Effects of access to information on farmer's market channel choice:
The Case of Potato in Tiraque Sub-watershed
(Cochabamba - Bolivia)

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Abstract

In Bolivia, potato production and marketing is important for farmers' livelihoods and anecdotal information shows that cell phones and women are extremely important in the potato marketing chain. Efforts to improve incomes of poor highland potato producers should recognize roles of different actors within the chain and access to market information. This study explores the effects of access to information and gender relations within the potato chain; on farmers' market channel choice in the Tiraque Watershed (Bolivia). The analysis of qualitative information was useful to deepen the understanding of the subject and complement the quantitative analysis. The main source of data comes from a survey of 400 households from the watershed. Rapid Market Appraisal and Case Studies were used to collect qualitative data. The quantitative data were used to estimate two econometric models (Logit and MNL) to evaluate the importance of farmer and market characteristics on market choices. This analysis demonstrates that the determinants affecting market channel choice include market attributes (time to reach the markets and the nearest paved road), production (number of plots owned by farmers) and household-related variables (access to loan, cell phone ownership, location and age of the head of the household). An important unexpected result is that even though the qualitative analysis shows that gender plays an important role in marketing activities; the econometric analysis shows that gender has no effect on farmer's market choices.

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Chapter 1. Introduction

1.1. Background and problem statement

1.1.1. The economic problem and its importance

Markets are the main "transmission mechanisms" between growth in the wider economy and the lives of the poor. They help determine the speed and extent of poverty reduction and create linkages between local, national and global economies. However, markets may also fail, and they often fail for the poor (DFID/OPM, 2000). Exchange systems may fail when the poor are unable to access them, or can only access them on unfavorable terms, due to lack of resources, active discrimination, or lack of information. In the specific context of poor rural areas in developing countries, markets may be too "thin" leading to market power by one or other agents, or the risks and costs of participating in markets may be too high (Hussain 2003). Social or economic barriers (market power, economies of scale, asymmetry or costly information) may mean that the poor are excluded from certain markets. Imperfections in markets for information mean that costs of obtaining reliable information can be prohibitively high. Lack of information can create inefficiencies and welfare losses for participants and potential participants (DFID, 2005).

In many poor rural areas in the Andean region most communication is still oral; people obtain much of their information from informal local networks[1]. These organizations are manifestations of individual and group social capital. Although social networks continue to be important means of acquiring information in rural communities and play a decisive role in the social and economic organization of farmers, they have been suffering stress and undergoing transformation due to the increasing importance of the market economy (Escobal, 2001). As poor producers in remote areas become more integrated into local and regional markets the value of information to them increases. They may also need new kinds of information. In order to maintain their livelihood strategies and reduce their vulnerability in the face of social, economic, and environmental challenges, disadvantaged populations need enhanced access to market information (Scott, 2007).

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[1] Relations between actors (organizations or persons) in a social context; this relations can be virtual or physical; familiar, affective (friendship), or work related.

Market failure is more likely to be severe and distorting when there is asymmetric information between buyer and seller or when relevant market information does not exist or is imperfect (Golan, *et al* 2001). Information is essential for farmers, since it allows them to allocate resources in a way that reflects relative scarcity and meets market demand. Expensive, imperfect and asymmetric information generates several problems for farmers: increased risks associated with marketing, inefficient allocation of resources, higher transaction costs and poor decisions about marketing (Tracey-White, 2003). Overcoming *"information constraints"* to make markets work more effectively for the poor is a challenge that depends on local conditions, such as physical proximity to markets, performance of other markets and infrastructure services (Ferrand, *et al,* 2004). Because information is incomplete, asymmetric and costly to acquire, additional risk is introduced into transactions. Transaction costs must be incurred to acquire information and provide protection against these risks. Improved telecommunications can lower the cost of acquiring information and affect competitiveness. These services can offer previously unconnected farmers the means to access up-to-date price information (Ferrand; *et al,* 2004).

Clearly, time and money can be saved by substituting travel to markets with telecommunications, especially for long distances. In this context, it is important to take into account different Information and Communication Technologies (ICT) that allow market participants to gather and communicate information through different means such as radio, television, cell phones and computer networks (hardware and software). This new ICT, especially Internet services and cell phones, may dramatically reduce the cost of connecting potential buyers and sellers. These cost savings, combined with quick access to information and instant communication with trade partners many kilometers away, open up new possibilities (Lyon, 2000).

Since information is central to economic efficiency, many empirical studies have assessed the effects on decision makers of improvements in information access. Few of these studies address questions such as how much market performance can be enhanced by improving access to information, how much society gains from such improvements and how those gains are shared between producers and consumers (Jensen, 2007). There however is macro and micro level evidence that ICT can promote economic growth.

At the macro level, Roller and Waverman (2001), using evidence from 21 countries members of the Organization for Economic Cooperation and Development (OECD) over a 20-year period, found that there is a significant positive causal link between telecommunications infrastructure and economic growth. Torero, Chowdhury, and Bedi (2006), using data from 113 countries over a 20-year period, estimated that a 1% increase in the telecommunications penetration rate is expected to lead to a 0.03% increase in GDP. Jensen (2007) and Overa (2006) conducted micro-level studies of the effects of ICT. Jensen showed that the adoption of mobile phone service by fishermen in Kerala (India) was associated with a dramatic reduction in price dispersion across markets, elimination of waste and an increase in consumer and producer welfare. In Ghana, Overa demonstrated the that impact of the phenomenal growth in access to cell phones on informal traders' business practices can reduce the risk of transaction for market participants (i.e. consumers and traders), develop mutual trust, and especially reduce both transportation and transaction costs, in particularly information asymmetries.

For markets to work better for poor people, they must increase the opportunity to build and acquire assets, and help reduce vulnerability. They must become progressively more developed, more complete and more accessible to poor people (DFID, 2005). A key element in efforts to break the cycle of poverty has been to facilitate greater access of farmers to knowledge about markets and prices (Shepherd, 2000). Information access is a critical need if efforts to promote agricultural growth and reduce poverty are to be successful.

1.1.2. Transaction costs

Transaction costs are the costs associated with trading, acquiring information and transporting goods. Perhaps the most used definition of transaction costs is North's (1990) which defines them as the costs of measuring what is traded as well as the costs of monitoring compliance with agreements (i.e. negotiating, concluding, monitoring and enforcing contracts). Transaction costs include *ex-ante* costs of determining whether an exchange is advantageous (information access), costs of reaching and selecting market channels (i.e. the path through which goods will flow from producers to consumers) and costs of transportation; which can arise ''*because information is costly and asymmetrically held by the parties of exchange*'' (North, 1995). A "*market failure*" can be a result of large transaction costs which combined with production costs might exceed farmer's total revenue. Janvry, Fafchamps and Sadoulet (1991)

have documented the fact that transaction costs keep many rural households from participating in markets, since inadequate means of transportation (bad roads) and lack of access to telecommunications (high cost of gathering market information) make transactions more risky and increase the cost to traders of gathering information on potential trading partners.

High transactions costs are especially important for poor farmers because they tend to produce and sell low volumes, making it relatively more difficult to spread fixed costs of acquiring information. Escobal (2001) showed that transaction costs in rural Peru equal almost 50% of the sales value, and these costs are appreciably higher (60%) for farmers who have access to the market via non-motorized vehicles. In order to reduce the costs of information and make better decisions about marketing activities, small-scale farmers need more and better access to market information, so they can choose the markets that offer better prices for their products and reduce the differential transaction costs and risks between markets.

1.1.3. Gender issues

Gender is defined as a set of social, cultural, political, psychological, legal and economic characteristics assigned to people in different ways according to sex (Lagarde, 1994). These differences manifest themselves in the roles, responsibilities, local knowledge, needs and priorities related to access, management, use and control of resources that each person plays in the society (Infoagro, 2000). For instance, in the study area, even though the whole family participates in production and marketing activities, their responsibilities are differentiated by gender (SANREM, 2007). Thus, it is important to understand the roles, responsibilities and decision-making of men and women within the dynamics of household economy, market access and social organization.

The Food and Agriculture Organization (FAO) found that women supply a large proportion of the agricultural labor in the world, and in some societies produce up to 80% of food crops. In the case of potato production, rural women play a central role in guaranteeing family food security and providing labor for breeding[2], seed selection, planting, harvesting, storing and marketing (FAO, 2007a). In the Andes, Quechua women farmers are key decision

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[2] Andean women possess a unique reservoir of knowledge and skills in domesticating wild potatoes and adapting new varieties, in order to preserve and enhance plant diversity, allowing them to cultivate in different agro ecological zones and cope with pests, diseases and climatic changes.

makers; they choose plants varieties to meet specific nutritional needs and decide what crops to sell and what crops to consume (USAID, 2006).

Nevertheless, women's roles are frequently under recognized and underappreciated. For instance, agricultural experts seldom recognize that most of Africa's smallholders are women or that women in the Andes perform 25% to 45% of agricultural field tasks (Lallement, 2008). Women farmers often face more constraints and receive fewer support services than men (Bardasi, Blackden, and Guzman 2007; Ellis, Manuel, and Blackden 2006; World Bank 2007a, 2007b). Experiential evidence points to significant gender disparities in access to product markets, although this is not very well documented (Lallement, 2008).

According to Hafkin (2002) infrastructure is a gender issue, since the huge gender gap that exists in access to communication is produced because infrastructure is concentrated in urban areas and most women live in rural areas. Thus, frequently the knowledge and information embodied in the different functions of a value chain are gender specific. Clearly, access to markets is affected by the channels of information that rural women can access to. The gendered nature of networks that link farmers to markets and consist of a majority of one gender or another, have an impact on the quality of information farmers receive and their bargaining power (Lyon, 2004).

Finally, it is important to consider, that in making decisions about their livelihoods, men and women have different perceptions of what is important, possibly basing their decisions on information from different sources. According to Quisumbing, Agnes and Maluccio (2000) households can be characterized using a collective model, where individuals have different preferences, control over their own resources and bargaining power; such a model implies that household decisions will vary according to the relative strengths of individuals' "*bargaining power*", assuming each member has different roles and responsibilities in the household.

1.1.4. <u>Current intervention to be examined</u>

Bolivia is a country whose rural reality is framed in traditional agriculture characterized by small family production units, lack of appropriate technology, low productivity, without basic sanitary and phytosanitary measures and limited access to information and technology (Alemán, 2002). The topic of farmer's market integration has received little attention in the literature on agricultural markets in Bolivia. Most of these reports included detailed descriptions of specific

crop supply chains with information about market prices, infrastructure and levels of efficiency (Mamani and Guidi, 2000). However this information does not respond to the question of why certain producers choose specific markets.

Additionally, the capacity to participate in certain agricultural markets is limited in part by transaction costs and gender; however the relationship between them and marketing strategies has received little attention (Figueroa, 2008). For instance, even though Bolivian laws favor gender equity, the access and contact that rural women have with governmental institutions, NGOs, ICTs and markets are limited because of customs that benefit more men than women (Alemán, 2002). In Bolivia producers particularly in isolated rural areas lack of information to help them to plan their marketing activities (FDTA, 2004). Because information is costly and access to it is unequal, producers obtain it from a variety of sources; these include wholesalers, radio, extension agents, and especially through social networks (Overa, 2006). Since information access is critical to promote poverty reduction and agricultural growth, the objective of the present study will be to determine how access to information affects farmer's market choices (channel supply) in order to maximize their profits.

1.1.5. Description of the study area

The study area is the Jatun Mayu watershed, located in southern Tiraque Province, about 70 km. from Cochabamba. It covers an area of 117 km^2, and is comprised of 14 communities, with a population of approximately 3,000 inhabitants. The focus watershed is between 3000 and 4200 meters above sea level and has three different agro-ecological zones, with different agro-climatic conditions, soil and specially, water availability. The principal irrigation system is called Totora Qhocha and it can irrigate approximately 5,000 hectares; however it has never reached its whole capacity of 22 millions of m^3, which limits famer's access to irrigation water, reducing thin the number of plots they can use and thus their production levels. The area is semi humid, with approximately 550 mm of annual rainfall, and a cold climate almost all year. Primary social problems are low incomes and lack of income-earning alternatives. The primary economic activities are small-scale agricultural production and livestock (cattle, sheep, pigs and poultry). Between 20% and 50% of total output in the area is sold. Farmers face the following marketing problems: high transport costs, low quality and prices, individual and isolated participation

within the chain, lack of market information and weak bargaining power. Wholesalers are an important link between farmers and markets (SANREM, 2007).

Farmers generally produce five crops: potato, faba bean, oats, wheat, and barley. The main crop is potato, which is sold in the rural markets of Tiraque and Punata, and in the urban markets of Cochabamba and Santa Cruz. In general, urban markets offer higher prices, but they are located far away, implying high transportations costs; as a result only about 10% of farmers go to these markets. For many farmers (almost 50%) the Tiraque market constitutes their main marketing node, since it is the closest to the watershed. Transportation costs needed to each market differ and so do prices received in them (SANREM, 2007). Farmers face choices about where to sell their products. Since potato marketing is an important source of income for many farmers, it is important for them to carefully select their market. If farmers had price information for all markets, price dispersion could be reduced, and crop production could be allocated across markets more efficiently. As a result, waste could be reduced and total welfare could be increased.

As the majority of the farmers are semiliterate, verbal communication remains the most important form of information exchange. Radio programs transmitting market information in the local language (Quechua) and cell phones are both widely used as information sources. Many farmers and almost all wholesalers and retailers in the area now use mobile phones to coordinate sales (SANREM, 2007). However, there still are deficiencies in access to information by location, since some areas have better signal than others. Also it is not known how much information cell phones provide. Therefore, the Tiraque watershed offers an ideal setting for exploring the effects of information through cell phones on market performance.

In sum, potato production and marketing is very important for farmers' livelihoods in this area. However, their activities are limited by market-level constraints, especially lack of information about markets. Nevertheless, anecdotal information shows that access to information through cell phones and the role that women play in these activities are extremely important in the potato marketing chain.

1.2. Objectives

i. Describe the potato marketing chain in the Tiraque region, with a special focus on the role that gender and access to information play within it;

ii. Analyze how gender relations and access to technology affect household potato marketing decisions;

iii. Determine how improvements in access to information through cell phones affect market channel choice for poor farmers in rural Bolivia.

1.3. Hypotheses

i. The introduction of mobile phone services in the study area has the potential to allow farmers to take better marketing decisions and increases prices received;

ii. The introduction of mobile phone service in the study area has produced differences in sales revenues among farmers across this region.

iii. Transaction costs, specifically transportation and search costs, constrain the transmission of price information;

iv. Access to markets is influenced by gender relationships within the household and the potato market chain.

1.4. Methods

The main source of the data used for this thesis comes from the project *"Watershed Based Natural Resources Management in Small Scale Agriculture, Sloped Areas of Andean Region: Sub-watershed Jatun Mayu river (Bolivia)[3]"*. This project, referred to as the *SANREM Project,* collected information through a baseline survey applied to 400 families in 14 communities within the watershed and four communities outside of it. This data was used to asses the impact of access to cell phones on market channel choices farmers make. For the analysis Logit and Multinomial Logit econometric models were used.

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[3] This project is part of the Sustainable Agricultural Natural Resource Management - Collaborative Research Support Program (SANREM-CRSP) that executes its activities in Bolivia in collaboration with PROINPA Foundation.

In order to describe the potato market chain, a Rapid Market Appraisal (RMA) methodology was used. This methodology consists of semi-structured interviews with stakeholders who have direct contact with farmers, in the market chain (producers, wholesalers, retailers, indirect actors) and key participants (people who know how the chain works). The semi-structured interviews helped us understand characteristics, activities, roles, responsibilities and participation of these stakeholders as well as the roles of market information and gender in the chain.

Finally, case studies were conducted to provide a better understanding of marketing dynamics, farmer decision-making processes and the effects that information and gender have on those decisions. These case studies were undertaken with families chosen from the 400 families previously surveyed. The following participatory tools were used in the case studies: regenerative cycles (commercialization seasonal schedules of potato activities with a focus on access to information and gender) and marketing budgets.

1.5. Outline

The thesis consists of five chapters. Chapter 2 presents background on the potato market chain in Cochabamba – Bolivia. Chapter 3 provides a conceptual framework, presenting a review of previous economic analyses relevant to the problem and the microeconomic foundations, including the theoretical models. Chapter 2 and Chapter 3 are based on a comprehensive literature review. Chapter 4 describes the data, methods and empirical models. The research results and discussion are presented in Chapter 5. Finally Chapter 6 presents a synthesis of the main points and discusses policy implications.

Chapter 2. Background

This chapter presents background on the potato crop in Bolivia, and focuses on production, consumption, marketing and characteristics of the potato market chain. We examine the roles of different actors in the chain, their access to information, gender and market performance. Additionally, a description of how Information and Communication Technologies (ICT) in Bolivia is given, with a focus on their role in economic and social development, gender access and specifically cell phones.

2.1. Importance of the potato crop in Bolivia

2.1.1. Production and consumption

Potato is grown in more than 100 countries and ranks as the world's fourth most important food crop, after maize, wheat and rice (FAO, 2007). Bolivia and Peru are jointly the origin center and domestication of the potato crop; this crop has an ancient tradition in both countries. In Bolivia, food security depends on potato production and currently it is, after tourism and before soybean production, the second mayor economic activity at the national level. Bolivia's wide genetic variability of potato varieties (1400) holds potential for plant breeding, especially for disease resistance and abiotic factor tolerance (Guidi and Mamani, 2000). Potato growing is still highly labor-intensive and it is grown across some 135,000 hectares of land by more than 200,000 farmer families (34% of the labor force in the country). In most of the potato producers are are smallholders who produce mainly for household consumption and rely heavily on traditional varieties (Crespo, 2003; FAO 2007).

Bolivia produces between 700,000 and 900,000 metric tons (t) of potato per year, with an average yield of 7.4 t/ha[4], but the crop has a range of yields between 4 to 20 t/ha. In Latin America Bolivia ranks around seventh place in production and is in seventeenth place in yield with 5.5 t/ha, which is lower than the regional average, which is 17 (Salcedo, 2005; FAO 2007). Potato in Bolivia covers great extensions of land but has low yields. These low yields can be attributed to lack of technologies, use of varieties with low productivity, poor soil fertility and

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[4] One hectare is equivalent to 2.471 acres

limited access to water (only 5% of the cultivated area in the country has irrigation) (CEPAL, 2002; INNOVA, 2004).

Even though Bolivia's potato production is important to the national economy and has expanded steadily over the past decade, it has also had a low growth rate, with an annual increase in volume produced of only 1% per year, below the rate of population growth. Some studies show that potato supply has a slightly deficit, especially when is not harvest time; that is mostly cover by illegal imports from Argentina and Peru (Seleme and Crespo, 2005). Nevertheless according to Balderrama (2008), in 2006 the imports, both illegal and legal, only represented a minimal part of total potato consumption. Potato production in Bolivia faces numerous problems such as land tenure (small plots), low soil fertility, limited access to water, abiotic factors (early morning frost and drought), lack of technology and high sensitivity to diseases and pests. All these adverse factors cause low yields and low quality production. Despite all these constraints, per capita potato consumption in Bolivia is still high. According to Zeballos (1997), an average a Bolivian consumes between 80 and 140 Kg/year; this consumption is especially high in rural areas, where this crop is especially important for low income households (provides 60% of calories per day). However this consumption has been decreasing over time. Nevertheless, for most rural households, potatoes remain the main source of food.

