-oriented farmers, (2) to determine whether informal financial institutions act as complements to or substitutes for farmers' strategies for funding, (3) to determine the effect of credit constraint by formal financial institutions on farm productivity, and (4) to identify the factors limiting investment in farms. The four issues are subsequently dealt with in Chapters 2 – 5.

In approaching these objectives two innovative methods are used throughout. First, qualitative information collected in interviews is used to identify three categories of credit

constraints from both the demand and supply side of the credit market, namely, quantity, risk, and transaction-cost constraints. Second, a panel-data structure is used in all econometric analysis in this study, which allows us to obtain estimators that are more efficient than those based on cross-sectional analysis only.

Credit rationing status and its determinants are investigated in Chapter 2. Using data from two surveys conducted in 2006 and 2008 with a sample of 177 farmers, the research focuses on the importance of social capital variables, namely the number of relationships that a farm has with export and/or input supplier firms and the length of the farm-bank relationship. The main finding is that both variables reduce borrowers' transaction-cost and risk rationing, but not quantity rationing. Results show that 16.4% and 13.6% of the sample felt credit constrained in 2006 and 2008, respectively, with most farmers being quantity rationed (10.7% and 9.6%, respectively). A much lower share of farmers is constrained by risk (2.8% and 3.4%, respectively) and transaction cost (2.8% and 0.6%, respectively).

Chapter 2 concludes that the most important variable explaining quantity rationing is land size. Its negative and significant impact support the fact that titled land can be used as collateral and is able to overcome adverse selection and moral hazard problems. On the other hand, the insignificant effect of the length of the relationship between the bank and farm may indicate that a long-term relationship not only improves information about the farm, but also that this information can be used by banks for calculating the credit ceiling. As both effects work in opposite directions, the combined effect is indeterminate. However, both relationship variables, namely the number of relationships that a farm has with export and/or input supplier firms, and the length of the farm-bank relationship, reduce the probability that a farmer would be risk and transaction-cost rationed. This indicates that higher social capital reduces transaction cost and risk associated with credit contracts.

Chapter 3 identifies the relation between formal and informal lenders by determining whether formal and informal loans act as complements or substitutes in rural financial markets. As a special feature, the study explores the determinants that influence access to informal credit using a panel probit model that controls for the endogeneity of credit constraints. With a control for the endogeneity of credit constraints, the analysis suggests that formal and informal credit are complementary to one another. This complementary relationship appears due to their distinct uses; that is, formal credit funds investment in fixed assets, whereas informal credit funds working capital. If farmers invest less because they are credit constrained by formal institutions, they need less working capital, so their demand for informal credit also declines.

Chapter 4 explores the factors that determine productivity of fruit and vegetable growers in central Chile, focusing especially on the effect of short-term credit on farm output for market-oriented farmers. If credit availability affects production and, consequently, productivity, that would be evidence for supporting non-separability of consumption and production decisions, and thus a financial market failure. Otherwise, the financial market for short-term credit would not affect production and allow separation of consumption and production decisions. However, in testing the effect of credit on farm productivity, causality problems may emerge because less productive farmers may be more likely to pursue a loan than highly productive ones. If true, credit constrained farmers may be correlated with those who have lower productivity. These endogeneity problems are addressed by using a subsample of constrained farmers where the decision to provide a loan was externally chosen. A drawback of this sample selection procedure is the selectivity that might introduce biased estimates. We test for this bias by using a sample selection model for panel data.

Result show an insignificant effect of short-term credit on farm productivity under credit constraint conditions, implying that farmers can optimally choose their levels of input

regardless of access to credit. Although farmers may be credit constrained, it does not limit their productivity. An explanation for this result is the presence of informal lenders. Although some farmers are credit constrained from formal credit institutions, others have access to short-term credit from informal credit institutions as export and input supplier firms.

In Chapter 5 farm investment under imperfect capital markets is investigated. Specifically, the aim is to determine the effect of the volume of formal credit on fixed investment. By controlling for endogeneity problems, results show that credit constraint status has a negative impact on investment decisions, reducing the probability to invest for farmers in central Chile by a factor 2.5. This outcome reveals long-term financial market imperfections, most probably because the only providers of long-term credit are commercial banks for whom long-term lending is considered risky.