2.1.2. <u>Potato marketing characteristics</u>

The starting point of the potato marketing flow is primarily rural markets, where farmers sell their production to wholesalers who transport it to urban markets. The cities that produce most of the potato consumed in Bolivia are Chuquisaca (109,826 t/year), Cochabamba (153,637 t/year) and especially La Paz (162,917 t/year) (INE, 2000). Usually farmers sell potato in bags, called "*carga*", of approximately 100 kg, which has an average cost of 160 Bs[5] (i.e. 20 $) (FAOSTAT, 2009). The only quality control that buyers make is checking for damage, by simply opening the top of the bags or putting the production on the ground. Sales are in cash; the final price is result of negotiation between farmers and wholesalers. Despite the fact that in Bolivia a large number of potato varieties are produced, only two varieties represent approximately 70% of the potato commercialized in Bolivia's markets. One of them is a native variety (Waycha) and the other one is from Holland (Holandesa) (Shadai, 2000).

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[5] 1 $ = 7 Bs

Prices vary cyclically during the year; however these fluctuations are relatively minor because potato in Bolivia can have up to five harvest seasons. These cycles are related to sowing and harvesting seasons in the different regions of the country. Thus, it only slight price variations are observed between cities and months. Highest prices are observed from October to December, especially in markets from La Paz (250 Bs[6]/100 Kg) and Santa Cruz (230 Bs/100 Kg). Beginning in January, prices start lowering until April to approximately 145 Bs/100 kg (SIMA[7], 2009). This behavior shows strong linkages between major national markets. In general, consumer prices between cities differ from 10 up to 20 Bs per 100 kg (INE, 2006). Among the factors affecting price variability are quantity produced, potato variety, quality (i.e. size and pest free), type of market (urban or rural), harvest season and imports from other countries.

2.1.3. Characteristics of the potato chain

Guidi and Mamani (2000) characterized the potato food chain in Bolivia. This study was conducted in the three biggest cities of the country: La Paz, Santa Cruz and Cochabamba. Findings include:

✓ Input suppliers: Most farmers do not have the means of obtaining appropriate inputs. The most important inputs are: fertilizers, pesticides, machinery rental and seed. On average 95% of seeds used by farmers are produced by them.

✓ Farmers: Sell their production on their farms or in rural or urban markets. In general, small farmers sell most of their production to wholesalers. The average potato plot is between 0.3 and 0.7 ha. Most famers have low yield, low quality and high production and transaction costs. Currently, some farmers are organizing themselves into producer associations in order to reduce costs and be able to reduce the influence of wholesalers.

✓ Wholesalers: Collect production at the farm-gate or in rural markets and transport it to urban markets. Sometimes they sell directly to restaurants and supermarkets chain. Transactions with farmers are paid in cash. Most of the time wholesalers get higher revenue and better incomes than farmers, and provide farmers with loans for their production. The relationship between farmers and wholesalers is more than just business, since there are emotional ties between them that bind farmers and increase wholesalers bargaining power.

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[6] Bs is Bolivia's currency: 7 Bs = 1 US$
[7] Sistema de Informacion de Mercados (Market information system), which collects price information in Bolivia's main markets.

✓ Retailers: Sell different agricultural products, including potato, at popular markets in urban areas. Supermarkets, restaurants and convenience stores are also considered retailers. They sell potato in small quantities directly to consumers. The relationship between retailers and wholesalers is usually monetary.

✓ Processing: This activity in Bolivia is poorly developed, because most consumers prefer fresh potatoes. About 15% to 18 % of total potato production is processed into potato chips, potato starch, mashed potato, potato peeled and frozen, and selected chuño[8] and tunta[9].

✓ Consumers: Mostly households, restaurants and informal family-style dining rooms located at popular markets.

Fair economic relationships between participants within the potato market chain, imply equitable, transparent and fair partnership between actors; and they are important to provide farmers with a fair price that properly values and rewarded their work, also that offer better trading conditions, opportunities to participate in other markets and build long-term relationships. However, some of the constraints that prevent these fair economic relations include poorly maintained roads, lack of storage in the markets, poor information systems and lack of effective communication services. However the latter have been improving in the last decade thanks to cell phones.

2.1.3.1 Wholesalers importance

The perception that farmers are at the mercy of wholesalers is widespread, because farmers have limited access to knowledge about markets and prices, while wholesalers may have better information and more power during negotiation (Mamani and Guidi, 2000). Nevertheless, wholesalers and retailers perform many valuable tasks of intermediation such as sorting for and attesting to quality, storing goods, transport, organizing sales, assuming or pooling risk and supplying credit (Stigler 1961; Biglaiser 1993; Li 1998; Van Raalte and Webers 1998; Jones 1985, Medeiros et al 2007). It would likely be inefficient for rural farmers to assume all of these tasks. In the case of Bolivia, Jones (1985) showed that in Cochabamba (Pocona Province)

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[8] Dehydrated potato elaborated through freezing and sublimation of the water. It is mainly produced in the Andean region of Bolivia and Peru.
[9] Product similar to Chuño that differs from the latter by the use of water floods (especially from rivers and streams) to eliminate dark components resultant from oxidation process.

middlemen are integral parts of the production process since they provide a worthwhile financial and technical role, especially when their activities and profit are viewed in a larger production context. However, they have generally been ignored because they are perceived to gain their incomes at the expense of farmers. Theoretical work confirms that under most circumstances, the optimal amount of intermediation is positive (Biglaiser 1993).

The problem with wholesalers, especially in information-isolated settings, is often that there are too few. They can have a monopoly because of well-developed relationships and high transaction costs and by making entry into the system difficult. However, competition among wholesalers and traders can increase if information were available through ICT's, since it would be easier for others to enter the market. This competition, according to some studies, can constrain wholesalers' ability to exploit information asymmetry, to reap excessive profits or to exploit customers (Eggleston, Jensen and Zeckhauser, 2002).

For instance, Hayami, Kikuchi and Marciano (1999) showed that rice marketing in the Philippines (Laguna Province) is highly competitive, preventing wholesalers from exploiting peasants and consumers through monopoly pricing. The share of income for each marketing agent (collector, miller and retailer) was estimated to be about 5% or less of the retail price. These results are largely consistent with many other studies including Scott (1985) on potato in Peru; and Hayami and Kwagoe (1993) on the marketing of upland crops in Indonesia and Mérel, et al (2009) on middlemen market power in developing countries. These results show the importance of improving rural infrastructure, marketing information, reliable and appropriate property rights, and contract mechanisms.

2.1.3.2. Gender

Even though women and men are very active in product markets, a recent *World Development Report* (World Bank 2007) emphasized that women's role in crop agriculture is often restricted to produce subsistence food crops with low potential to generate income (e.g. cereals, tubers, fruit, and vegetables). This occurs because women have limited access to essential production resources, such as land, labor, inputs (seed and fertilizer), knowledge, affordable credit, infrastructure, access to ICTs and information. If women had more access to these resources, productivity could increase, as proved by a study made by DFID (2007) which

calculated that agricultural productivity in sub-Saharan Africa could increase by 20% if women's access to such resources were equal to men's.

In Latin America, rural women that participate in marketing activities have a double disadvantage compared to men. First because overall, women are confined to the household management and second because men control the income generated from the marketing of the agricultural products (FAO, 2002). This is important, since women represent more than 50% of the employment in rural areas in Latin America and they generate between 30% and 50% of the income, in both agricultural and non-agricultural activities. Specifically, in the Andean region it is estimated that women's participation in agricultural and livestock activities is approximately of 10 million, which represents 70% of the female economically active population in this region. Thus, women's contribution to food production is very important and it should be considered when efforts to improve farmer's competitiveness are to be implemented (Grynspan, 1999; Duryea, et al 2000). In the case of Bolivia, agriculture is also the main activity that concentrates rural women, working 84% from the total female rural working population in agricultural related activities (INE, 2000; Alemán, 2002).

In general, since women have limited access to resources to develop lengthy marketing networks, they confine themselves to local markets where access, mobility, and networks are easier for them to negotiate. This local focus frequently results in excessive competition and under pricing. For instance in Lao PDR, only 5% of women-owned enterprises use electrical or motorized equipment compared with 48% of male-owned enterprises (Richardson, Howarth, and Finnegan 2004). Discriminatory cultural attitudes may prevent women farmers from entering value chains altogether or allow them very limited roles. In Guatemala, for example, women hold only 3% of snow pea production contracts but contribute more than one-third of total field labor and virtually all processing labor (World Bank 2007c). Ellis, Manuel and Blackden (2006) demonstrated that in Uganda women's enterprises are frequently at least as productive and efficient, as men's enterprises, but women face higher barriers to entry.

In Bolivia, anecdotal information shows that women and men perform different tasks along the potato supply chain; consequently they may have gender-specific knowledge related to potato markets. Gender task separation may mean that neither men nor women possess a complete understanding of the entire chain and how the roles and responsibilities of actors intersect and interact at different market stages. Efforts to improve incomes of poor highland

potato producers should recognize that roles are differentiated by gender and determine if gendered networks affect access to potato markets. It is essential to understand the role that women play in the potato food chain because it affects the gender division of labor and in turn influences resource management, income flows, expenditure patterns, food security, and gender relationships.

2.2. Information and Communication Technologies (ICT) in Bolivia

2.2.1. Introduction

Three fourths of the poor in developing countries live in rural areas and depend on agriculture-related activities. In these areas, access to timely information about prices and quality requirements is of central importance. It is very important to reduce the information gap. ICTs have become a powerful tool in removing information asymmetries that often prevent the poor in remote areas from accessing markets (Von Braun, 2009). ICTs have three defining characteristics: convergence, speed, and comparatively low operating costs. These characteristics offer a broad range of possibilities for information collection, manipulation, transmission, storage, and presentation, which can be effectively applied in rural contexts to improve farmers' livelihoods, offering rural populations new ways of networking and communication (FAO and GTZ 2006). ICT are considered public goods because once they are produced they are available to all on a nonexclusive basis. As well, additional individuals may benefit from them at zero marginal cost (non-rival) (Nicholson, 2008).

Studies of ICTs' impacts on rural households have shown a wide range of positive impacts that permit communities and households to integrate into the local, regional, national, and world economies (Tye and Chau 1995; Leff 1984; Tschang et al. 2002; Andrew and Petkov 2003; Gotland et al. 2004). It is important to understand that the technologies themselves do nothing. Complementary investments by public and private actors to realize ICTs impact is needed (Wattegama, 2004). There are high hopes that ICT projects can play an important role in reducing gender inequalities (Balakrishnan, 2002). Since communication costs are not proportional to distance to markets and the marginal cost of providing information to new players is zero; ICT becomes a crucial vehicle for the promotion of international trade and regional integration.

2.2.2. ICTS and rural women

According to Lallement (2008), ICT services have proved effective in bringing market information to both men and women. The latter frequently benefit more from these services, because they have lesser mobility and literacy. These services can be highly effective in addressing women's disadvantages in access to information, communication, transactions, education, resources, earning and employment opportunities. In India, for example, telephony has enabled rural women to obtain direct information on the price of food crops, empowering them to better negotiate prices with middlemen (Huyer and Sisoska, 2002). In many developing countries, women face barriers of unequal access to ICTs since cultural attitudes discriminate against their access to technology and technology education. Compared to men, rural women are less likely to own communication assets such as a radio or cell phone.

ICT can improve economic conditions of whole communities, generating positive externalities that benefit a large number of agents. For instance, in Bolivia, the project Agricultura Ecologica[10] (AGRECOL) use ICTs to share local knowledge related to organic agriculture and resources management among farmer communities. Women have benefited from the documentation process through increased access to information, which in turn increased crop yields and income. This has created new learning opportunities for rural households and effectively reached women farmers who had been excluded (Piepenstock, Arratia, and Aguilar 2006). Even though gender-differentiated data are difficult to find, there are reports that indicate gender differences, but they are hampered by the lack of reliable statistics. The major collector and disseminator of statistics on ICTs is the International Telecommunication Union (ITU 2000, 2001), however, it does not disaggregate any of its ICT indicators by gender. As a result there are few, if any, reliable statistics on women's use of ICTs in developing countries.

2.2.3. ICT in Bolivia

In developing countries like Bolivia, it is important to consider whether the benefits of ICT will reach the poor and at whether it helps reducing poverty. Better access to education, market information and government services via radio and cell phones have a higher value for the poor because they are unable to access to them through traditional media. In short, the support that ICT provides to information diffusion and decision making process can make a real

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[10] This project is financed by the International Institute for Communication and Development (IICD)

contribution to development (TIC, 2005). Among the most important ICT identified in rural Bolivia are the following:

✓ Radio is considered the most important communication system in rural areas throughout Bolivia, because it has national coverage, wide audience, uses different languages and its programs are in line with the activity timetable of the productive rural sector. Several radio stations nationwide broadcast daily information on agricultural prices in Bolivia's major markets. The collection and broadcasting of this information is funded by a private Foundation called FDTA-Valles[11]. However, its impact on potato producers is low because there are no specialized programs related specifically to this crop (FDTA Valles, 2009).

✓ Fixed telephone lines are accessible to farmers in rural areas, thanks to public phones booths. By 2003, Bolivia had 14,086 payphones of which 30% were located in rural areas. The competition in this sector, compared to the cell phone sector, is lower since the former requires greater infrastructure investments (SITTEL, 2003). However, the actual effect of access to fixed telephone lines on the potato food chain has not been investigated quantitatively.

✓ Cell phones have an effect on market information dissemination among the different actors along the potato chain. However, it mainly depends on the signal coverage, which is gradually increasing throughout the country.

2.2.4. <u>Cell phones</u>

2.2.4.1. Introduction

Mobile phone penetration throughout the world has been rapidly increasing. Data published by the International Telecommunication Union's (ITU) continues showing high growth rates in the mobile market, and particularly in developing regions which have 70% of the world's mobile subscribers. By the end of 2007 the number of mobile phone users worldwide soared to over 3.3 billion (a penetration rate of 49%). Africa remains the region with the highest growth rate (32% in 2006-07). In absolute numbers, China (the world's biggest cell phone market) and India are the countries that have the greatest number of mobile subscribers. It is estimated that more than half of the world's population will be using mobile phones by early

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[11] Foundation for the Development of Agricultural Technology of the Valleys (www.fdta-valles.org)

2010 and worldwide mobile subscriptions will rise from 3.3 billion in 2008 to 5.6 billion in 2013 (ITU, 2008). The penetration level in all least developed countries will go from 2.2% to 19.4% (Andersson et al. 2007).

Mobile cellular is increasingly dominating the telephone market and worldwide mobile subscribers represent no less then 71% of all (fixed and mobile) telephone subscribers. In Africa, this percentage is close to 90%. In Latin America and the Caribbean it is estimated that fixed telephone is available in 36% of households but only 12% of rural homes. But, even though mobile phones have a similar overall penetration as fixed (33%), many more rural households have mobile phones (21% on average), including over half of rural homes in Paraguay (Piet, Dasgupta, Thomas and Wheeler, 2008)

Cellular telephone is the technology of choice in terms of bridging the information gap between rich and poor; becoming one of the most likely access devices for agricultural market information, creating economic opportunities and strengthening social networks in rural areas around the world (C. K. Pralahad, 2005). According to DIRSI (Regional Dialogue on the Information Society) 2007 report[12] about mobile phones and poverty in Latin America and the Caribbean, mobile adoption for the poor has long become the most cost-effective and accessible alternative to improve their livelihoods. Presenting an economic impact expressed mainly in terms of improved social capital variables such as the strengthening of trust networks and better coordination of informal job markets. Given their limited access to traditional fixed telephony, the poor attribute a significant improvement in quality of life to mobile access. Because of rapid improvements in ICT in developing countries, especially mobile phones, there is a growing interest in its impacts on agricultural markets. There is a vast evidence about the positive effects that cell phone have had around the world. The widespread, voluntary adoption of ICTs for marketing by producers and traders observed in many developing countries suggests that similar gains are likely to be found elsewhere.

Aker (2008), for example, studied the impact of the staggered introduction of cell phones on grain market performance in Niger between 2001 and 2006. The primary mechanism by which cell phones affect market-level outcomes appears to be a reduction in search costs for markets. The results provide evidence that cell phones reduce grain price dispersion across

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[12] The report is based on over 8,000 face-to-face interviews conducted with individuals aged 13 to 70 residing in low-income households in Argentina, Brazil, Colombia, Jamaica, Mexico, Peru, and Trinidad and Tobago.

markets by a minimum of 6.4% and reduce intra-annual price variation by 10%. Cell phones have a greater impact on price dispersion for market pairs that are farther away, and for those with lower road quality. This effect becomes larger as a higher percentage of markets have cell phone coverage, suggesting that this improved consumer and trader welfare in Niger. Goyal (2008) identified that internet kiosks that provide wholesale price information and alternative market channels to soybean farmers in India has led to an increase in the monthly market price by 1-5%. In addition the area under soybean production has increased significantly. In Bangladesh, Bayes (2001) reported that agricultural output prices are higher when villages are equipped with pay phones.

Overa (2006) found in Ghana that traders are more efficient since they reduced their transactions costs and waste thanks to mobile phones. A study develop by Jensen (2007) about cell phone adoption by fishermen in Kerala, India shows that this tool has provided access to different market prices and opportunities to complete market transactions without being physically present. He found that mobile phones help fishermen choose a fish market where they can sell their fish for the highest price (less variation), reduce waste by 100% and increase fishermen's profits by 8%. Torero (2000) found that access to a telephone is important in explaining why low income households do not drop into poverty, since households that acquired a phone increased their incomes and their access to financial savings and credit, although causality here is not clear. Muto and Yamano (2009) estimated the impact of mobile phone network expansion on farmers' market participation in Uganda, where coverage of the mobile phone network expanded from 46% of the population in 2003 to 70% in 2005 (ITU, 2007). The results suggest that the expansion of mobile phone coverage encourages market participation of farmers who are located in remote areas and produce perishable crops, increasing the probability of banana sales by 20% points for instance.

2.2.4.2. Cell phones in Bolivia

One of the sectors that has contributed greatly to Bolivia's economic growth is the telecommunication industry, specifically because of strong investments in recent years. In 2003 Bolivia GDP was 26,836 million Bs, where this industry contributed with 631 million Bs, from which 113.9 millions Bs were invested in fixed and cell phones (INE, 2006). In Bolivia, cell

phone service was launched in 1991 with 295 phone lines[13], which exponentially increased to 1,023,333 lines in 2003 and to 4,830,000 in 2008 (ITU, 2008). Ninety percent of these lines are found in the three biggest cities in Bolivia (Santa Cruz, La Paz and Cochabamba). An important aspect in the evolution of the mobile market in Bolivia is the entry, in 1996, of new service providers (i.e. ENTEL, AES, Cotas, Boliviatel, NuevaTel, ITS, Telecel and Cotel). This entry stimulated the demand growth and the number of users by 362% that year (SITTEL, 2003).

Table 2.1. Boliva Telecommunication Sector Growth statistics

Statistics	*1991-95*	*1996*	*1997*	*1998*	*1999*	*2000*	*2003-08*
Average yearly growth	122.5%	362%	254.6%	102.0%	75.7%	37.94%	30.4%
Additional lines added in the year	6,934	26,171	85,033	120,839	181,072	159,471	3551.2

Source: SITTEL

Increased competition in this market can be explained by the following factors: i) the existence of an unsatisfied market for traditional phone services, ii) the entry of new operators into the market with the modality Calling Party Pays (the caller pays), which reduces prices; iii) introduction of a prepaid mode that allows users to have a controlled consumption (87% of the users preferred this type of service in 2003) and; iv) relatively high cost of local fixed telephone service. Additionally, unlike fixed telephones, for cell phone operators it is easier to enter in this market since it does not require a complex and expensive physical network infrastructure (SITTEL, 2003). Finally, it is important to emphasize that towns in rural areas with a population between 350 and 10,000 habitants are considered very important for phone companies because by the concession contract signed with the government, they have to expand their service coverage to rural populations with those characteristics, reaching a certain minimum percentage established in that contract (SIRESE, 1994). For instance by 1997 only 614 rural towns had access to telephone lines, but in 2003 this number increased to 3500, which represents a growth of 479% (SITTEL, 2003).

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[13] Telephone connection or the wire that carries telephone signals

2.3. <u>Summary of the chapter</u>

Potato is clearly one of the most important crops for many rural households in Bolivia, and rural livelihoods depend on potato markets. The role that women play in the potato market chain is significant and important. Marketing agents play an important role in potato markets and there is some evidence that the might be able to exploit poor producers who lack fundamental market information. The competitiveness of the potato market chain can be improved through the use of ICT. Widespread use of ICT can reduce price dispersion across spatially separated markets, transactions cost and gender discrimination. Cell phones are one of the most likely information devices to improve market information dissemination among actors in the potato chain. Access to cell phones and cell phone signals is widespread throughout the Andean Region and it is important to investigate how this access affects market decisions and, ultimately, household well-being.

The conceptual framework upon which this research is based is presented in the following chapter. A review of previous economic analysis as well as the microeconomic foundations of the problem provide us with concepts, theories and ideas to model this research. Furthermore, theoretical model formulas and model predictions are established in chapter three.

Chapter 3. Conceptual framework

In this chapter, a conceptual framework of the microeconomic foundations of market choice among small-scale producers is presented. A review and main findings of previous economic analyses relevant to the problem are presented. These ideas and information give us direction and are intended to serve as a guide for an empirical model.

3.1. Previous economic analysis relevant to the problem

3.1.1. Review

Many economic studies stress that in order to have efficiently functioning markets, access to information is critical. This can be observed in two of the most well-known results in economics: The First Fundamental Theorem of welfare economics (i.e. competitive equilibria are Pareto efficient) and the "Law of One Price" (i.e. the price of a good should not differ between any two markets by more than the transport cost between them). These results rely heavily on the assumption that agents have the necessary price information to engage in optimal trade or arbitrage and reflect some of the most fundamental functioning advantages of a market economy. In such markets profit-seeking suppliers reallocate their goods towards a market where a price differential that arises when goods are more highly valued in one market than in another. This process reduces the price differential and increases total welfare (Jensen, 2007). However, as emphasized by Stigler (1961), information is often costly or incomplete; in such cases it can not be expected that price differences provide an efficient allocation of goods across markets.

A common mistake in specialized literature focusing on the evaluation of specific policies is the assumption that rural households are completely integrated into markets. This assumption can cause an overestimation of farmer's responses to changes in prices (Escobal, 2001). Janvry, Sadoulet and Fafchamps (1991) showed how, in different contexts, the erroneous modeling of how rural households make decisions could lead to the overestimation of price elasticities of agricultural supply. Typically, this overestimation originates from mistakenly assuming that decisions on consumption and production are separable.

For an important fraction of households in low-income countries, output markets play a central role in determining their incomes. Jensen (2007) focuses in how access to information can improve market performance, and welfare in the south Indian fisheries sector. He shows the potential value of information and communication technologies (ICT) for economic development. Because of the limited access to information, the potential for inefficiency in allocation of goods across markets is great. However, this inefficiency can be reduced through access to ICT. De Janvry, Sadoulet and Fafchamps (1991) documented that the existence of transaction costs keeps many rural households from participating in certain agricultural markets. Overa (2006) examines the potential of telecommunications technology to develop and change trading practices in Ghana, reducing traders' time use and transportation costs. Since transaction costs are major determinants of traders' producer-wholesale margin, they affect the income of producers and traders and ultimately, the availability and cost of goods for consumers. Overa also addresses the question of how the introduction of telephones into a high-risk and low-trust environment can reduce transaction costs. According to Abbott (1989) the issue of impact from information technology generally focuses on the extent by which farmers adopt information technologies, whether they provide the best source of information and how information technologies affect the use of other information sources.

Current literature that studies market choices focuses on determinants and welfare implications of those choices as key issues for farmers' livelihoods in developing countries. Fafchamps and Vargas-Hill (2005) focused on household characteristics, self-discipline motivations[14] and how transaction characteristics affected Ugandan coffee farmer's market channel decisions. Key, Sadoulet and De Janvry (2000) studied the effects on Mexican corn farmers' production and marketing decisions of proportional and fixed transactions costs. Another interesting study about market channel choice is the one conducted by Hobbs (1997) who estimates the influence of transaction costs and farm characteristics variables using data from U.K. beef farmers.

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[14] Farmers self-discipline motivations in the market refers to the temptation to spend the revenue generated from the sale in sudden desires that they might regret later, such alcohol and other frivolous expenditures.

3.1.2. <u>Main findings of previous studies</u>

Although much has been investigated, few studies examine the role that quality incentives play in driving farmers' market channel choice and its welfare implications in developing countries. However, Jensen (2007) using micro level survey data studied the effect, between 1997 and 2001, of the introduction of mobile phone service throughout Kerala, a state in India with a large fishing industry, where over 60% of fishing boats and most wholesale and retail traders were using mobile phones to coordinate sales. He found that the introduction of mobile phones dramatically reduced price dispersion across markets, reducing the mean coefficient of variation of price across markets from 60-70% to 15% or less. In addition, there were also almost no violations of the Law of One Price once mobile phones were in place, compared to 50-60% of market pairs before. Further, waste, averaging 5-8% of daily catch before mobile phones, was completely eliminated. Finally, fishermen's profits increased on average by 8% while the consumer price declined by 4% and consumer surplus in sardine consumption increased by 6%. This suggests that there are likely to be net welfare gains associated with the introduction of this technology; increasing both consumer and producer welfare.

Overa (2006) demonstrated that exchange of information and networking among traders can be made more efficient through the introduction of telecommunications technology. This research argues that more transactions can be conducted in an uncertain economic environment after adopting new technology which enhances micro-level trust building within preexisting trade networks, creating better services and higher profits. Jano (2007) demonstrated that the determinants of market channel choice include not only transaction-related variables (i.e. quantity sold or means of transport) and farmer characteristics (wealth, level of isolation and belonging to an association), but quality of production variables.

Escobal (2001) confirms that transaction costs in the Peruvian Andes are much higher for small-scale farmers than for large-scale ones (67% versus 32% of the sales value), and that larger transaction costs are associated with lower market responsiveness of farmers. This study shows that between the variables that explain market integration strategies (i.e. when and where to sell) are distance and time to the market, social networks, access to information, farmer's experience and how much farmers invest to obtain relevant information and to monitor compliance of contracts. Lower transactions costs provide the following potential: quick and effective response

to market incentives, increased bargaining power, fewer information asymmetries, better relationships between market actors (less risky) and new marketing opportunities. In the long term, farmers with lower transaction costs may increase their marketed surplus, allowing them to exploit the benefits of specialization and improve incomes.

In many countries, especially developing ones, there is a concern over a perceived internal digital divide, since the ICT access and the resulting benefits from them may benefit only the wealthiest or most educated and mostly men, leaving others behind. However, studies provide evidence that suggests that the benefits of ICTs can be found among fishermen or farmers, not just software engineers or call-center workers. For instance, Jensen showed that while it was primarily the largest fishermen who adopted mobile phones, there were significant spillover gains for the smaller fishermen who did not use phones due to improved market functioning. Thus, rather than simply excluding the poor or less educated, the "digital provide" appears to be shared more widely throughout society.

Fafchamps and Vargas-Hill (2005) developed an interesting model of market channel choice for Ugandan coffee farmers, showing that market choice is a result of rational decisions. Farmers seek to maximize utility given the constraints that are common in developing countries such as small amounts of production, geographic isolation, few formal market institutions and high transaction costs. The rest of this paper will be built based on this model, which allows us to explore market channel choice, including the role that cell phone and gender play in driving that choice by potato producers from the Jatun Mayu watershed (Bolivia).

3.2. Microeconomic foundations of the problem

In order to understand how access to information affects household decision making, a producer choice model will be used. Households will be treated as a single decision-making unit. Since this is a model of supply, it is assumed that the farmer goal is profit maximization. However, the main focus will be on market channel choice, since production costs and potato production are assumed to be predetermined. The main goal is to analyze how farmers allocate their production when deciding whether to sell at rural (Tiraque and Punata) or urban markets (Cochabamba and Santa Cruz).

Farmers consider the following when choosing markets: sales prices, transportation and information cost, their experience in the market, available time, and quantity destined for sale. To maximize profits farmers, decide the optimal amount of output to supply to the different markets. Since potatoes are a staple food in Bolivia, their demand curve is inelastic. Potato producers are assumed to be price takers and their output decisions do not affect market prices, thus their marginal revenue is equal to the price at which a unit sells. The market however, is not perfectly competitive, since wholesalers may be able to influence market prices. Moreover, since farmers will allocate their production across different markets, they will face changes in prices in the short-run. Because agricultural goods are both seasonal and perishable, the synchronization of supply and demand for traders is important. Potato is a semi-perishable commodity, because it does not require refrigeration, but it still has a limited storage life of three months. Its perishability depends on storage characteristics, because potatoes need to be kept away from light as they will start sprouting (Guidi and Mamani, 2000). This synchronization can be achieved through access to information, which in turn will facilitate market prices determination and increase bargaining power as well.

The starting point for the economic analysis is that information has economic value, i.e. it allows individuals to make choices that yield higher expected payoffs than they would obtain from choices made in the absence of information. Because information has special characteristics compared to other goods, its analysis can be more difficult. However, in the end information influences decisions and reduces uncertainty, and there lays its importance (Stigler, 1961). For this paper, it is assumed that farmer's decision to participate in a specific market (channel choice) depends on their potato supply, differences in prices across markets, gender, as well as their access to information through cell phones. This price difference can result from transaction costs related to the region in which the household is located as well as the different features of specific markets. Additionally, even though the development of telecommunication in rural Bolivia is at an early stage; during the last decade its impact on development has been strikingly positive.

Theoretical model formulas

In order to construct a model of farmer's decision to sell at rural markets or travel to urban markets, the following assumptions are needed:

✓ Profit function: Farmers supply potatoes to markets based on respective demands, prices and transaction costs necessary to reach them.

(1) $\text{Max } \Pi = \sum\limits_{i=1}^{4} R_i(Q) - PC(Q) - TT_i(Q);$ for Market i (M_i) = 1,2,3,4

Where: Π: Total economic profit
$\quad$ Q: Total production to be sold
$\quad$ R_i: Market revenue earned at market i (for i=1,2,3,4)
$\quad$ PC: Production cost
$\quad$ TT_i: Transaction costs at market i (for i=1,2,3,4)
$\quad$ $M_i = M_1$: Tiraque, M_2: Punata, M_3: Cochabamba, M_4: Santa Cruz

In this case, PC and Q are assumed to be fixed because the model is concerned with market choice based on information availability that maximizes farmers' profit.

The profit maximization function is subject to:

-Total production destined to sales: $Q = \sum\limits_{i=1}^{4} q^s_i(P_i, TT_i, Z^s);$

-Transaction cost to reach target makets: $TT_i = \sum\limits_{i=1}^{4} TC_i * (q^s_i) + \sum\limits_{i=1}^{4} IC_i$

- Profit responds to changes in prices as follows: $\partial \Pi / \partial P_i = q^s_i (P_i, TC_i, IC_i)$

Where: q^s_i: Amount of potato supplied at market i (for i=1,2,3,4)
$\quad$ P_i: Price paid to the farmer at market i (for i=1,2,3,4)
$\quad$ TC_i: Transportation cost to market i (for i=1,2,3,4)
$\quad$ IC_i: Information cost or cost to search for markets through cell phone
$\quad$ Z^s = exogenous variables that affect supply

✓ Transportation costs: It is also important to examine the effect of distance from the markets on transportation costs. It is assumed that these costs increase with distance:

(2) $TC_i = TC_i (d_i, q^s_i, t, Z^{tc})$

Where: d_i: Distance to market i (for i=1,2,3,4)
$\quad$ t: means of transport
$\quad$ Z^{tc}: exogenous variables that affect transportation costs

✓ Access to information: Access to market information gives farmers knowledge about prevailing prices in various markets. It is a function of social networks and access to technology, both of which can vary with wealth. Enhanced access to information through cell phones allows farmers to make profitable marketing decisions.

(3) $AI = AI [SN, T (Y), Z^t]$

Where: AI: Access to information
SN: Social Networks
T: Access to technology
Y: Farmer's wealth
Z^t: exogenous variables that affect access to technology

✓ *Decision of where to sell* (Market channel choice): The four focal markets are not perfectly competitive and the price may vary by more than transaction costs. Formally, let market prices paid to farmers at Tiraque, Punata, Cochabamba and Santa Cruz be: P_1, P_2, P_3 and P_4 respectively. Based on information about the structure of the potato chain in the area, the Information Market System (SIMA) that operates at national level, and price information collected by the SANREM project (2007); the following relation exists between markets prices: $P_1 \leq P_2 \leq P_3 \leq P_4$.

(4) $P_{rural} < P_{urban} - TC_{urban}$ thus: $D_{urban} = P_{urban} - TC_{uban} - P_{rural}$

Where: P_i = Price paid at market i (for i=1,2,3,4)
D_i = Difference between markets

For instance, if $D_{urban} \geq 0$ it means that farmers should sell at urban markets, but if $D_{urban} < 0$ then it is better to sell to rural market.

Finally, there may be also farmers who have greater access to market information, for instance through cell phones. In addition to transport cost these producers have search costs. Search for information allows them to know the state of the markets with more certainty, allocate their production more efficiently and avoid unnecessary transportation costs. When the cost to have information equals the gain from arbitrage (net of transportation costs) more farmers will be willing to pay for this information, and price dispersion between markets will be reduced. Producers will buy the technology (i.e. cell phones) when the gains from switching markets over the life of the technology exceeds the cost. Therefore, the characteristic of price transmission in market *i,* will be a function of different exogenous variables.

3.2.1. Model predictions

Using the theoretical model, the following predictions can be made:

✓ Household characteristics: Market access is determined by a mix of factors intrinsic to farmers (i.e. gender, education, access to credit, location, age) that will determine where farmers choose to go.

- *Hypothesis 1:* The decision of where to sell their potato production may be influenced and constrained by household characteristics (i.e. age, size of the household and gender of the head of the household), human capital (e.g. education), financial capital (e.g. loan) and location (i.e. cell phone signal).

- *Hypothesis 2:* The role that women play in marketing activities is of great importance, especially in the markets, since they can influence the negotiation process and consequently the final price received. Thus, gender of the farmer who goes to the market will influence the decisions of where to sell, becoming gender a marketing strategy.

✓ Production Characteristics: The quantity supplied to the markets depends on the level of quantity produced, and will be influenced by access to land and irrigation. Families divide the total harvest in three parts: seed for the next season (13% of the total production), consumption (29%) and sales (58%) (SANREM, 2007).

- *Hypothesis 3:* Farmers can hire public transportation for a price (TC_i=Bs/100 kg) which depends not only on the distance to markets but also on the quantity transported ($\partial TCi / \partial q^s_i$). Thus, even though farmer's unit transport cost does not increase with the quantity (q^s_i) transported, the total cost of transportation does, which means that farmers are more likely to travel to more and farther markets if the quantity produced is large (i.e. urban markets).

- *Hypothesis 4:* Farmers with higher income have access to better transport infrastructure. The probability that these wealthy farmers go to more and farther markets is high, since the marginal cost of transporting decreases. The proxy used to determine farmer's wealth will be number of plots owned by each household.

✓ *Access to information:* Departing from Fafchamps and Vargas-Hill model, we consider that access to information is a factor that influences farmers' market choice (where to sell potato). Once they have information, they can make better marketing decisions, decrease their transportation costs and increase their profits. Currently, one of the cheapest and fastest ways

to access to information is through use of cell phones. Access to information is determined by access to technology, which depends, as well, on wealth. It is important to explore the relation between access to information and market channel choice. Farmers can get higher prices at farther markets, which is reflected in $P_1 \leq P_2 \leq P_3 \leq P_4$.

- *Hypothesis 5:* Farmers who have access to information through the use of cell phones have a higher probability of selling to the market that offers a better price, normally urban markets. They also to go to more markets.

- *Hypothesis 6:* Access to information through cell phone in this area depends on the location of the household with respect to the Watershed, because it will affect the signal coverage provided (the cell phone signal is quite weak outside the watershed)

- *Hypothesis 7:* The decision to buy a cell phone will be influenced by the age and gender of the head of the household, and also by the number of plots. In order to investigate this hypothesis we will use interaction terms between cell phones and the previous farmer's characteristics.

✓ Access to markets: Cost to reach market i (TCi) is a function of distance to markets (d_i), quantity transported[15] for sale (q^s_i), means of transportation (t), and different exogenous variables (Z^{tc}).

- *Hypothesis 8:* It is assumed that TC_i increases with distance ($\partial TC_i / \partial d_i > 0$), therefore, the more isolated farmers are, the higher probability of choosing rural markets and not more than one. In our model, distance will be determined by the time required to go the each markets. It is common for potato producers in this area to make only one trip to the market.

- *Hypothesis 9:* Because more farmers in the study area have access to public transportation, it is expected that the ownership of a motorized transport (t), will not affect the number of markets farmers decide to go to sell their production. Using motorized means of transport will reduce the time required to travel, increasing D_i (difference between markets) and thus the likelihood of selling to more distant markets.

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[15] Normally the transportation cost is per 100 kg (measure unit called carga), but is different for each market

3.3. Summary of the chapter

The main concern of this research is to explore the effects of access to information through cell phones and gender relations on market performance. This chapter provides reviews of previous economic analysis that highlights the importance of access to technology and gender roles on market choices. These studies contributed to improve our understanding on the problem at hand. They also provide guidance on how to achieve the objectives of this research.

In the next chapter data collection and analytical methods are presented. Summary statistics from the household survey are presented and discussed.

Chapter 4. Methods: Data collection and analysis

The objective of this chapter is to describe the methods used to collect and analyze the data and other evidence. This information was used to examine the hypotheses about decision-making processes and the impact of information and gender on decision making. Several methods were used. The main source of quantitative data was the Baseline Survey from the SANREM Project[16]. These data were analyzed using two econometric models. To enhance and deepen our understanding of potato markets, we complemented the quantitative analysis with a qualitative Rapid Market Appraisal (RMA) and detailed Case Studies.

4.1. Rapid Market Appraisal

The market chain concept is a useful analytic tool to understand a series of postproduction activities and individuals and institutions involved in marketing. A value chain is comprised of the full range of activities required to bring a product or service from production to consumers (Kaplinsky and Morris 2001). In order to describe the potato market chain dynamics in the study area and validate the results from the econometric models; a Rapid Market Appraisal (RMA) was used to collect qualitative data through semi-structured interviews (Simon, 1994). This method aims to provide a quick, flexible, and effective way of collecting, processing, and analyzing data about markets and marketing systems. The RMA used in this research is based on the technique developed by Holtzman (2003), and relies on a combination of secondary and primary data collected through semi structured interviews with a minimum number of key informants at different stages of the market chain.