To evaluate risk in farming projects, the bank officer's experience in assessing farming projects is important. Agricultural projects have complexities that make assessment difficult. Variable market prices and weather conditions as well as exchange rate fluctuations make farming projects more uncertain than most other activities. If a bank does not have well-versed officers capable of assessing the risk of farming projects, it will be less willing to extend a loan to such projects as compared to other, more familiar projects.

The other variable that affects farm investment decisions is a time trend. This result shows that farmers' probability to invest decreased from 2006 to 2008, revealing the negative effect of the 2007 global financial crises on investment.

In the final chapter, several implications of the present research concerning rural financial markets are discussed. (1) Although to some extent a credit constraint was found to be effective, this study does not generally find it prevalent in the Chilean rural financial market. This has probably to do with the result of the economic liberalization in both financial and trade markets which took place in the 1970s. However, the Chilean context suggests that

to get the benefits of liberation policies, it is important to develop some degree of coordination in the market, for example, through clusters, combinations of farmers and trade firms operating in the market chain. (2) Results in Chapter 5 point to imperfections in long-term credit markets. Policies to address this problem may aim at improving information about farmers in the credit market by, for instance, having them adopt proper accounting management practices. Other mechanisms to improve information in rural financial markets would be for banks to have risk evaluation departments specialized in agricultural projects. (3) An important outcome of this study is that formal and informal lenders complement each other in providing credit to farmers. This finding suggests that instead of policies that try to abolish informal lenders by encouraging formal lenders, it may be better to explore how informal lenders can be stimulated to provide other services such as long-term credit.

Samenvatting

Voor rurale ontwikkeling is toegang tot agrarisch krediet voor landbouwers essentieel. Bij onbeperkte toegang tot krediet kunnen productie- en consumptiebeslissingen onafhankelijk van elkaar worden genomen. Als gevolg daarvan kunnen boeren de voor het productieproces benodigde inputs optimaal kiezen, zonder daarbij afhankelijk te zijn van krediet. Zijn landbouwers echter beperkt in hun toegang tot krediet, dan hangen bedrijfsbeslissingen van de beschikbaarheid van krediet af. Betere toegang tot krediet bevordert dan investeringen en betere inzet van inputs, en daarmee het bedrijfsresultaat Te denken valt aan kostenbesparingen via toepassing van betere technologie, of inkomensverbetering als gevolg van aanpassingen in het productieproces om uitdagingen als veranderende consumentenvoorkeuren of opwarmingsverschijnselen het hoofd te bieden.

Voor een land als Chili zijn weinig studies over de toegang tot agrarisch krediet beschikbaar. Er is daarom behoefte aan grondig empirisch onderzoek om kredietbeperking door banken te meten, om het effect van informele kredietinstellingen op deze beperkingen te bepalen, en om het effect van kredietbeperking op het productie- en investeringspatroon vast te stellen.

Doel van het onderzoek dat in deze studie wordt gepresenteerd is het meten van de toegang tot krediet, en het empirisch vaststellen van de effecten van kredietbeperking op productie en investeringen van op de markt gerichte agrarische producenten in centraal Chili. Meer in het bijzonder worden vier onderwerpen onderscheiden: (1) het identificeren van de belangrijkste factoren die de toegang tot krediet voor marktgerichte producenten bepalen; (2) het nagaan of informele financiële kanalen complementair aan of concurrerend zijn met formele kredietinstellingen bij de financiering van agrarische bedrijven; (3) het vaststellen van de effecten van kredietbeperkingen van formele financiële instellingen op de

bedrijfsproductiviteit; en (4) het identificeren van factoren die agrarische investeringen beperken. Deze onderwerpen worden achtereenvolgens in hoofdstukken 2-5 behandeld.