The information provides insights about the main features of the potato market chain, by identifying functions performed at each point (stakeholder's roles), prices and information and market constraints and opportunities. Information about the roles that cell phone and gender play within the chain was also gathered. This information helps us understand how the flow of information along the chain affects productivity and efficiency, and how mobile

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[16] "Watershed Based Natural Resources Management in Small Scale Agriculture, Sloped Areas of Andean Region: Sub-watershed Jatun Mayu river (Bolivia)"

telecommunications and gender affect the chain. A "gender focus[17]" to the market chain analysis made it possible to identify gender-based division of activities, differential opportunities and gender power relations that influence the chain. This method also allowed identification of the characteristics of potato markets.

4.1.1. Data collection and analysis

The field work was carried out by PROINPA researchers in the Jatun Mayu watershed and in the markets where farmers from this area sell potatoes, during February-July 2008. It included 4 types of interviews differentiated by actor, for a total of 25 interviews with key informants. The first step in the analysis was to conduct a review of relevant literature and secondary data. The analysis of this information allowed a general description of the potato chain in this area that includes the roles of different actors in the chain, their access to information, gender and market performance. Also based on the secondary data we were able to describe the situation of ICT in Bolivia, focusing on gender access and importance of cell phones. The literature review provided us with some evidence about the important role that women play in the potato market chain, as well as how poor producers might be exploited by market agents due to lack of market information, which can improve through widespread use of ICT, specially cell phones. This review allowed us to identify the information needed to be gathered through the interviews in order to investigate how access to this technology affects market decisions and, ultimately, household well-being. This information was used to develop the questions for the interviews.

The second step was to identify a small but purposely selected sample of stakeholders to interview: farmers, wholesalers, retailers, key and indirect actors. Following a rule of thumb, a three to five interviews were conducted at each stage in the chain. A semi-structured interview guide was created; it helped make the interviews more consistent, systematic and focused. The information was cross-checked asking similar question to actors at different levels of the market chain; this procedure is referring to as "mirroring" (Appendix A). The sample was selected as follows:

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[17] Gender focus is an alternative approach that considers first the analysis of gender relations to base on it the decision making process and actions to achieve development. It is a way to observing reality based on sex and gender variables and their manifestations in a geographic, cultural, ethnic and historic context given. Talking about gender means to stop believing that the social and cultural roles assigned to men and women are natural (Infoagro, 2000).

- ✓ Farmers were classified into two categories depending on where they are located and where they sell their production (rural or urban markets). In total 6 farmers from 4 different communities, within and outside the watershed, were interviewed. All the farmers interviewed were men, but in four households women participated as well.

- ✓ Wholesalers and retailers were identified by the farmers interviewed previously through the technique called "snow ball" Holtzman (2003). In total 5 wholesalers and 3 retailers were interviewed, all of whom were women.

- ✓ Indirect actors, such as NGOs, local government and extension agents, are crucial to the development of the chain, since they provide support services to direct actors. Five interviews were applied to the representatives of the organizations (3 of them women) identified by farmers during the interviews.

- ✓ Key actors were also identified. These actors do not participate directly in the chain but possess knowledge of it, such as: people who work in the market, truck drivers, municipality personnel and personnel that collect price information for a private institution. Six interviews were made from this group (2 were women).

- ✓ Additionally direct observation was used to describe the four markets: Tiraque, Punata, Cochabamba and Santa Cruz.

The information was organized and systematized, using standardized formats. The data were structured to reflect how well the actors in the chain are organized and also how well the chain is supported by a range of marketing development services. These include transporters, local administrators, market information and financial services. Since the performance of a market chain is partly a result of these services, it was important to assess both goods and services along the chain and the relative strengths of market information and gender.

4.2. Case Studies

Our Case Studies then provide an opportunity to deepen understanding of the subject under study, and address questions of how and why a specific phenomenon is happening (Yin, 2003). This information served as a backup to the farmer and market chain data and helped confirm survey results. Case studies were used to facilitate a better understanding of the

dynamics of the marketing decision process within the household and the influences that access to information and gender have on this process. This method, through semi-structured interviews, involved working closely with farmers using participatory tools, to get a better insight about their activities. In addition to the interviews, two participatory tools were used: regenerative cycles and marketing budgets. These tools gathered marketing information on seasonal schedules of potato activities, focusing on access to information and gender. It is important to clarify that the objective of Case Studies is not to generalize the findings to the entire population of similar cases, but its goal is to determine how plausible the logic of the analysis is.

4.2.1. Data collection

The first step was to identify the families for the case studies. Use of case studies allowed us to focus on small number of experimental subjects in depth. A logic of "*literal replication*" was followed, because the results are expected to be similar when comparing each family selected as a case study (Yin, 1994). Care was taken in selecting them for this purpose. Case study families were chosen from the 400 households who participated in the baseline survey. This selection took into account expert guidelines, according to which random sample selection used for statistical analysis is adequate in the selection of cases (Eisenhardt, 1989; Stake, 1994). With case studies the generalization of the results through the use of the logic of replication is needed (Easton, 1994; Yin, 1994). Therefore the selection of the case studies was based on theory and logical sampling. The sample chosen was discretionary and left to the investigators judgment, guided by convenience and special interest of the study. Moreover, the size of the sample was large enough to ensure the credibility of the data, and small enough to ensure a study with the proper depth ((Eisenhardt, 1989).

Case study selection was based on the following criteria: 1) farmers who participated in the baseline survey; 2) geographical location: 4 members of the communities within the Watershed and 2 outside of it; 3) farmers who produced and marketed potato; 4) extended families, i.e. at least five members; and 5) confidence level of the SANREM project technicians with the families chosen (Appendix B). Following these criteria, 6 families were chosen. This number of cases identified meets the minimum recommendations for this type of study (Eisenhardt, 1989).

Case studies typically rely on multiple sources of information and methods to provide as complete picture as possible. The main method used was semi-structured interviews with household members. A protocol was developed laying out a set of procedures and guidelines to structure and govern the study (Yin, 1994) (Appendix B). The interviews were not highly structured; therefore there was a preponderance of open-ended questions and focus on general observations and perceptions. All the interviews were recorded using a digital device. Case study data collection took place between April to July 2008. Every family was interviewed three to four times (depending on time availability), since it was important to make follow-up visits. Each visit lasted more than two hours and in each one of them both spouses were present.

In addition to the interviews, two participatory tools were used: 1) Creation of a marketing budget to determine the cost to reach the markets (transportation, storage and other costs in the markets); and 2) Regenerative cycles: to describe marketing activities and decision making within the household throughout the year, taking into account holidays, irrigation system, climate changes, labour availability, and production and marketing activities.

4.2.2. Plan of Analysis

A data base was created to facilitate the analysis of the evidence from the case studies and to ensure the overall reliability (Rialp, 1998). The data were classified and summarized using conceptual tables that help to organize both, quantitative and qualitative data. These tables consist of three main categories, which are: household, production and marketing characteristics that include access and management of resources, economic activities, decision making, gender roles and responsibilities and access to information. When possible, the qualitative data were coded in order to find patterns, label topics, develop categories and identify how these elements relate to each other and respect to the propositions of the research (Patton, 2002).

Once the evidence was tabulated, the analysis followed Yin's (1994, 2003) recommendations, which are the most common for explanatory case studies. Therefore the general strategy of analysis used was Pattern-matching, which determines the internal validity of the research. This technique allows comparing the results of the analysis (pattern obtained empirically) with a predicted pattern to corroborate previous theories or to contribute to development of new theoretical approaches or for more detailed explanations of the phenomenon under analysis (Yin, 2003).

Pattern-matching analysis starts from general implications and works down to specific cases that need to be studied (deduction). It focuses only on patterns, not in "levels" of patterns or relationships between patterns. The first step was to make individual case descriptions. Then the data from each case was compared and contrasted (cross-case analysis) to the other cases, to help identify patterns among them. Later, in an analytical phase of greater complexity and higher explanatory value, the analysis was done using the hypothesis derived from the theoretical review carried out throughout the thesis. These propositions were contrasted with the evidence, to be either confirmed (total or in part) or rejected, as a general analytical strategy. It should be kept in mind that in case studies analysis, the validity criteria have a logical nature that allow the generation of objective explanations (Fong, 2003, 2005). Therefore, if two or more cases support the same theory, it can be considered that the empirical basis of it is correct and that it was possible to replicate the experience (Yin, 1994).

4.3. <u>Baseline survey</u>

The SANREM Project baseline household survey collected basic information on farmer households, production and marketing characteristics, as well as their exposure to communication technologies, such as cell phones, that might affect production and market choices. Data collection occurred from June to September 2007. A stratified sample was used. First, four areas comprising 18 communities within and out of the watershed were identified. Second, within those areas and proportional to the population proportion (overall population of 1000 farmers in the watershed and 600 from outside of it), 400 families were selected randomly.

4.3.1. <u>Econometric model specifications</u>

The primary goal of the econometric models is to explain the effects of the independent variables X_i (i.e. farmers household, production and marketing characteristics) on the probability of choosing between going to more than one market or one of the four markets, considered in our study: Tiraque and Punata in the rural areas and Cochabamba and Santa Cruz in the urban areas. The outcome is nominal because the categories are assumed to be unordered. Therefore the most appropriate model to estimate farmers' decision to sell in one of these four different markets is a strategy choice model, specifically a Multinomial Logistic Model (MNL). This model was used

because it is the standard method for estimating unordered, multi category dependent variables. It also assumes independence across the choices, that is, it does not allow correlation or substitution between them (Wooldridge, 2008).

In this model each household makes only one choice from a group of available strategies, and this discussion is based on a number of exogenous factors. Those factors include household-level and area-specific variables. The probability with which farmer j chooses one of the given market i (P_{ji}) is specified as follows (Cameron and Trivedi 2005):

$$P\,[y_j = i] = P_{ji} = \frac{\exp{(x_j{}'\beta_i)}}{\Sigma \exp{(x_j{}'\beta_k)}} \qquad P\,[y_j = i] = P_{ji}\,(\beta_o + \beta_1 x_1 + \ldots + \beta_k x_k) = P_{ji}\,(\beta_o + \mathbf{x}\boldsymbol{\beta})$$

$$0 < P_{ji} < 1 \qquad\qquad\qquad\qquad \mathbf{x}\boldsymbol{\beta} = \beta_1 x_1 + \ldots + \beta_k x_k$$

Where: y_j = *probability with which farmer j chooses market i Pr [y_j = i]*
   Market i: 1=Tiraque (base group), 2=Punata; 3=Cochabamba; 4=Santa Cruz and 5=more than one market
   x_j = *vector of household, production and marketing variables;*
   β_i = *vector of coefficients associated with the ith market choice.*

The MNL probabilities have the following properties: i) P_{ji} is necessarily between zero and one. ii) The choice probabilities for the five alternatives markets have to sum to one, so there is no need to estimate the coefficients for all choices (Greene, 2003). If an alternative has no chance of being chosen by a farmer, it can be excluded from the choice set (Train, 2003: McFadden and Train, 2000). iii) The relative probabilities of any two outcomes are independent of the probabilities of other outcomes. iv) The relationship between X_j and P_{ji} is non-linear. v) This model assumes that the log of odds ratio is linearly related to X_j. vi) β_i measures the average effect (or the difference on the probability) across the groups.

In addition to the MNL, a Logit Model was used to explain the effects of the independent variables on the probability of choosing between two alternatives, whether to go to only one market or more than one. This model is appropriate to analyze farmers' decision because it estimates the probability of an event occurring or not, by predicting a binary dependent outcome from a set of independent variables. The Logit model assumes that the log of odds ratio is linearly related to X_i. The model can be expressed as follows:

$$G\ (z) = \frac{\exp\ (z)}{[(1+\exp\ (z)\ ]} . \qquad\qquad P\ [y=1] = G\ (\beta_o + \beta_1 x_1 + \ldots + \beta_k x_k) = G\ (\beta_o + \mathbf{x\beta})$$

$$0 < G\ (z) < 1 \qquad\qquad\qquad \mathbf{x\beta} = \beta_1 x_1 + \ldots + \beta_k x_k$$

Where: y_j = *probability with which farmer j chooses to go only to one market P [y = 1] and P [y = 0] if farmer j choose to go to more than one market (base group).*

x_k = *vector of household, production and marketing variables*

β_k = *vector of coefficients associated with the ith category.*

The Logit probabilities exhibit the following properties: i) G(z) is necessarily between zero and one; ii) the choice probabilities for both alternatives have to sum to one; iii) the decision maker necessarily chooses one; and iii) The relationship between X_i and P_i is non-linear. Multiple regression models will allow estimating the effect of various explanatory variables on qualitative events. Since this research is dealing with individuals (households) and cross-sectional data, self-selection[18] has to be considered as well (Wooldridge, 2008).

4.3.2. Variable specification

In this section we present a description of the independent variables considered in our econometric models, which include household, production and marketing characteristics.

4.3.2.1. Household-related variables

We identify seven variables regarding farmer's characteristics that we consider important in determining farmer's market selection. These variables include, size of the household, and characteristics of the head of the household. The number of members per family supply with agricultural labor and thus it influences farmers' production capacity. We expect a positive relationship between this variable and the quantity of potato supply to the markets. Finally, since the size of the household determines how much potato is going to be consumed (staple food) it does affect the final quantity available for the markets.

We considered some features of the head of the household because clearly these variables will influence their decision making. These variables include: age, literacy and gender. Age is expected to have a negative relationship with the quantity produced and access to new technology (i.e. cell phones), since older farmers are less likely to keep producing large

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[18] Deciding on an action based on the likely benefits, or costs, of taking that action

quantities and are more reluctant to use new tools. Most farmers in rural areas are illiterate, which might also prevent farmers from using new technology. Also since it is argued that conflict of interest between spouses may affect their decision to select markets, we included a dummy variable for the gender of the head of the household, which should capture that effect. In rural markets female participation affects the marketing process, thus gender is an important determinant to account for. However, our variable might not be ideal because it does not make any reference of who take marketing decisions (survey does not provide this information), it only help us to differentiate who the head of the household is.

4.3.2.2. Production-related variables

Farmers' production capacity determines their access to potato markets, thus quantity produced is an important factor to account for, since livelihoods of most farmers from this area relies heavily on this crop. We also include three other variables that we considered influence farmer's productive capacity, such as access to loan, number of plots and access to irrigation. Loans are mostly acquired to cover production costs, allowing farmers to increase their production. Also, the quantity produce depends on the number of plots farmers owned ($\partial q^{prod} / \partial$ # plots). This variable will also used as proxy of farmer's wealth, since it is quite difficult to get information about household income. Furthermore, it is important to consider the effect that gender of the head of the household has on the number of plots owned by family, since most of the time women have limited access to vital agricultural inputs, such land. Finally access to irrigation definite affects potato production, because we believe they are positively related.

4.3.2.3. Market-related variables

Access to markets can be improved if information dissemination improves as well. In this context the most likely device to improve this access are cell phones, because they are cost-effective and accessible alternatives for farmers. Therefore, for our analysis, the proxy used to determine information access will be cell phone ownership. Also, cell phones depend on the location of the household with respect to the watershed since it will affect signal coverage and thus the impact of this toll on decision making. In addition to location, we also considered the effect that gender and age have in determining the decision to buy a cell phone or not. Another important asset that will influence farmer's selection of markets is accessibility of motorized

transport, since it has been observed that in this area public transportation has improved, changing market channels used by farmers since before most of them prefer to sell at farm-gate rather than going to the markets, because of the lack of transportation.

Additionally, the decision of where to sell depends on time needed to reach the nearest paved road and to each one of the markets they usually go (i.e. Tiraque, Punata, Cochabamba and Santa Cruz). For our analysis we use travel time to each market as a measure of cost of transportation for each household. Also based on the literature review it appears that urban markets are more competitive than rural markets, then it is expected that farmers choose to transport potato to the former markets when price there is greater than the price at rural markets. Price differential includes the effects of distance to markets that can be observed in time to reach them and means of transportation (i.e. access to motorized transportation). Therefore, farmers are expected to sell at urban market if the difference (D_i) between markets is positive, that is $D_{urban,}$ $_{(versus\ rural)}$ = $Price_{urban}$ - $Price_{rural}$ - $Transp.Cost_{uban}$, Otherwise, the farmer will sell to the rural market. That is:

If:	D_i	Farmers will choose market:	
		If $D_i \geq 0$	If $D_i < 0$
$P_1 < P_2 - TC_2$	$D_{1,2} = P_2 - TC_2 - P_1$	2 – Punata	1 – Tiraque
$P_2 < P_3 - TC_3$	$D_{2,3} = P_3 - TC_3 - P_2$	3 – Cochabamba	2 – Punata
$P_3 < P_4 - TC_4$	$D_{3,4} = P_4 - TC_4 - P_3$	4 - Santa Cruz	3 – Cochabamba

$M_i = M_1$: Tiraque, M_2: Punata, M_3: Cochabamba, M_4: Santa Cruz

To empirically test the model, let *M* denote the decision on where to sell (Market channel choice), with M_i, if the farmer sells directly to the market *i*. This decision depends on the latent variable $D_i^* = D_i + u$ where *u* is an error term. We have M_i, if $D_i^* \geq 0$. Thus factors that raise D_i make farmers more likely to sell to the market.

4.3.3. Estimation method

In a binary response model, the nonlinear nature of E (y|x), makes Ordinary Least Squares (OLS) and Weighted Least Squares (WLS) inapplicable. Therefore, the appropriate estimation method for both models is the Maximum Likelihood Estimation (MLE), which estimates particular values of the parameters that create the greatest probability of one of the alternatives, in other words, it will estimate in the case of the Logit Model farmers' discrete decision to go to only one market using the decision to go to more than one as base for

comparison; and in the case of the MNL it will estimate farmers' decision to sell at the Punata, Cochabamba, Santa Cruz or to more than one market using the Tiraque market as base for comparison (normalized channel). This allows for a normalization to make comparisons of the coefficients interpretable. MLE provides a consistent approach to this type of parameter estimation and is applicable for a variety of estimation situations. Furthermore it can generate minimum variance unbiased estimators as the sample size increases, it has approximate normal distributions and sample variances that can be used to generate confidence bounds and hypothesis tests for the parameters.

4.4. Summary statistics

From the 400 families surveyed by the SANREM project, 12 did not provide or answered all the questions, therefore they were removed from the data set. The final sample was thus 388. However, some of the observations had to be removed as well because they did not provide any information about market channel choice. Since the model will predict farmers' market choice, farmers who do not sell their production as well as farmers who sell other crops different than potato were deleted from the data set. Observations that would substantially alter the results (i.e. outliers) were also deleted (14 observations). The final sample size was 303 observations. Appendix C shows the summary statistics.

In the surveyed area, the median household size is six individuals, which is relatively small, because normally farmer's families are large and extended. Young children and elderly people represent a bit more than half of the average household. Even though in this area more than 80% of the interviewees are literate, only 6% of the literate are women. Approximately 14% of surveyed households are headed by women. In table 4.1 variables regarding farm size, quantity produced, access to irrigation and time to reach the markets are differentiated by gender. These results are similar when we compared farmers who live inside the watershed and farmers who live outside.

Table 4.1. Production related variables differentiated by gender

| Head of the household | | Average | | Average time to reach the markets (hours) | | | | Access to irrigation (%) |
Gender	%	Farm size (ha)	Quantity produced (kg)	Tiraque	Punata	Cochabamba	Santa Cruz	
Male	86%	2.55	7374.18	0.67	1.31	2.45	12.35	88%
Female	14%	1.18	4009.40	0.68	1.32	2.46	12.35	12%
Difference		1.37	3364.78	-0.01	0.00	-0.01	0.01	

Regarding access to land, on average a family owns 2.4 hectares; which fluctuates from 0.05 up to 15 hectares and only few farmers owned between 20 and 30 hectares. This is also observed in the number of plots own per family, which ranges from 1 up to 15, with an average of 5 plots per family. Farmers who live in the watershed owned on average 0.5 hectares of land more than farmers who live outside the watershed, which can explain the fact that the former produce 67% more than the latter and are able to sell twice as much. The average quantity of potatoes that farmers sold in a single transaction was 4866 Kg; this variable ranges from 100 to 37500 Kg. Most farmers (98%) produce a commercial potato variety called Waycha and 58% of them sold their product in rural markets, mostly Tiraque. There is not difference regarding market preferences based on location with respect to the watershed; farmers inside and outside the watershed sell at similar markets in similar proportions. Variation in prices goes from 0.26 to 2.5 Bs/Kg, however when we observed the average prices between markets the difference between them are minimal. Farmer households sell about 60% of their production, using the rest for self consumption and seed. On average, 70% of total household income comes from potato. In general, farmers secure loans to cover their production cost; however, only 18% of the surveyed farmers have received a loan from banks when the surveyed was applied, the rest of them either have access to inputs and loans from wholesalers and other financial institutions; or produce according to their economic situation.

Disaggregating the means of transport used for the last sale shows that 86% of the farmers who market potatoes do not own motorized transportation. The average transportation cost for transporting potato for the last sale was 4.98 Bs/100 kg. This is the cost of leasing motorized transport (e.g. trucks and taxis), a common practice for most farmers. Even though access to transportation in this area is not a problem it can be observed that farmers who own a truck generate at least 22% more revenue than farmers who do not. Nevertheless the time both

types of farmers need to reach the markets is almost the same. Based on the qualitative analysis it has been observed also that the use of cell phones help farmers to coordinate trucks rentals from their farms to transport their production to the markets. This tool allows farmers to call truck drivers and conduct the negotiation over the phone (e.g. cost, quantity to be transported, market to go and initial location), saving time and money since before they had cell phones, farmers had to go personally to the markets and look for theses truck drivers.

Another factor that influences market choice is access to cell phones; 49% of the farmers surveyed owned at least one cell phone. Only 12% of farmers with access to this technology are women. About 59% of the farmers who live inside the watershed have cell phones, compared to 21% who live outside of it. Interestingly when we compared farmers with cell phones with those who do not have them, we find that the former own more land (at least 1 more hectare) and generate at least 30% more in revenues from potato sales than the others. They also pay more for transportation (at least 9% more). Also farmers who own a cell phones own more land (at least 1 ha more/1 plot) and produce 40% more than those who do not (i.e. 1100 kg more). Therefore we can conclude that wealthier farmers are more likely to buy a cell phone. Also, younger people tend to have cell phones.

About 69% of farmers only go to one market, specifically Tiraque, Punata, Cochabamba and Santa Cruz; which have the following distribution: 44%, 14%, 6% and 5% respectively. The median distance to the nearest market (Tiraque) is 19 km and to the farthest (Santa Cruz) over 400 Km. The time spent to reach these markets varied between 0.26 and 12.78 hours. Farmers who live outside the watershed spend less time than farmers inside of it going to the market of Santa Cruz; nevertheless they need more time going to the other markets. Comparing farmers who go to rural markets with farmers who go to urban markets, we find that the latter own at least 2.4 hectares more, sell about 3500 kg more and generate 5200 Bs more revenues than the former, even though transportation costs are higher (7.7. Bs/sack higher). Farmers who go to more than one market produce on average more than 5000 kg, which allows them to split the production among the different market locations. These farmers prefer rural markets over urban markets, because the transportation costs to them are lower, which allows them to allocate their production at lesser cost. Thus they generate approximately as much revenue as farmers who go to only one urban market.

4.5.<u>Summary of the chapter</u>

In this chapter the methods used to collect and analyze the data were presented. We provided ad detailed description of qualitative data collection and a plan of their analysis. The econometric model and variable specification, as well as the estimation method are explained. One limitation we faced was our inability to coordinate the design of the survey and application of qualitative methods, which could have improved the accuracy of the data collected. Thus this limitation should be taken into account when the results are being interpreted. Summary statistics were presented and provide a general picture of the study area. The next chapter presents the results of the qualitative and econometric analysis, followed by conclusions in chapter six.

Chapter 5. Results and Discussion

This chapter builds on background information gathered about Bolivia's potato marketing chain and uses quantitative and qualitative field research techniques to test hypotheses about market level constraints. The qualitative analysis deepens and complements the quantitative analysis. We provide a general description of the potato chain in the Tiraque region and the decision making process related to market choice. We pay special attention to the effects of gender relations and access to information. We analyze the effects of improvements in access to information through cell phones on farmers' market channel choice.

5.1. Description of the potato marketing chain in the Tiraque region

5.1.1. General characteristics of actors

The analysis is based on 25 semi-structured interviews with stakeholders involved in the potato market chain. These interviews provided insights on the main features of the chain by identifying functions performed at each link, the importance of market information and gender, as well as constraints and opportunities in the chain. The actors identified in the potato marketing chain are: farmers, intermediaries (wholesalers and retailers) and consumers. Key participants and indirect actors that provide inputs and different services to the chain were included in the analysis. The main features of these actors are presented below.

✓ *Producers*

The primary activity of all farmers interviewed is agriculture. Most have been producing potatoes for more than 20 years. Potato sales are the main source of income and savings; about 80% of the farmers' livelihood depends on this crop. Certain varieties of potatoes are for own consumption while other are destined for the market. The variety that is most frequently sold is the Waycha. In general, farmers do not produce according to specific quality standards such as use of specific pesticides, harvesting, selection and packing specifications. Nevertheless, they try to satisfy consumer and wholesaler requirements (e.g. cleaning and selecting potato by size).

Potatoes can be harvested at least twice a year in Tiraque and it is one of the most expensive crops to produce. Total production cost is on average $1,500/ha, 38% of which goes to

labor, 24% to seed, 16% to agricultural inputs (fertilizer and pesticides), 14% to rent animals to plow the fields, 4% to agricultural machinery and 4% to others. (Zeballos *et, al.* 2009: 109). To cover these costs, all farmers secure loans; however because the banking system has high interest rates and demanding requirements, only 30% of farmers turn to it. This shows the Bolivian reality, where access to the banking system is limited not only to rural farmers but to most Bolivians with limited resources. Most farmers are forced to secure loans with farmer's organizations, small businesses, institutions that work in the area and even wholesalers (zero interest rate).

In general, labor requirements are met by family and community resources. All of the families interviewed use Ayni[19], a Quechua word meaning "reciprocal work" based on cooperation and solidarity. However, when family labor and Ayni are insufficient, especially during sowing and harvesting seasons (real demand periods), farmers hire outside labor, which can become quite expensive (i.e. increasing from 15 to 50 Bs/day).

Because more than 50% of the farmers do not own potato storage facilities, they sell their crops immediately after harvest. Around 80% of them do not own mechanized forms of transportation; but trucks can easily be rented by both men and women. However, because most roads are in various states of despair and poorly maintained, time to markets can vary greatly, depending where the community is located. The number of market transactions needed to sell the entire harvest depends on the quantity produced, and market demand. Clients are mostly wholesalers and retailers in rural and urban markets. On average a farmer conducts transactions with 10 to 17 wholesalers (80% are women) per year.

During our interviews, male and female farmers continually stated that intermediaries are trying to take advantage of them, mostly of men since they are not well-engaged in the negotiation process as women are. Farmers portray intermediaries as the "*bad guys*". According to farmers, from this relationship wholesalers end up most of the time in a better position than them, because, as farmers said "*wholesalers, do not work as hard as we do, they just buy potatoes at lower prices and sell them at higher prices, and just like that they have a good profit*". Also, farmers stated that even though there is a lot of negotiation going on and they do their best to get the highest price possible, wholesalers are able to pressure them to lower it.

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[19] Ayni is a concept found in many Andean societies. This concept encompasses the idea of helping other members of the society in hard times, knowing that this help will be paid back in the same amount when needed. It constitutes a livelihood maintaining strategy and cultural union between indigenous families

Moreover, there are some farmers that receive different services (e.g. loans, inputs, information) from intermediaries with the condition to accept any price they offered to them.

Overall, there is a difference in perceptions between farmers and intermediaries regarding the negotiation process, since both feel that the other is always trying taking advantage of them. Thus, these two actors look for long-term relationships to reduce this distrust, going from a commercial relation to a friendship one, thus the ties become harder to break.

✓ *Intermediaries*

Wholesalers and retailers are intermediaries whose main source of income is potato marketing, although they often sell other crops such as vegetables and fruit. Generally intermediaries are responsible for most of the dynamics in the potato chain. According to the intermediaries, they help farmers be more efficient in marketing by assuming and pooling risk in the chain. Wholesalers provide farmers with different services, such as, transport, loans, organizing sales, sorting for and attesting to quality, and storing goods and inputs. However these transactions come with conditions. For example, farmers who receive any support from wholesalers are obligated to accept the price they establish and are not allowed to sell directly to consumers at urban markets. Even though wholesalers provide farmers with some market information, sometimes this is not very accurate because, for instance, these actors stated that occasionally when farmers call them (or vice versa) they lie to them about the prices; convincing farmers to go to the markets where wholesalers keep shop.

Wholesalers have extensive knowledge of markets, experience in the potato business, access to market information, strong social networks across markets and economic power. The potato business generates great income to wholesalers, who have the power to prevent the entry of new wholesalers in this business. Some of the farmers and indirect actors interviewed believe that they are like the "*mafia*". For instance, there are some rural markets that are controlled by a few families, who prohibit other purchasers from entering, this is the case, for instance, of the market of Quillacollo[20]. In the case of the markets that concern to our study (i.e. Tiraque, Punata, Cochabamba and Santa Cruz), most wholesalers who work there do not have family ties between them, but they are able to prevent the entry of new intermediaries and sometimes, according to

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[20] Like Tiraque, Quillacollo is a province of Cochabamba

farmers, they get together before the market opens and agree on a range of prices for that day, which is denied by wholesalers (we could not prove this).

Wholesalers can be classified into two types: 1) those that collect potatoes from rural markets; and 2) wholesalers who keep shops in urban markets and wait for farmers to come to the market. Both sell potatoes to retailers and consumers. Wholesalers buy large quantities of potatoes; for instance in the Tiraque market, a large wholesaler may spend between US$ 5000 and 7000 on potatoes in a single day, purchasing as much as, 40,000-50,000 kg. The wholesalers who purchase such large quantities have as many as 100 suppliers (the majority of whom are women) and sell to as many as 45 retailers. The other type of intermediary is the retailer who collects potatoes in the same manner as a wholesaler but in smaller quantities. Retailers deal with smaller quantities mainly because they do not have trucks and are unable to handle greater quantities. Retailers buy directly from wholesalers and sometimes from farmers. The retailers interviewed attend two rural markets and buy most of the time the same quantities from each one; usually between 600 up to 2000 Kg/day. In some cases, when farmers have small quantities that wholesalers do not want to buy, farmers themselves will become retailers in rural markets.

From the intermediaries' point of view, they do not take advantage of farmers; on the contrary, they state that it is the other way around. This distrust happens because potato is sold in sacks of 100 Kg; and according to the intermediaries, occasionally sellers are able to hide potato in bad conditions in the middle and add dirt to the make the product heavier. Normally this happens when the type of relationship between these actors is opportunistic and has a casual basis, and farmers sell to the highest bidder. Also, intermediaries face many risks when issue with loans to farmers; because there is a risk of borrower default, since there is no contract between them. Therefore, in order to reduce this mistrust problem, intermediaries try to have long-lasting bond with some farmers. Many of the famers interviewed have being doing business with the same intermediaries for more than 15 years and they consider that their relationship goes beyond a commercial one, since both consider each other friends and business partners. The difference between these two types of relationships is related to mutual trust.

The qualitative analysis shows that thanks to accessible transportation, access to cell phones and opening of new financial institutions, farmers have a stronger position during the negotiation process than before. Many wholesalers state that now is harder to convince farmers to accept the price they offer, becoming the negotiation process more difficult. On the other

hand, at certain degree farmers also try to take advantage of the intermediaries, when they provide them with products of low quality. However, wholesalers have more economic power than famers, thus we considered that at the end they are more likely to take advantage of farmers.

✓ *Consumers*

Consumers generally attend urban markets and buy from retailers and wholesalers. The relationship between intermediaries and consumers is a casual one. Because farmers rarely sell directly to consumers, no consumers were interviewed in this study.

✓ *Indirect actors*

Most institutions in this area focus their work on helping farmers with production issues by providing inputs, training and infrastructure. This is the case of the Tiraque Municipality and PROINPA[21]. Few institutions provide services for marketing activities, and those that do, are mostly related to management of the Tiraque market (Municipality) and development of marketing studies for different products (PDA[22]). However, there is a Market Information System of Agricultural Products (SIMA) created seven years ago by a private foundation (FDTA-Valles[23]). SIMA collects and disseminates information about prices, variety, origin, size and quality from over 500 products from the biggest markets of Bolivia[24]. SIMA utilizes a national radio network to disseminate this information to the whole country. This information is intended to support farmers in their marketing process. In the Tiraque area 80% of the famers own at least one radio and thus have access to this show, which is widely listened to by them. Also, there is one institution that provide technical assistance to farmers from this area, called INCCA[25] (Farmers Technical Training Institute).

The perception that farmers have regarding these actors is that they have neglected to provide them with marketing support. Even thought, technical assistance in production activities is important, farmers need to be able to improve their access to markets, for which they need the support from these institutions.

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[21] Foundation for Promotion and Research of Andean Products
[22] Development Area Program
[23] Foundation for the Development of Agricultural Technology of the Valleys
[24] Cochabamba, La Paz, Santa Cruz, Sucre and Tarija
[25] Instituto de Capacitación Campesina

5.1.2. Marketing process

5.1.2.1. Markets

Potato marketing takes place through two different channels. The first channel begins with purchases made at the farm gate, where the producer waits for the wholesalers to collect the product. This situation allows wholesalers to impose the price they want without space for negotiation. However, in the last 10 years because transportation has become more accessible for farmers, this practice is slowly being abandoned. At the time of the interviews only one farmer was using this method. He stated that there was not a great difference between the prices he receives and the prices at the markets. The rest of the farmers use the second channel, which is comprised of own deliveries to the rural markets of Tiraque and Punata and the urban markets of Cochabamba and Santa Cruz. Producers take their potatoes to markets and sell directly to wholesalers and/or retailers.

Figure 5.1. Potato market chain in the Tiraque Region
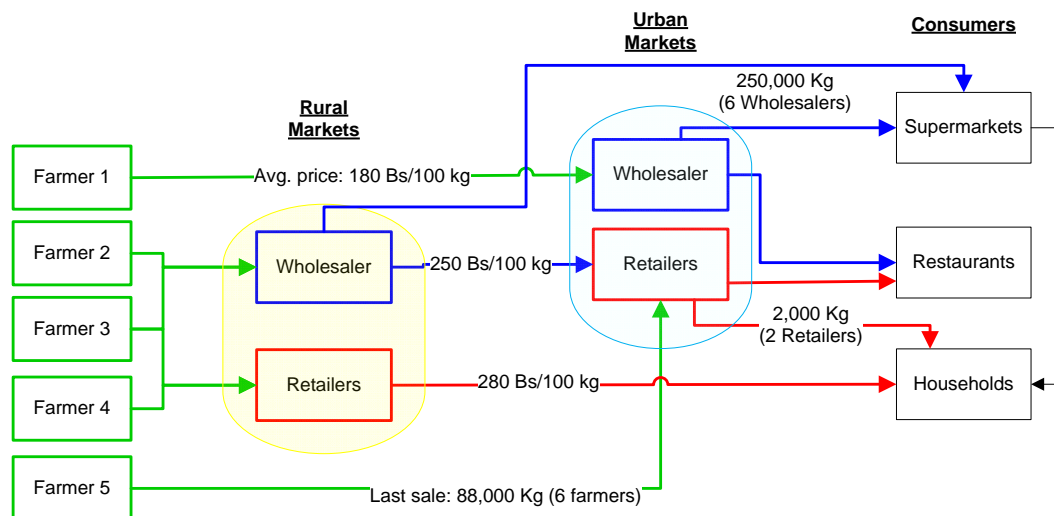
All the farmers interviewed have been going to the rural markets, especially Tiraque, consistently for more than 20 years, but thanks to recent improvement in transportation they also started going to urban markets. Many sell their products at more than one market and they are distributed as follows: 100% go to Tiraque, 50% to Santa Cruz, 60% to Punata, and 30% to Cochabamba. Factors affecting choice of market are: quantity produced, distance, transportation costs, prices, quality requirements, access to information, cost to participate in the markets (i.e. payment that farmers and intermediaries make to the Municipality for the use of the space in the

markets) and management of the markets. Also, gender of who goes to the market has become a marketing strategy for farmers to get the highest price possible. For instance, most of the time female farmers go to rural markets where their negotiation skills are needed and male farmers prefer to go to urban markets, specially to Santa Cruz, where they state that there is not many room for bargaining since the intermediaries are so well organized that they are able to agree and determine a range of prices for the day.

Some interesting features about these markets are for instance that the Tiraque market is one of the biggest potato markets in rural Cochabamba. It is estimated that more than 2000 producers from more than 110 communities attend this market the day that this market is opened (i.e. Friday). An important feature of the Santa Cruz market is that it is the only market where the municipality obligates both buyers and sellers to weigh potatoes. This provision allows for exact pricing but reduces room for negotiation. Weighing does not take place in other markets, where weight is estimated according to the size of the bag, usually losing farmers some money[26]. This is one reason, according to the interviewees, that the number of farmers from Tiraque who go to Santa Cruz has grown in the last five years. Also in this market, there is no difference if the seller is male or female since it will not have an affect on the final price, thus mostly men go to this market. General features of these markets are presented in Table 5.1.

Table 5.1. Characteristics of the markets farmers attend

Characteristics	Rural Market		Urban markets	
	Tiraque	Punata	Cochabamba	Santa Cruz
Schedule	Thu - Fri	Mon – Tue	Mon – Sat	Every day
Highest price	300 Bs/100 kg (June-Aug)		400 Bs/100 kg (July-Oct)	
Lowest price	60 Bs/100 kg (April-May)		100 Bs/100 kg (April-May)	
Average time	30 min – 1 hr	1 – 2 hrs	2-3 hrs	10-12 hrs
Transportation cost	2.5-4 Bs/100 kg	4-8 Bs/100 kg	8-10 Bs/100 kg	10-20 Bs/100 kg
Cost in the Market*	2 Bs/100 kg	3 Bs/100 kg	0	2 Bs/100 kg

It is a fee paid by farmers to be allowed to sell in the markets. Depending on the market sometimes it includes the right to weight the production, if farmers want.

5.1.2.2. Negotiation process

Every farmer and wholesaler has his or her clients to whom they always sell/buy potatoes. However, because they are not contracted to do so, they rely heavily on mutual trust. Most actors have been working together for more than 15 years. All negotiations are conducted

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[26] This procedure was explained by the farmers interviewed and also observed in the markets.

in Quechua and all payments are in cash. Independently of the type of relationship between farmers and intermediaries, on average in rural markets negotiation time can vary from 30 minutes to two hours, and less than half hour in the urban markets. However, in cases that intermediaries provided farmers with some services and thus conditions about the prices, there is no negotiation. The qualitative analysis shows that before farmers go to the market, they determine an initial price based on their production costs, market information, transportation costs and distance to the markets. This base price helps them negotiate with the wholesalers. Wholesalers determine their base price according to the season, market, price of the first sale in the market, retailers' sale prices in urban markets and the return they expect. Finally, the main factors that affect the negotiation process are the origin of the potato (e.g. potato from lowlands are considered good for consumption and from highlands for seed; Tiraque potato is highly demanded), quality (i.e. size, variety, appearance, pest free and no damage), age and gender. According to all the interviewees, wholesalers (most of whom are women) take advantage of the old, the young and of men.