Bij het uitwerken van dit onderzoek worden door de gehele studie heen twee vernieuwende methoden toegepast. Ten eerste wordt er kwalitatieve informatie gebruikt, verzameld door middel van uitgebreide interviews, om drie soorten kredietbeperkingen vanuit de vraag- en aanbodzijde van de kredietmarkt vast te stellen. Dit betreft (1) beperkingen van kwantitatieve aard, (2) beperkingen die samenhangen met risico, en (3) beperkingen als gevolg van transactiekosten. Ten tweede wordt voor alle econometrische analyses een panel data structuur gebruikt die het mogelijk maakt schatters vast te stellen die betrouwbaarder zijn dan schatters die alleen via cross-secties worden verkregen.

In hoofdstuk 2 worden de verschillende vormen van kredietbeperking en de factoren die deze bepalen nagegaan. Op basis van een tweetal surveys in centraal Chili onder 177 landbouwbedrijven in 2006 en 2008, richt het onderzoek zich vooral op de betekenis van variabelen die met sociaal kapitaal samenhangen, namelijk het aantal relaties dat een agrarisch bedrijf heeft met een exporteur en/of een leverancier van inputs, en de lengte van de relatie tussen bank en bedrijf. Beide variabelen blijken de kredietbeperking die samenhangt met transactiekosten en risico te verminderen, maar niet de kwantitatieve kredietbeperking die een bank kan opleggen. Van het aantal onderzochte bedrijven blijkt in 2006 en 2008 resp.16,4% en 13,6% aan een kredietbeperking onderhevig te zijn. Voor de meeste agrariërs geldt dat deze beperking een kwantitatief plafond betreft (10,7% en 9,6%). Beperkingen op basis van risico zijn aanmerkelijk lager (2.8% en 3,4%), die als gevolg van hoge transactiekosten komen nog lager uit (2,8% en 0,6%).

De belangrijkste variabele die kwantitatieve kredietbeperking bepaalt is de bedrijfsomvang in ha. De gevonden negatieve invloed geeft steun aan de veronderstelling dat geregistreerd land als onderpand kan dienen en daarbij tevens de problemen van adverse

selection en moral hazard kan voorkomen. Het effect van de lengte van een relatie met de bank blijkt voor een bedrijf niet significant te zijn. Dit kan er op wijzen dat de duur van een relatie niet alleen leidt tot meer informatie over het agrarische bedrijf, maar ook dat deze informatie door de bank kan worden benut om een kredietplafond te bepalen. Aangezien beide effecten in tegengestelde richting werken, is het totaaleffect onbepaald. Daarentegen verminderen de beide gehanteerde relatievariabelen, het aantal contacten dat een bedrijf met een exporteur en/of leverancier heeft en de contactduur tussen bank en bedrijf, de waarschijnlijkheid dat een agrariër door risico of transactiekosten een kredietbeperking ervaart. De mate van sociaal kapitaal werkt dus gunstig uit op de toegang tot krediet.

In hoofdstuk 3 wordt de relatie tussen formele en informele kredietverschaffers geanalyseerd door na te gaan of formele en informele instellingen complementair dan wel concurrerend zijn in rurale financiële markten. Bijzonder in dit hoofdstuk is het onderzoek naar de determinanten van de toegang tot informeel krediet met behulp van een panel probit model dat rekening houdt met een mogelijke endogeen zijn van kredietbeperkingen. Op basis hiervan suggereert de analyse dat formeel en informeel krediet als complementair beschouwd kunnen worden. Deze complementariteit blijkt veroorzaakt te worden door verschillen in kredietgebruik: formeel krediet financiert investeringen in vaste activa terwijl informeel krediet in werkkapitaal voorziet. Als boeren minder investeren als gevolg van een kredietbeperking die opgelegd wordt door formele instellingen, dan zal ook de behoefte aan werkkapitaal afnemen, en daarmee de vraag naar informeel krediet.

Hoofdstuk 4 verkent de factoren die de bedrijfsproductiviteit bepalen van groente- en fruitkwekers in centraal Chili. Daarbij gaat speciale aandacht uit naar het effect van kort krediet op de productie van marktgerichte bedrijven. Als beschikbaarheid van krediet de productie, en daarmee de productiviteit, metterdaad beïnvloedt, dan zijn beslissingen over

productie en consumptie binnen een agrarische huishouding niet langer te scheiden, en is er daarmee sprake van falen van de financiële markt.