5.1.3. Decision-making process related to market access

In this section the principal results obtained through case studies are presented. These results show the existence of a common pattern of strategic household behavior related to market access, according to gender relations, and access to technology characteristics. Appendix D summarizes main empirical results from the six cases obtained by using the pattern-matching analysis technique (Yin, 1989, 1998).

5.1.3.1. Household characteristics

On average each household has five members, all of whom speak Quechua. Most of the time men speak Spanish as well, but in some households children (boys and girls) are learning this language too. None of the interviewees finished high school; they started working at early ages in order to support their families. Clearly, low levels of education are related to principal activities (agriculture). All farmers interviewed, women and men, are literate. The main services and infrastructure farmers have access to are: roads (in various states of disrepair), public transportation (farmers can ret trucks or use taxi services at any time), water for irrigation (normally insufficient), basic services (water and electricity), and access to loans (for agricultural

inputs). Additionally, they all are part of local communities' organizations called "Syndicates" which are the main social and political institution in each community; and also they form part of the local irrigation associations. Finally, farmers also participate in activities developed by different institutions present in the area, such as PROINPA, PDA and INCCA.

5.1.3.2. Production

Main source of income is agriculture, even though it is risk prone and occasionally leaves them unable to recuperate their investments. The main crops are: potato, faba beans, cereals (oat, wheat, corn and barley) and vegetables (onions and carrots). Potato is the most expensive crop to produce, but it is the most important as well; it is the main source of food, income and savings. Other crops are mostly produced for consumption and occasionally to sell in local markets. All the interviewees have secondary activities in order to increase their incomes such as production (i.e. agricultural labor mostly for sowing and harvesting seasons) and construction work, transportation, plumbing and mattresses manufacture; all of these are mostly developed by men. Secondary activities that women assume include midwifery, production and construction jobs (for which they are paid less than men). Children mostly work at their farms helping their parents in production and construction activities. Finally, other incomes that farmers receive come from remittances from relatives that live in other countries.

All farmers produce the potato variety Waycha, mostly for market; they produce other varieties for consumption (e.g. Imilla, Pukanawi, Runa, Ikari and Wayku). Potato is produced at least twice a year depending on water and land availability. Normally the potatoes harvested in raining seasons, from April to June (i.e. no irrigation is needed), are used for food and seed, and the potatoes harvested from December to March in dry season (irrigation is needed) are intended for the market, since yields are quite low in this season. The quantity available for the markets will influence farmers' decision of where to sell and also sometimes who goes to the markets.

The essential problems farmers face are: poor access to water, land and labor (migration effects), poorly maintained roads, deficient market services and infrastructure (which has been improving in the Tiraque market in the past five years), and quality of the potato. Migration has reduced male labor supply for agricultural activities, increasing the cost of labor for the few who stayed and increasing women participation in activities that were previously exclusively for men. Also, some other effects from migration are remittances that help increase farmers income and it

also motivate the use of cell phones as an important communication tool to be in touch with their families. Finally, the main risks in their activities are from weather (frost, drought, hail, rain) and pests.

5.1.3.3. Marketing process

All negotiation in the four main markets is in Quechua, even in Santa Cruz where this language is not normally used in the city but it is in the markets, since most wholesalers and farmers come from the Andean Region. Five out of six farmers interviewed go to more than one market, usually during the harvesting season (from December to April). The interviewees always go to the Tiraque market, while 50% also go to Punata and Santa Cruz, and 30% to Cochabamba (see Appendix E, table 1).

Farmers band together with other producers to hire trucks to transport their production. Half the farmers interviewed sell their production to the same wholesalers every time. Farmers consider wholesalers to be their friends so this relationship is based on trust; no contract is needed and all payments are in cash. On average each farmer has six wholesalers all of whom are women. Farmers who do not have fixed wholesalers sell to the highest bidder. In 2007, the months of highest prices were between June and October (300 Bs/100 Kg); and the lowest in May (100 Bs/100 Kg); generating on average a total income of 3500 Bs per family interviewed that year. The cost to reach the markets for these families was approximately 500 Bs, of which 80% is transportation cost.

Even though there is free-flowing information in the markets the negotiation with intermediaries, especially wholesalers, is not easy; however most of the time, according to the farmers, both agree on the final price. Nevertheless farmers always feel that wholesalers have more power to influence the negotiation and get what they want. Thus, before farmers go to the market, they determine an initial price for their products, which will help them during the negotiation. This price is based on production costs, information on prices received from SIMA, and cell phone calls to friends, relatives and wholesalers. Once in the markets farmers, mostly women, walk around to determine the prices charged by other producers and intermediaries. The negotiation process can go on from 30 minutes to 2 hours and it can get heated, which is one reason male farmers say they avoid it and that their wives are better at it. When farmers and intermediaries have a strong relationship, meaning more than 5 years doing business, is quite rare for them not to come to an agreement, even after a heated negotiation.

5.1.4. Analysis of gender roles and access to information

5.1.4.1. Gender roles and decision making

Division of labor and responsibilities within households including production and marketing activities is intrinsic to gender in Andean societies. The management of the household is women's responsibility, but men are still considered to be household heads. Decisions about loans, savings, participation in community organizations and purchase/sale of goods, are made by both spouses; nevertheless, all the negotiations are made by women. The whole family participates in production activities, but the degree of involvement and responsibilities depends on gender and age. Because men have more knowledge and experience in production, they bear most of the work load and decision making, but they always count on the support and opinion of their wives. Women help their husbands mostly during sowing and harvesting seasons. Recently, as an effect of outmigration, women are increasingly engaged in production activities that had been exclusive to men. An important point to note is that women receive at least 30% less payment than men for agricultural labor when hired, because according to male famers women are smaller and less able to do heavy physical work than men.

Marketing decisions are made by men and women together; however, men are the ones who search for market information. The main source of this information is constituted by their regular networks (i.e. friends, family, neighbors and intermediaries), visits to markets and a Market Information System broadcasted by radio networks. Recently, cell phones have become an important and efficient gathering tool that most men use to collect information from their regular networks. Men assume an important role as information facilitator, a kind of "*middleman*", since they gather market-related information that they then share with their wives and before jointly deciding the best market. On the other hand, women are in charge of the physical marketing activities, all the negotiations, sales and subsequent management of the money. At first, it seams contradictory that even though women have a better overall sense of what is going on in the markets they are not in charge of gathering market information but men. However, male farmers state that they assume this role because they are the head of the household and providers of their families; thus they are in charge of the management of the assets the family own, such as land, motorized transport, radio and cell phones.

According to 80% of the men interviewed, they "allow" their wives to conduct these activities because women have better negotiation and bargaining skills, women are not consistent when quoting prices, and because most wholesalers (80%) are women and men consider it undignified to argue with women. Male farmers stated that "*between women there is better understanding and our wives can argue better with them than us*", they also added that "*it is not manly to start an argument with a woman*". Finally 30% percent of the men stated that they are verbally abused by female wholesalers during negotiations. Men transport and care for the potatoes in the market. Women manage the profits from the sales because they spend it more efficiently than men, who are thought to squander it on alcohol or just lose it (100% of the interviewed men admit this). Regarding the administration of the money, male farmers, stated that "*this is the way that always has been, because our wives are good at it. We, men, always spend it on alcohol, women do not*". Nevertheless, we think that the alcohol issue is just a men's justification, because many farmers from the watershed are part of evangelistic churches that have a strong presence in this area, which implies most of the time that members of churches do not drink.

The same situation that is observed with farmer women regarding the marketing process can be observed in the next link of the chain, where over 80% of wholesalers and retailers are women. Intermediaries stated that they mostly deal with women producers, but they prefer to negotiate with men. According to the intermediaries interviewed (all of them women), they make all the decisions and manage their money, without asking their husbands, whose role is to help them with potato transportation. These women state that they do not depend on their husband's help, since they can afford to hire outside help if needed.

According to all the interviewees, markets are controlled by women. These markets are organized by product, which is directly related to gender. For instance in Tiraque more than 60% of the potato section of the market is under the control of women, 70% in the case of faba bean, 80% for cereals and 100% for vegetables, fruits, food and barter. However, in the market of Santa Cruz, gender does not have great influence on the negotiation process, since prices are already fixed by wholesalers in this market, who are well organized and can come to an agreement on prices; thus women are less likely to go the market of Santa Cruz.

Regarding farmers' local organizations in the study area, all are under the control of men but women's participation has been increasing. Additionally most men participate in activities

supported by institutions that work in the area (e.g. PDA, PROINPA and INCCA). There are also women's organizations, sponsored and promoted by only one institution that works in the area: PDA. Their activities are mostly related to training women in issues related to child nutrition (food security and health) and education (technical assistance on vegetable production and care of small animals); 70% of the interviewed families participate in this program.

5.1.4.2. Access to information

Farmers from the Tiraque area have different degrees of access to information about prices and markets. This information affects marketing choices (i.e. where, when, to whom and at what price to sell) and quantity to be sold. The principal means of gathering market information is through cell phones and radio. The success of cell phones as a market data gathering tool relies on the strength of farmers' social networks which include relatives, friends and wholesalers who are regular market participants. Larger social networks imply larger and more trustworthy sources of information, allowing farmers to take decisions based on it. Thus, based on the qualitative analysis we were able to build farmers' social networks (Figure 5.2), which include different types of relations within the network. Dimensions include business, community, cell phones (flow of information) and services received from institutions. Business and community networks overlap with information networks connected by cell phone. The cell-phone connection creates stronger links between already-existing nodes (e.g. family, friends and neighbors), and creates new connections (e.g. intermediaries, indirect actors and truck drivers) as well. This technology allows farmers to expand their links to new nodes in farther markets, opening more marketing opportunities. For instance, one of the farmers interviewed state that he conducts all his transactions over the phone, i.e. he gathers market information from his social networks, then agrees on the price and quantity with the wholesalers in more than one market at the same time (which he could not do before), and he also hires truck drivers; doing everything without moving from his farm.

Figure 5.2. Farmers social networks in the Tiraque watershed
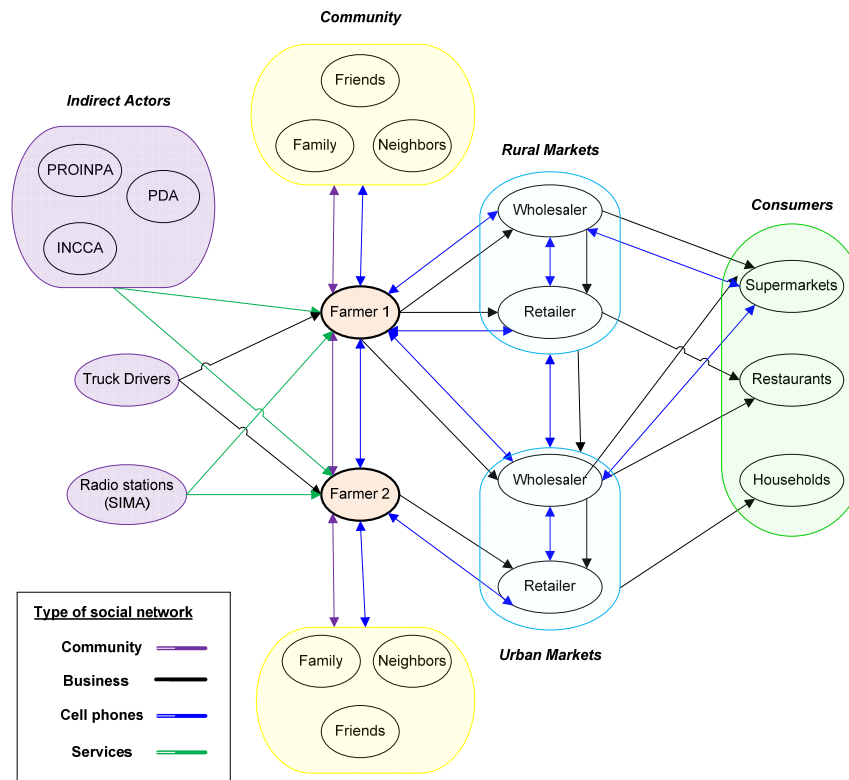
In addition to cell phones, farmers have access to a SIMA-information through the radio. SIMA provides farmers with information about prices, quantities and products offered in different markets across the country. This show is broadcast twice a day in Quechua, from Monday to Friday, at hours when the whole family is together (7am and 7pm). According to farmers, the information is not completely accurate because the prices offered are final consumers' prices and from markets they do not attend. Therefore, they use it as a guideline to establish a base price. As an example, they assume that the difference between those prices and the price they might receive would be at least of 2 Bs/100 Kg lower. Because farmers have access to more information than ever before, they have more negotiating power.

5.1.4.3. Cell phone uses and benefits

All farmers stated that their marketing process and thus their lives have improved since the appearance of cell phones. The main reason that motivated most farmers to buy a cell phone was the need to communicate with emigrating relatives, a phenomenon that has been increasing over time[27]. Once these farmers had this tool, they realized its potential to save time and money

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[27] At the end of 2004 more than 1.4 million Bolivians migrated (Ferrufino et, al. 2007:15). But the government estimates that in 2006 there were between 2.3 to 3.3 millions of Bolivians out of the country.

in potato marketing. Before farmers were using cell phones, most of them already had established business networks but generally in only one market, especially in rural areas which are closer to their communities. Thanks to cell phones, farmers are able to expand their business networks to farther markets and thus expand their information sources and marketing opportunities. Occasionally, farmers will negotiate with wholesalers over the phone. Furthermore farmers use it to call truck drivers to arrange transportation.

Before farmers had access to cell phones, they used to choose markets without good price information. In some cases, they used to go to the markets themselves to gather price data before transporting their products. They also walked to main roads and asked passing truck drivers about market prices. Another option was to wait for their friends to return from the market, or visit the closest town to use a phone; all these methods implied transaction costs. The use of radio and cell phones has made the task of gathering market price data much cheaper and faster. Having this information before heading to the market allows farmers to make a cost/benefit analysis for each channel option and decide which is most beneficial.

The cost of a cell phone is affordable for farmers. On average each family spends 40 Bs/month on phone calls, but this cost may increase up to 300 Bs/month during harvest seasons. All the intermediaries and 80% of the farmers interviewed own at least one cell phone. Those, who do not own cell phones usually, have access to one by borrowing it from friends. The main reason why these families do not have a cell phone is because in the area where they live the signal is too weak to be useful. This area is located outside of the Tiraque watershed and too far from the only cell phone tower that provides services in this area. Even though the signal is a problem for these farmers, they access cell phones and thus signal by borrowing cell phones from neighbors and climbing a hill or walking to the closest paved road until they have signal or find a taxi or truck driver to rent one (1 Bs/call).

5.1.5. Summary of the qualitative work

The qualitative analysis paid special attention to the effects of gender relations and access to information. This analysis provides a general description of the potato chain in the Tiraque region, where intermediaries play a very important role since they assume and pool risk in the chain; helping farmers to be more efficient in their marketing activities. Intermediaries and farmers try to have long-lasting bond with each other based on trust, thus both can maximize

their income. It was observed, that the main factors that affect the negotiation process are the origin of the potato, quality, age, information and gender. Wholesalers (most of them are women) take advantage of the old, the young and of men. Overall, markets are controlled mostly by women. Generally, all the decisions in the household are taken by both spouses, but men have a leading role in production and women in marketing activities. Nevertheless, men play an important role as information facilitator since they are in charge of gathering market information, being cell phones and radios the principal means to do it. The success of cell phones as a market data gathering tool relies on the strength of farmers' social networks. Cell phones help farmers to reduce search costs and make their marketing activities more efficient. This information affects marketing choices and quantity to be sold. Furthermore gender has become a marketing strategy that farmers use when choosing markets. Between the factors that affect market choice are: quantity produced, distance, transportation and access to information.

5.2. Effects of improvements in access to information on farmer's market channel choice

This section examines factors influencing farmer potato market selection. We used two models: a Multinomial Logistic Model (MNL) model to explain why households choose certain markets (among 5 options) and a Logit model to explain the number of markets farmers choose. These models help determine the effect of independent variables on decision-making about markets farmers choose to sell their product. The Logit model examines the choice of single versus multiple markets. In the MNL model, the options were choosing between going to more than one market or one of the following four: Tiraque, Punata, Cochabamba and Santa Cruz. The variables included in each model are presented in table 5.2. All the independent variables were used in their linear form, but age was included in a quadratic form. We use travel time to each market as a measure of cost of transportation for each household. These distances were calculated using Geographic Information System (GIS) software called ArcGIS. This measurement was possible thanks to the efforts of the SANREM project team that was careful in taking GPS[28] location of every household which participated in the base line survey.

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[28] The Global Positioning System (GPS) is a U.S.-owned utility that provides with positioning, navigation, and timing services. GPS uses satellite technology to enable a terrestrial terminal to determine its position on the Earth in latitude and longitude. It has become widely used aid to navigation worldwide, and a useful tool for map-making, land surveying, commerce, etc (http://www.gps.gov/systems/gps/index.html, 2009)

Table 5.2. Variables description in choice models

No	Variables	Description	Unit	Logit	MNL
		Dependent variables			
1	marketmnl	Farmer market channel choice (MNL model)	1 = Tiraque 2 = Punata 3 = Cochabamba 4 = Santa Cruz 5 = more than one market		X
2	marketslogit	True if farmer visits one market (Logit Model)	1 = farmer j chooses 1 market 0 = farmer j chooses more than one market	X	
		Independent variables			
3	qproduced	Total quantity produced last year	Kg	X	X
4	location	Location of the household with respect to the watershed	1 = household is located inside the watershed; 0 = household is outside the watershed	X	X
5	age	Age of the head of the household	Years	X	X
6	age2	Age square	Years	X	X
7	literacy	Literacy of the head of the household	1 = head of the household is literate	X	
8	gender	Gender roles: Gender of the head of the household	1 = head of household is female	X	
9	hsize15	Number of members per family older than 15	Number of members	X	X
10	loan	Access to financial capital: Credit receipt for production	1 = household received a loan	X	X
11	cellphone	Access to information through the use of cell phone	1 = household owns a cell phone	X	X
12	transport	Means of transportation: ownership of a motorized transport	1 = household owns a truck or taxi	X	
13	nplots	Number of plots own by farmers as proxy of wealth	Number of plots	X	X
14	irrigation	Access to irrigation water	1= household has irrigation	X	X
15	htiraque	Distance to Tiraque market	Hours		X
16	hpunata	Distance to Punata market	Hours		X
17	hcbba	Distance to Cochabamba market	Hours		X
18	hccz	Distance to Santa Cruz market	Hours		X
19	hpavedroad	Distance from the farm to the nearest paved road	Hours	X	X
		Interaction terms			
20	celllocation	Farmers' location* Access to information trough the use of cell phone		X	
21	cellgender	Access to information trough the use of cell phone * Gender of the head of the household		X	
22	agecell	Age of the head of the household* Access to information trough the use of cell phone			X
23	loanqprod	Access to loan for production*Quantity produced		X	
24	irrigationprod	Access to irrigation*Quantity produced			X
25	nplotsgender	Number of plots* Gender of the head of the household		X	
26	hpavedroadnplots	Distance from the farm to the nearest paved road*number of plots			X

In order to make valid statistical inferences we first verify that the models satisfy the underlying assumptions of logistic regression. We conduct several specification tests[29]. To assure that the error terms are independent and identically distributed, robust standard errors are reported. Some of the coefficients generated by the models were not as anticipated and in these cases we used the qualitative information to try to explain the reasons for the perceived problem. Finally, since the interpretation of the estimated coefficients in both models is not straightforward[30], odds-ratios as well as marginal effects are presented.

5.2.1. Single or multiples markets

The Logit Model is used to determine the effect of eleven independent variables on farmer decision-making about the number of markets chosen to sell potatoes. The independent variables used include household demographic, production and marketing characteristics. The household variables were age, gender and literacy of the household head, and household size. Household size is important because household members are the main source of labor for agricultural production and also because it affects the quantity available for sale since farmers save part of the production for consumption and seed first. Production variables include quantity produced, such as number of plots owned (on average a family owns 5 plots), access to irrigation water and access to loans. Marketing related characteristics were access to transportation, time to reach the nearest paved road, cell phone ownership and location with respect to the watershed that affects cell phone signal coverage. Finally, four interaction terms were included to model the relationship between cell phone and location, access to loan and quantity produced and finally how gender affects access to land and cell phones. Maximum-likelihood results of the Logit model estimation are presented in Table 5.3.

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[29] This means that they are the right link functions to use, have the relevant predictors and that the independent variables are measured without error. The MNL show a log likelihood chi-square (Prob>chi2 = 0) and pseudo R-square of 30%. The Logit model presents a likelihood ratio chi-square of 25.29 with a p-value of 0.027. Furthermore we used specification link test ("linktest") that show that Logit is the right link function to use. None of the models presented perfect collinearity problem, for which we performed Hosmer Lemeshow chi-square goodness-of-fit.

[30] The interpretation in this model is more difficult than in ordinary linear regression because the relationship between the predicted probability and the independent variables is nonlinear.

Table 5.3. Logistic results for market channel choice

Dependent Variable	True if farmer visits one market 1 = farmer j chooses 1 market 0 = farmer j chooses more than one market	
Independent Variable	**Estimated coefficients (log-odd units)**	**Odds-ratio******
qproduced	-0.0001	0.99995
	(0.00*)	(0.00)
Nplots	-0.172	0.84197
	(0.07**)	(0.06)
Irrigation	0.156	1.16882
	(0.32)	(0.37)
Location	0.1478	1.1593
	(0.43)	(0.50)
Gender	-0.5582	0.57223
	(0.93)	(0.53)
Literacy	0.0989	1.10391
	(0.49)	(0.54)
hsize15	-0.139	0.87025
	(0.09)	(0.08)
Loan	-0.9274	0.3956
	(0.47**)	(0.18)
loanqprod	0.0001	1.00007
	(0.00*)	(0.00)
cellphone	-0.5491	0.57747
	(0.70)	(0.40)
Transport	0.5459	1.72624
	(0.46)	(0.80)
nplotsgender	0.1721	1.18774
	(0.17)	(0.20)
Agex	0.0013	1.00126
	(0.01)	(0.01)
agex2	-0.0005	0.9995
	(0.00)	(0.00)
hpavedroad	1.3552	3.87769
	(1.8417)	(7.14)
celllocation	0.7957	2.21592
	-0.7717	(1.71)
cellgender	-1.4936	0.22456
	(0.7544**)	(0.17)
_cons	2.2752	
	(0.7834***)	
Log Likelihood	-169.7	N	302
LR Chi Square	29.98	R2_p	0.1

*** Denotes significance at 1% significance level. ** significant at 5%, * significant at 10%.
****The odds ratio can be computed by raising **e** to the power of the logistic coefficient: Odd-ratio = e^{β}

The estimated coefficients are the values for the logistic regression equation, and show the relationship between the independent variables and the dependent variable. These estimates show the amount of increase in the predicted log odds of the dependent variable (marketslogit=1) from a 1 unit increase in one of the independent variable, holding other variables constant. The interpretation of these coefficients is difficult because they are in log-odds units[31]. The estimated coefficients tells us that for every one unit increase in one predictor, for instance the number of plots, the log of the odds of going to one market (vs. going to more than one market) decreases by a factor of 0.17. However it is easier to interpret the results if we can get rid of the **log** and express the coefficients in odds by taking **e** to the power for both sides of the equation, which is e^{β} (Bruin, 2006). Marginal effects[32] are shown in Table 5.4, where we also show the changes in the predicted probabilities when the variables change from their maximum to their minimum.

Table 5.4. Marginal effect after Logit robust on market channel choice

Independent variable	from: x=min	to: x=max	dif: min->max	from: x=0	to: x=1	dif: 0->1	Marginal Effect
qproduced	0.7707	0.2670	-0.5036	0.7734	0.7734	0.0000	0.0000
Nplots	0.8311	0.3070	-0.5242	0.8539	0.8311	-0.0228	-0.0359
irrigation	0.6795	0.7125	0.0330	0.6795	0.7125	0.0330	0.0325
location (d)	0.6795	0.7109	0.0313	0.6795	0.7109	0.0313	0.0308
gender (d)	0.7201	0.5954	-0.1246	0.7201	0.5954	-0.1246	-0.1164
literacy (d)	0.6866	0.7075	0.0209	0.6866	0.7075	0.0209	0.0206
Hsize15	0.7627	0.4792	-0.2835	0.7869	0.7627	-0.0242	-0.0290
loan (d)	0.7383	0.5274	-0.2109	0.7383	0.5274	-0.2109	-0.1933
loanqprod	0.6824	0.9672	0.2848	0.6824	0.6824	0.0000	0.0000
cellphone	0.7583	0.6444	-0.1139	0.7583	0.6444	-0.1139	-0.1145
transport	0.6881	0.7920	0.1039	0.6881	0.7920	0.1039	0.1138
nplotsgender	0.6811	0.9227	0.2416	0.6811	0.7172	0.0362	0.0359
Agex	0.6965	0.7146	0.0181	0.7038	0.7040	0.0003	0.0003
Agex2	0.7260	0.5262	-0.1998	0.7261	0.7260	-0.0001	-0.0001
hpavedroad	0.6890	0.8766	0.1876	0.6890	0.8957	0.2067	0.2825
celllocation	0.6229	0.7854	0.1625	0.6229	0.7854	0.1625	0.1659
cellgender	0.7220	0.3683	-0.3536	0.7220	0.3683	-0.3536	-0.3114

(d) for discrete change of from 0 to 1

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[31] A logit is defined as the log base e (log) of the odds: logit(prob.of success) =log(odds)= log(prob. of success/ prob.of failure). Logistic regression is in reality ordinary regression using the logit as the response variable: logit(prob. of success/ prob. of failure) = β_o + $x\beta$ (Bruin, 2006)
[32] The effect on the dependent variable that results from changing an independent variable by a small amount: $\partial Y_i / \partial X_i$ (Wooldridge. 2008)

In the Logit model the significant variables are access to loan and number of plots per household. The marginal effects tell us that farmers who have access to loans, holding all else constant, are less likely than farmers who do not, to go to a single market, i.e. access to loans decreases their predicted probability by 19 percentage points. Furthermore, the change in the probability of choosing one market is reduced by 0.04 when the number of plots increases by one, all else constant. Clearly these variables will determine the number of markets farmers choose, since more plots implies more production and access to loan implies that farmers will be better able to cover their production costs.

Even though the variables of most interest in the Logit model (access to cell phone and gender) were not statistically significant, their marginal effects are useful to explain farmer choices. If farmers do not have the capacity to satisfy demand in many markets (e.g. enough production), it does not matter if they have information about them or if gender is important in these markets because they would not go to them. The interaction term between these variables is statistically significant at 5% level. This means that together gender and access to cell-phones help determine the number of markets farmers choose. The marginal effect of each of these variables on the predicted probability of selecting a single market is negative (i.e. -0.12 in each case), but when we interact them the effect is larger. For instance, holding all other variables constant at their mean, a woman head of the household who has access to a cell phone has a 0.31 higher probability than a man of going to more than one market .

Even though the other variables in the model were not statistically significant, when we consider their marginal effect they show interesting results. For instance, holding all else constant, as the number of household members increases (larger households provide more labor), the probability of going to only one market decreases marginally . Access to irrigation has an unexpected effect, because farmers who have access to it increase their odds of going to only one market by a factor of 1.86 (Table 5.3.). Thanks to the qualitative analysis, we observed that access to irrigation does not necessarily mean higher production. Farmers explain that they have two types of plots differentiated by access to irrigation. On one hand they have plots that do not have access to their irrigation system because of their location (i.e. they may be located up in the mountains) thus they use this plots only during rain seasons. Conversely, there other type of plots are the ones that have access to irrigation and are used only in no rain seasons, which reduces their yields, because the irrigation system does not water the plots evenly as rain water would do.

Quantity produced, access to loans and number of plots are jointly significant at 1% in the Logit model, affecting then the number of markets farmers go. Although quantity produced independently is not statistically significant, its marginal effect, though small, is interesting. As the quantity produced increases from its minimum to its maximum the probability of going to only one market will be reduced from 77% to 27%. This result is also confirmed by they qualitative analysis, where it was observed that farmers are more likely to travel to more and farther markets as the quantity produced increases. Finally, none of the variables related to access to markets, i.e. motorized transportation ownership and time to reach the nearest paved road, were significant in determining the number of markets to be chosen. Nevertheless, they provide interesting insights. For instance, access to motorized transportation, all else constant, increases the probability of going to only one market by 0.10; farmers who have a truck for instance, spend more effort to go to the markets than others; it is highly probable that they go to only one market.

5.2.2. Choice of market

MNL model was used to explain farmers' market choice among 5 options: Tiraque, Punata, Cochabamba and Santa Cruz or more than one market. Like the Logit model, the independent variables included in the MNL cover household, production and marketing characteristics. In the case of household characteristics only two variables were considered, size of the household and age of the household head. The other household variables of interest (gender and literacy), were not significant. The production variables included in the model were quantity produced, number of plots, access to irrigation and loans. Variables used to describe marketing characteristics were time to reach each market, time to the nearest road, cell phone ownership and location with respect to the watershed. The time each farmer needs to go to each of the four markets is used as a measure of transportation cost. Additionally, it is important to consider the time needed to reach the nearest paved road, because these costs can affect market selection.

Finally, three interaction terms were used: 1) age with cell phones, because older people are more reluctant to invest in new technology; 2) irrigation and quantity produced; and 3) number of plots and time to reach the nearest paved road, which will influence access to transportation and time to market. Our response variable is categorical and it includes 5 options

with no natural ordering. Because there are multiple categories, we choose the Tiraque market as a base category which is used as the comparison group. Tiraque was chosen because it is the market where most farmers go (69%) and choice of base category is arbitrary in MNL estimation. Results are presented in Table 5.5.

Table 5.5. Multinomial logistic estimation results: Estimated coefficients

Dependent variable	Farmer market channel choice: Estimated Coefficients			
Independent variable	Punata	Cochabamba	Santa Cruz	More than one market
Htiraque	-8.68009	-29.35017	-9.143512	-3.887648
	(3.345**)	(11.621**)	(6.209)	(2.719)
Hpunata	3.578796	-2.776492	-2.513625	-0.6994016
	(3.078)	(4.757)	(4.814)	(2.677)
Hcbba	-62.58552	-85.58118	-21.42435	-13.33482
	(25.342**)	(41.152**)	(44.088)	(19.013)
Hscz	-84.09955	-134.8444	-35.67347	-22.38823
	(29.784**)	(51.302***)	(51.376)	(22.102)
Hpavedroad	162.1463	228.067	55.01346	45.07946
	(54.440***)	(91.232**)	(98.489)	(41.569)
Qproduced	0.0000661	0.0001905	0.0002663	0.0001724
	(0.000)	(0.000)	(0.000**)	(0.000**)
Location	3.432986	5.732676	-0.3776717	1.176553
	(0.813***)	(1.221***)	(1.521)	(0.631*)
hsize15	-0.1001837	0.0036845	0.1581835	0.0902826
	(0.137)	(0.185)	(0.301)	(0.100)
Loan	-0.9008992	-0.2462719	0.4009525	0.2846014
	(0.722)	(0.809)	(0.705)	(0.401)
Cellphone	0.3419171	0.7411416	8.768489	0.4094123
	(0.476)	(0.606)	(2.147***)	(0.335)
Nplots	0.080121	0.1455597	0.1875658	0.2037454
	(0.127)	(0.155)	(0.152)	(0.088**)
Irrigation	0.786946	1.781241	1.522076	0.5217476
	(0.651)	(1.182)	(1.408)	(0.526)
Agex	-0.0012682	-0.0155398	-0.4530994	0.0008466
	(0.016)	(0.034)	(0.119***)	(0.014)
agex2	0.0004429	-0.0025893	-0.0027611	0.000368
	(0.001)	(0.002*)	(0.002)	(0.001)
Agexcell	0.0254566	0.0105478	0.3710494	0.0074651
	(0.029)	(0.048)	(0.097***)	(0.020)
irrigationprod	-0.0001695	-0.0002519	-0.0002495	-0.0001438
	(0.000)	(0.000)	(0.000**)	(0.000)
hpavedroadnplots	-2.320874	-4.492446	1.033938	-1.290295
	(1.406*)	(4.187)	(3.588)	(0.765*)
_cons	1181.167	1877.433	485.9093	307.1453
	(427.212)	(730.987)	(737.669)	(317.380)
Pseudo R-Square	0.2003	p = 0	chi2=170.0986	Number of obs= 302

*** Denotes significance at 1% significance level. ** significant at 5%, * significant at 10

Therefore, Table 5.5. presents four replicates of the predictor variables, representing the four models that were estimated: Punata, Cochabamba, Santa Cruz and more than one market, all of them relative to Tiraque. Each parameter represents the impact of a unit change in one independent variable relative to the referent group (i.e Tiraque) and the standard interpretation would be for instance, if a farmer were to increase the time to reach the Tiraque market (i.e. htiraque) by one hour, the multinomial log-odds for preferring the Punata market over the Tiraque market would be expected to decrease by 8.7 units while, holding the other variables constant. Therefore, we can say that, overall the farther farmers live, the more he/she will prefer the Tiraque market over Punata. Clearly the interpretation of the estimated coefficients is not straightforward, thus we use these coefficients in terms of Relative Risk Ratios (RRR) or odds, presented in Table 5.6. These odds are obtained by taking the exponent of the coefficients.

Table 5.6. Multinomial logistic estimation results: Relative Risk Ratios (RRR) or odds

Independent variable	RRR or Odds****			
	Punata	Cochabamba	Santa Cruz	More than one market
Htiraque	0.0002	0.0000	0.0001	0.0205
	(0.00***)	(0.00**)	(0.00)	(0.06)
Hpunata	35.8304	0.0623	0.081	0.4969
	(110.30)	(0.30)	(0.39)	(1.33)
Hcbba	0.0000	0.0000	0	0
	(0.00**)	(0.00**)	(0.00)	(0.00)
Hscz	0.0000	0.0000	0	0
	(0.00***)	(0.00***)	(0.00)	(0.00)
Hpavedroad	2.6e+70	1.1e+99	7.80E+23	3.80E+19
	(1.40E+72***)	(1.00E+101**)	(7.70E+25)	(1.60E+21)
Qproduced	1.0001	1.0002	1.0003	1.0002
	(0.00)	(0.00)	(0.00**)	(0.00*)
Location	30.969	308.7944	0.6855	3.2432
	(25.18)	(377.10***)	(1.04)	(2.05*)
hsize15	0.9047	1.0037	1.1714	1.0945
	(0.12)	(0.19)	(0.35)	(0.11)
Loan	0.4062	0.7817	1.4932	1.3292
	(0.29)	(0.63)	(1.05)	(0.53)
Cellphone	1.4076	2.0983	6.40E+03	1.5059
	(0.67)	(1.27)	(14000***)	(0.50)
Nplots	1.0834	1.1567	1.2063	1.226
	(0.14)	(0.18)	(0.18)	(0.11**)
Irrigation	2.1967	5.9372	4.5817	1.685
	(1.43)	(7.02)	(6.45)	(0.89)
Agex	0.9987	0.9846	0.6357	1.0008
	(0.02)	(0.03)	(0.08***)	(0.01)

agex2	1.0004	0.9974	0.9972	1.0004
	(0.00)	(0.00*)	(0.00)	(0.00)
Agexcell	1.0258	1.0106	1.4493	1.0075
	(0.03)	(0.05)	(0.14***)	(0.02)
Irrigationprod	0.9998	0.9997	0.9998	0.9999
	(0.00)	(0.00)	(0.00**)	(0.00)
Hpavedroadnplots	0.0982	0.0112	2.8121	0.2752
	(0.14**)	(0.05)	(10.09)	(0.21*)
Pseudo R-Square	0.2003	p = 0	Chi2=170.0986	Number of obs= 302

*** Denotes significance at 1% significance level. ** significant at 5%, * significant at 10
****The odds ratio can be computed by raising **e** to the power of the logistic coefficient: Odd-ratio = e^{β}

These odds shows the risk of the outcome falling in one of the four markets presented in the table compared to the Tiraque market. In general if the RRR<1, the market selected is more likely to be the referent group (Bruin, 2006). To further facilitate the interpretation of the results, marginal effects presented in Table 5.7. These results will help us to see the change in the predicted probability when one (or more) independent variables vary.

Table 5.7. Marginal effects of the first MNL model on market channel choice

Dependent variable: Market channel choice					
Variable	Tiraque	Punata	Cochabamba	Santa Cruz	More than one market
htiraque	1.285648	-0.63038	-0.12842	-0.00239	-0.52446
hpunata	-0.04385	0.356759	-0.01369	-0.00093	-0.29829
hcbba	6.089084	-5.17879	-0.35261	-0.00343	-0.55425
hscz	9.103015	-6.77561	-0.56017	-0.00644	-1.76079
hpavedroad	-17.843	13.00537	0.924608	0.007268	3.905792
qproduced	-3.8E-05	-7E-07	6E-07	1E-07	3.77E-05
location	-0.35215	0.169269	0.014291	-0.00045	0.169041
hsize15	-0.01238	-0.0127	-9.8E-05	4.82E-05	0.025131
Loan	-0.02262	-0.07389	-0.00127	0.000143	0.097633
cellphone	0.012419	0.002479	0.02401	0.071456	-0.11036
nplots	-0.04428	-0.00064	0.000283	3.64E-05	0.044604
irrigation	-0.14416	0.047286	0.005578	0.000358	0.090938
agex	2.31E-05	-0.00012	-7.4E-05	-0.00016	0.000339
agexcell	-0.00288	0.002026	2.36E-05	0.000131	0.000701
agex2	-8.8E-05	2.77E-05	-1.3E-05	-1.1E-06	7.46E-05
irrigationprod	3.76E-05	-9.8E-06	-9E-07	-1E-07	-2.7E-05
hpavedroadnplots	0.383754	-0.16058	-0.01791	0.000641	-0.2059

In the MNL model the variables that are statistically significant for all outcomes (market choices) at the 5% level are: access to cell phone, location with respect to the watershed, age of

the head of the household, time to reach the markets of Tiraque and Santa Cruz, time to reach the nearest paved road and the interaction term between age and cell phone. These variables explain farmer's market choices, but have different impact depending on the market of choice. For instance, the older farmers are, the higher the probability of going to closer markets. This is confirmed by the qualitative analysis, where all the farmers interviewed have been going to these rural markets (i.e. Tiraque and Punata) at least for the last 20 years. Other reasons for this preference may be that older farmers produce less[33] and thus they are less willing to make longer trips. When older farmers own cell phones, they are less likely to go to Tiraque and begin to go to more and farther markets. Even though the change produced by age is not very high (see Table 5.7.) clearly cell phones affects marketing decisions.