Bij het toetsen van het effect dat krediet op de productiviteit van een landbouwbedrijf heeft, kunnen causaliteitsproblemen rijzen omdat, bij gelijke omstandigheden, minder productieve ondernemers eerder een lening nodig zullen hebben dan hun meer productieve collega's. In dat geval zijn door krediet beperkte ondernemers ook degenen die een lagere productiviteit hebben. Aan dit endogeniteitsprobleem wordt het hoofd geboden door gebruik te maken van een deelverzameling van producenten voor wie de beslissing om hen een lening te verschaffen extern is genomen. Een nadeel van deze procedure is het selectieve karakter dat kan leiden tot een bias in de schattingen. Deze mogelijke bias wordt daarom getoetst door gebruik te maken van een model voor steekproefselectie uit panel gegevens.

Resultaten van de modelberekeningen geven aan dat het effect van kredietbeperkingen voor kort krediet op de bedrijfsproductiviteit niet significant is. Dit houdt in dat landbouwers het niveau van inputs optimaal kunnen kiezen, los van de toegankelijkheid tot krediet. Ofschoon agrarische bedrijven aan kredietbeperkingen onderhevig kunnen zijn, blijkt dat hun productiviteit niet te beïnvloeden. Een verklaring van dit resultaat kan gelegen zijn in de rol die informeel krediet speelt. Waar sommige boeren een kredietbeperking door formele kredietinstellingen ondervinden, zullen anderen toegang hebben tot informeel krediet afkomstig van exporteurs en leveranciers.

Hoofdstuk 5 behandelt het investeringsgedrag door landbouwbedrijven in het geval de kapitaalmarkt onvolkomen functioneert. Daarbij wordt in het bijzonder nagegaan wat het effect is van de omvang van formeel krediet op het investeringsvolume. Rekening houdend met mogelijke endogeniteit, tonen de resultaten aan dat de vorm van de kredietbeperking een negatieve invloed heeft op investeringsbeslissingen: de waarschijnlijkheid dat agrarische bedrijven in centraal Chili investeren vermindert bij beperkte kredietvoorziening met een

factor 2,5. Deze uitkomst illustreert de onvolkomenheden in de markt voor lang krediet. Deze worden waarschijnlijk veroorzaakt worden door het riskante karakter dat lange-termijn landbouwkrediet heeft in de ogen van commerciële banken.

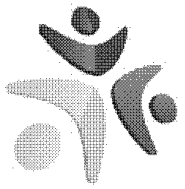
Om het risico van landbouwprojecten juist in te schatten is de nodige expertise bij de kredietverschaffer onontbeerlijk. Land- en tuinbouwprojecten zijn doorgaans complex, hebben met wisselende prijzen te maken, zijn onderhevig aan weersfluctuaties, en staan door hun sterk op het buitenland gerichte afzet bloot aan veranderende wisselkoersen. Dit alles maakt landbouwprojecten in de ogen van de bank onzekerder dan veel andere projecten. Bij gebrek aan voldoende expertise om de risico's van agrarische projecten te beoordelen, zal dit een negatieve weerslag hebben op de bereidheid leningen ten behoeve van dit type projecten te verschaffen. Een tweede factor die landbouwinvesteringen blijkt te beperken is de tijdstrend. Tussen 2006 en 2008 is de waarschijnlijkheid van investeren aanmerkelijk gedaald, ongetwijfeld als gevolg van de wereldwijde financiële crisis vanaf 2007.

In het laatste hoofdstuk wordt een aantal implicaties van dit onderzoek voor rurale financiële markten besproken. (1) Ofschoon van een zekere mate van kredietbeperking sprake is, laat deze studie zien dat dit niet in algemene zin voor Chili geldt. Waarschijnlijk is dit het gevolg van de economische liberalisering op de financiële en handelsmarkten die in de jaren '70 plaats vond. In de Chileense verhoudingen is het echter van belang te onderkennen dat, om deel te hebben aan de voordelen van liberalisering, enige coördinatie in de markt van belang is, bijvoorbeeld via clustervorming door in de marktketen opererende boeren en handelaren. (2) De resultaten in hoofdstuk 5 wijzen op onvolkomenheden in de markt voor lang krediet. Om deze te redresseren valt te overwegen een beleid te ontwikkelen dat tot betere informatie over agrarische bedrijven leidt, bijvoorbeeld door het aanbieden van diensten op het gebied van accounting en management aan deze bedrijven. Het opzetten van speciale afdelingen bij banken voor de beoordeling van risico bij agrarische projecten kan

daarbij ook tot beter functioneren van de markt voor lang krediet leiden. (3) Tenslotte is een belangrijke uitkomst van deze studie dat formele en informele kredietverschaffers elkaar complementeren. Dit resultaat suggereert dat in plaats van een beleid te voeren dat formele instellingen ten koste van informele stimuleert, het beter is om te verkennen hoe informele kredietverschaffers ook andere diensten zoals lang krediet kunnen aanbieden.

The WASS Completed Training and Supervision Plan

Annex to statement
Name Alvaro Reyes
PhD candidate, Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan



Name of the activity	Department/Institute	Year	ECTS*
A) Project related competences			
Microeconomics I	Tilburg University	2005	6.0
Advanced Econometrics	Mansholt Graduate School	2006	6.0
Microfinance and Marketing in Developing Countries	Wageningen University	2007	6.0
Panel Data Analyses	Mansholt Graduate School	2007	1.5
Discrete Choice Modelling	Mansholt Graduate School	2007	1.5
Panel Data Analysis in Micro-economics	Mansholt Graduate School	2009	1.5
Theory and Practice of Efficiency and Productivity Measurement: Nonparametric Static Approach	Mansholt Graduate School	2010	1.5
B) General research related competences			
Introductory Course Mansholt Graduate School	Mansholt Graduate School	2005	1,5
Research methodology	Mansholt Graduate School	2006	2.0
Techniques for Writing and Presenting a Scientific Paper	Mansholt Graduate School	2009	1.2
Scientific Writing	CENTA	2006	1.8
C) Career related competences/personal development			
Teaching assistance: Methods, Techniques and Data Analysis of Field Research	RDS-21306	2010	1,0
Presentation in 3rd International research Workshop on Microfinance"	Groningen, The Netherlands	2010	1,0
Presentation in 117th EAAE Seminar "Climate Change, Food Security and Resilience of Food and Agricultural Systems"	Hohenheim, Germany	2010	1,0
Mansholt Multidisciplinary Seminar at Wageningen University (PhD Day 2007)	Wageningen University	2007	1,0
Mansholt Multidisciplinary Seminar at Wageningen University (PhD Day 2010)	Wageningen University	2010	1,0
MGS Cluster Economics Seminar, Wageningen The Netherlands	Wageningen University	2010	
4th European Microfinance Seminar, European Microfinance Program	Wageningen University	2009	
5ft European Microfinance Seminar, European Microfinance Program	Wageningen University	2010	
Total (minimum 30 ECTS)			**35,5**

Curriculum Vitae

Alvaro Reyes was born on October 29th, 1970 in Santiago, Chile. After completing secondary school in Santiago, he studied Agricultural Engineering with a specialization in Agricultural Economy at the Pontifical Catholic University of Chile. Based on his interest on economy, he studied a Master of Science in Engineering, mention management and economy at the same university.

In 2000, he worked in the National Fruit Growers Federation of Chile as manager of fruit research development projects. In this capacity, he submitted to public agencies over 40 research development projects elaborated in conjunction with universities and other public and private research institutions. In 2003 he was appointed as professor and director of the Agricultural Department at the Universidad Santo Tomas in Santiago, Chile.

Reyes joined the Development Economics Group of Wageningen University in September 2005 as a sandwich PhD student. During the period as PhD student, he has successfully completed the training program of WASS and was involved in teaching and research activities in Universidad Santo Tomas as part of his duties during his stay in Chile for three years.