Overall, farmers who have cell phones are more likely than farmers who do not, to prefer farther and more markets (Table 5.6). The marginal effect of having a cell phone has a positive impact on choice of going to urban markets, i.e. the predicted probability of going to farther markets increases by 2.5% points in the case of Cochabamba, by 7,15% points for Santa Cruz, all else constant (Table 5.7). On the other hand, their probability has a negative effect on participating in rural markets, reducing, for instance, the probability of choosing Tiraque by 1.2% points. Evidently, cell phones change farmer's choices about markets since this tool allows them to have access to information from distant markets. This result is confirmed by the qualitative analysis, which found that cell phones have become important marketing tools for farmers. Before having cell phone access, many farmers preferred staying at closer markets rather than taking the risk to travel to farther markets. Basically they did not know if incurring in higher transportation cost was worth it.

Another significant variable affecting market choice, is the time to reach the nearest paved road from the farm. If this time increases by one hour, all else constant, farmers are less willing to go to Tiraque and their probability of going to other markets increases. Although these marginal changes in Table 5.7 are quite high (e.g. the predicted probability of going to Cochabamba increases by 92% points) the predicted probabilities per se in each case are quite small. The interaction term between time to the nearest paved road and number of plots shows that the farther the plots are from the nearest paved road, the higher the probability of going to

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[33] On average older famers (more than 50) produce at least 26% less than younger farmers i.e. at least 2000 Kg less.

Tiraque. This situation might occur because farmer's houses are closer to the paved roads than their plots where most of the potato is harvest and transported to the markets.

Only the time farmers need to go Tiraque and Santa Cruz are consistently significant. This could be explained by the fact that these markets offer higher prices (SANREM, 2007) and different services than the other markets (based in the qualitative analysis). For instance, the Tiraque market has been growing in the last 5 years through providing better infrastructure and has become one of the biggest in rural Cochabamba. For Santa Cruz all the potato that is sold there has to be weighed and farmers are paid for the exact weight. Overall, if the time of going to either Tiraque or Santa Cruz, increases by one hour farmers will increase the predicted probability of going to Tiraque by 1.3 and 9.1 respectively (Table 5.7). This is understandable since the average time to go to these markets is 0.66 hours for Tiraque and 12 hours for Santa Cruz (Appendix C), thus farmers will prefer Tiraque to the latter. The qualitative analysis found that farmers only go to Santa Cruz when they are sure under most circumstances that the price there is higher than in Tiraque, so the transportation cost and time will be worth it.

The total quantity of potato produced by the household is also important in explaining market choice. This variable is statistically significant at 10% level. Furthermore, when we test the joint significance of this variable and the time to reach the markets they are significant at 1% level for all market choices. The odd-ratios associated with this variable are greater than 1, meaning that as the quantity increases, any market is preferred over Tiraque. For instance if the quantity produced increases from its minimum to its maximum, the predicted probability of going to Tiraque decreases from 73% to 0.27%. Although farmers that produce large quantities (e.g. more than 10,000 Kg) prefer to go to urban markets (i.e. Santa Cruz and Cochabamba) where they know they can sell everything; the change in the predicted probability of choosing them are very small. This may happen because transportation cost and time to reach these markets are quiet high (e.g. at least 12 hours to go to Santa Cruz). On the other hand, if the quantity produced increases by 10,000 kg the marginal effect on the predicted probability of going to farther market will increase in the case of Cochabamba by 0.6% points and Santa Cruz by 0.1% (Table 5.7).

It is important to mention, that the market of Santa Cruz is quite different, because it is located in a tropical region contrary to the other markets which are located in an Andean region. Santa Cruz is the farthest market with respect to the watershed, thus implies larger transportation

cost, however it will provide the highest price. Farmers who go to Santa Cruz have high levels of production, on average they produce more than 10,000 Kg, which is twice as much the quantity the other farmers produce. Farmers who go to Santa Cruz own at least 2 more plots (approximately 3 hectares), than farmers who go to the other markets. Also, these farmers have more than 7 members per family. All the farmers who go to this market are men, contrary to the farmers who go to the other markets, where 15% of them are women. Based on the qualitative analysis this happens, because according to farmers, in this market gender plays no role in the negotiation process and male farmers feel more comfortable dealing with female wholesalers. Additionally, in this market they receive an exact payment for the exact quantity they are selling, which does not happen in the other markets, thus it does not affects the negotiation process. 92% of the farmers who attend the market of Santa Cruz own a cell phone, but do not own a motorized transport. Nevertheless, this is not a constraint to go to the market of Santa Cruz, even though farmers need at least 10 hours more than the other markets to reach it.

5.2.3. Hypothesis testing

We use the regression results to test each of the hypothesis laid out in Chapter 4. According to hypothesis 1, household characteristics, such as farmers' age, size of the household, education, access to loan and location (i.e. cell phone signal) are important determinants of the number and type of potato markets chosen. This hypothesis is partially confirmed, because in the Logit model, only access to loan affects the number of markets farmers choose. However in the MNL model the variables that systematically influence specific market selection are: age, location, access to loan and size of the household. One variable that does not affect these decisions is literacy; this can be explained by the fact that most farmers in this area are semiliterate and there is little variation in observed literacy. Even though gender was not significant in any model, this does not mean that it does not have any influence on farmer's decisions about which potato market to choose; because gender is an important marketing strategy that for farmers use to maximize their benefits. Thus, hypothesis 2 is partially rejected. This might have happened (as explained before) by the type of variable we used to reflect "*gender*" i.e. the gender of the head of the household. Our survey does not have information on who makes marketing decisions, but the qualitative data, however, provided us useful insights into gender relations. Overall the gender of the head of the household does not matter or who has

access to information (in most cases men do); both spouses decide where to sell. However this discussion is made, women are in charge of the negotiations at the markets because they have better negotiation skill and can obtain higher prices than men. We need more data about it to determine the magnitude of these gender effects in the market place.

An important group of variables that influences farmer's market choice are related to on-farm production capacity, such as quantity produced, access to irrigation water and number of plots owned. The quantity produced is not significant in any model; it is jointly significant with time to reach the nearest paved road and time to reach the markets (at 1% level in the MNL model and 5% level in the Logit). This means that we fail to reject hypothesis 3, which states that farmers are more likely to travel to more and farther markets if the quantity produced is large. Farmer's unit transport cost does not increase with the quantity transported, but by the distance to the markets.

Hypothesis 4 states that wealthy farmers have access to better transporting infrastructure; thus the probability for them to go to farther and to more than one market is higher. The variable used as proxy of wealth is the number of plots owned by the family, which is jointly significant with transportation ownership at 1% level in the Logit model. Wealth influences the number of markets farmers choose. Even though only less than 20% of the farmers own a vehicle for potato transport, this is not a constraint to travel to more markets because there are taxis and trucks that are accessible to farmers. None of these wealth-related variables was important in the MNL model, which means that they do not influence the specific market farmers choose. Hypothesis 4 is partially rejected.

From the previous analysis we can see clearly that access to cell phones has an effect on market choice. Cell phones increase access to price information. Thus, farmers with cell phones go to farther markets, where prices are expected to be higher than local markets. When we test this variable in both models, we find that cell phone ownership is significant across outcomes (markets) at a level of 1% only in the MNL, which leads us to partially fail to reject hypothesis 5, because cell phones affect specific market choices, but not the number of markets chosen. This result could be explained by the fact that it does not matter if farmers have information about markets if they do not have enough quantity to sell or enough money to cover the transportation cost to go to more than one market.

Furthermore, when we consider the interaction between farmers characteristics (i.e. age, gender and number of plots) and cell phones, we found a positive significant effect for age and gender in the Logit model. Female and older farmers who have cell phones are more likely to go to more than one market. Additionally, when we test the joint significance of number of plots and cell phones across markets they are significant at 5% level in both models; wealth influences market information access. Based on the previous statements we fail to reject hypothesis 7. Finally, the interaction term of cell phone with location of the farm inside the watershed is not significant in any model, leading us to reject hypothesis 6. Location in the watershed (compared to outside of it) does not affect market choice. Moreover, when we compare the location of farms respect to the watershed and cell phone ownership, the probability of choosing only one market is almost the same for both (approximately 60%). Finally, this result is also supported by the qualitative data analysis, where we found that although location affects cell phones signal coverage, it does not affect the use of cell phones as much as we thought. Farmers have different strategies to solve the problem of access to cell-phone signals, such as climbing a hill until they have signal.

Lastly, access and selection of markets is determined by the time needed to reach the nearest paved road, the time needed to reach each market and the availability of transportation. Since ownership of a motorized transport is not significant in any model, we reject hypothesis 9 which indicates that farmers who have access to transportation are more likely than farmers who do not to sell the product to more and farther markets. Access to transportation in this area is not a problem (i.e. existing transportation is cheap and available to all farmers). Furthermore it can be observed that there is almost no difference in the time farmers need to go to the markets between the ones who own a motorized transport and the ones who do not. Finally, the time farmers need to go to the four markets is significant (at 1% level) in choosing market outlet, thus we fail to reject hypothesis 8, which states that isolated farmers are more likely to sell at rural markets (i.e. closer markets) and only to one, so the decision to sell at farther market is affected by isolation. Furthermore, when the time to go to any of the markets increases from its minimum to its maximum, the probability of going to rural markets is very high (between 20% and 100%).

Chapter 6. Conclusions

The goal of this study is to explore effects that access to information and gender relations within the potato market chain have on farmers' market channel choice in the Tiraque, Bolivia watershed. We use qualitative and quantitative data to achieve this goal. The main source of quantitative data comes from a survey of 400 farm households in 18 communities. These data were used to estimate two econometric models (Logit and MNL) that examine the effects of households, production and market characteristics on market choice. The qualitative analysis helped deepen the understanding of the subject and to complement and corroborate the quantitative analysis. The qualitative tools we used were Rapid Market Appraisal and Case Studies. These tools help us observe the topic under study through farmer's eyes and provide interesting insights and explanations. The importance of this topic and its main findings are presented in the following section, where we place special emphasis on variables of interest; access to cell phone and gender. We also discus the relative value of the research tools used and suggest further areas of research.

The Tiraque watershed could develop its potential as a high quality potato producer in the region by reducing market level constraints. Some of these market constraints were identified and analyzed by the research presented here. To make farmers more competitive in the potato market, access to information still needs to be improved. One method of achieving this goal could be through wider use of cell phones. Cell phone technology has great potential to increase access to information, improve negotiation power, and lead to higher returns. Better information is thus fundamental to reduce transaction costs and price dispersion, as well as to increase incomes, and welfare at the farm level. However, these benefits can only be achieved by improving and facilitating information transmission through the marketing chain. Therefore is important to understand and examine how this new technology is used by farmers, what factors determine cell phone ownership and what the benefits in farmers' marketing activities are.

6.1. Summary of findings

Research provides an analysis of the potato marketing chain and the nature of market constraints in Tiraque. The qualitative analysis confirms the importance of cell phone ownership and gender on market choice. The quantitative analysis found that determinants of market channel choice include market-related variables (quantity produced, number of plots owned, time required to reach markets and distance to the nearest paved road from the farm) and farmer characteristics (access to loans, household size, cell phone ownership, location in the watershed and age). Most of the signs of the coefficients were as expected. The most statistically significant variables were cell phone ownership, the number of plots owned, access to loans, age, location, time required to reach markets and distance to the nearest paved road. Gender and quantity produced were not found to significantly affect marketing decisions in the econometric analysis; however the qualitative analysis showed that gender is an important marketing strategy when choosing markets. The variables with the largest coefficients and marginal effects are access to loan, transport, cell phone, gender, location, time to the markets and to the paved road.

The qualitative analysis showed that farmers who have cell phones have better access to market information, which affects their decision of where to sell and how much. Furthermore, cell phones allow farmers to conduct transactions through the phone and this makes marketing more efficient. Farmers who wish to exploit these opportunities need to have substantial production and time to travel to distant markets. Higher price-markets are farther from the watershed and farmers will go to them only when they believe it is worth the transaction cost. It was observed that even though location does affect cell phone signal coverage; it does not affect the purchase of cell phones. Even farmers living in areas with weak signals buy phones and thus avail of improved market information.

According to the farmers, their main sources of market information are friends and market intermediaries. Intermediaries, in general, are not perceived to be transparent when doing business, creating distrust and high transaction costs that may reduce the transmission of market information. Even though they fill important roles, according to farmers they take advantage of them, mainly through control of information. The ability to do so has been reduced in the last 5 years due to cell phones technology and other information-transmission mechanisms. Yet this new form to exchange information faces some institutional constraints such as ad hoc access to

information, lack of "official" market information and others. The interviews provide interesting insights about the use of cell phones. Even though women conduct most of the potato marketing, they do not gather market information. Instead their husbands use the phones to obtain this information. We did, however, find that marketing decisions are taken together. This finding should help to guide further research on information diffusion, by considering men's important role as information intermediary and the effects that this role has on the quality of information provided by wholesalers who are mostly women.

As expected, based on the econometric models, access to cell phone has an effect on specific markets farmers choose. Farmers with cell phones are more likely to go to urban markets, mostly Santa Cruz. However, cell phones do not affect the number of markets farmers choose; rather the latter depends mostly on production capacity, time available to go to markets, and capacity to cover transportation costs. We confirmed that cell phone use and the advantage of owing a cell phone does not depend on where the farmer lives, even though it affects the quality of the service. Farmers have different strategies to solve this problem such as climbing a hill or walking until they have signal. Note, however, that the geographic coverage of our study is limited and we do not know now if cell phone access would affect market decisions in more remote areas. Based on the survey more than 50% of the farmers in the study area use cell phones in their potato marketing activities. Actors along the potato market chain also rely on cell phones. Furthermore, when we compare the total revenue generated, farmers who have cell phones have at least twice as much revenue from potato sales as farmers who do not have cell phones. Even though effects of using cell phones on market choice seem possible to identify, the interpretation of them should be made with caution, so the relation cause-effect that this technology has on improved market information is clear.

It is important to state that the success of cell phones as a market data gathering tool relies on the strength of farmers' social networks which include relatives, friends and wholesalers. Additionally the cost of a cell phone has fallen dramatically over time and is now affordable for most farmers. During farmer's interviews, they stated that their marketing process and thus their lives have improved due to cell phones. This effect is due to available market information before heading to the market which allows them to make a cost/benefit analysis for each channel. They also have a base price that they can use during the negotiation once they reach the market.

In the qualitative analysis, gender turned out to affect the markets chosen and the price paid to farmers. During our interviews, farmers indicated that even though the whole family participates in production activities, the degree of involvement and responsibilities along the chain varies by gender. Since men have more knowledge and experience in production, they bear most of the workload and decision making. On the other hand, women are in charge of marketing activities and market-related negotiations. Women conduct these activities because they have better negotiation and bargaining skills and because most wholesalers (80%) are women. Even though marketing decisions are made by men and women together, and women are in charge of almost all negotiations in potato markets, they are not the ones who make the cell phone calls to obtain market information. Husbands generally make the sales calls and then they transmit the information to the women. Thus both genders participate in marketing decisions and activities. Men assume this role as part of their roles as head of the households, as "*providers*" to their families. However, the qualitative analysis showed that most of the time the information that wholesalers transmit to farmers is not accurate. The final price farmers can expect is influenced by female farmers' negotiations skills.

6.2. Further research

The tools used for this research were of value, since they complemented each other. This complementarity helps to make the results more understandable and build our confidence in them. A main weakness was that most of the qualitative data was collected through interviews most of which were in Quechua (local language) and then translated to Spanish. This is a possible source of loss of information. Another limitation was our inability to better coordinate the survey with the qualitative work, since the study would have benefited from more careful interactions between the two components. The survey was conducted at the onset of the SANREM project and did not have many questions regarding our variables of interest (i.e. gender and cell phone access). If we had conducted the qualitative market analysis first, then we could have added some questions to the household survey and could have gotten better results. It would be useful to develop another survey covering these areas.

Regarding gender variables to be included in further research, we suggest: number of kinds, migration aspects (who migrated, why, how responsibilities in the household have

changed because migration), is access to transport influenced by gender, who manage the revenues from potato sales and why, importance of wholesalers on farmers activities (services they provide), how farmers perceived their relationship with intermediaries and who has the leading role and why regarding decision making process and roles within the household, production and marketing activities. On the other hand, information regarding access to cell phones should include: who controls and uses this technology, reasons and whose idea was to get one, strategies to solve signal problems, consumption costs, uses and benefits, to whom farmers call to gather market information, who makes the calls and why, importance of cell phones in marketing activities and suggestions for potential uses and services.

One interesting conclusion from this paper is that marketing transactions may not be motivated by profit alone. Most farmers keep selling to the same wholesalers even though they state that "*wholesalers never lose*" and dictate the price. Even though, farmers stated that sometimes they feel exploited by wholesalers, it has been observed that farmers want to balance their good relations with traders with their income expectations, since these intermediaries provide them with variety of services such as provision of loans, inputs and information; thus they are considered by farmers as "friends" or someone they can relay when they need help. Therefore, in the long term, price and profits may be less important because the farmer's relationship with intermediaries is important. Unfortunately, this aspect was not covered by the survey, and we could not include it in the econometric analysis. Nevertheless, any effort to improve the efficiency of the potato chain should consider the important roles that intermediaries play. Intermediaries fill several marketing roles for small scale potato producers. They also serve as the final client for farmer's production. Consequently, further efforts should not be unfair to intermediaries; but rather should consider these important roles and try to improve their contribution in these and other areas. For instance, institutions that work in the area should include intermediaries in market support projects and work closely with them since they are one of the most important sources of market information for farmers.

Since the econometric analysis did not capture the effect of gender on market choices, it is important to gather more data specifically related to gender roles to determine the magnitude of this effect and thus deepen this analysis. As mentioned, research on female potato farmers is limited since they do not take into account the importance of women in marketing activities and tend to limit their contribution to only household management and ignore the constraints they

face to access to markets. Furthermore, there are not reliable statistics that show the relationship of ICT and women. Additionally, the role that male farmers assume as information "*brokers*" to their wives is an interesting theme for further research.

Even though potato is very important for farmers, over the past 5 years its production has been decreasing in the Tiraque area due to emigration. It is not likely that the potato business will disappear, since this crop is Bolivia's staple food. To increase farmers' welfare more support is needed for production activities and especially access to markets and information. It was interesting to find that none of the institutions that work in the study area provide market-related services. Instead most of them focus on technical assistance to help farmers produce more efficiently and diversify production. NGOs should try to change the nature of the technical assistance towards more comprehensive objectives such as marketing and organizational issues. For instance, they could help farmers form agricultural associations to facilitate and strengthen their access to loans, transportation, information and markets. These associations could also reduce transaction costs. These institutions could also implement projects to exploit the potential of communication technology in rural Bolivia, taking into account its effects on the functioning of markets and on farmers' welfare.

Further research is needed to explore market-level and farm-level constraints to increase incomes from potato product, such as limited access to infrastructure, inputs, human capital, financial capital, new telecommunication technology as well as to explore the relationship between access to and use of cell phones, and other potential interactions. For instance, even though farmers have different strategies to overcome the main problem with cell phones which is signal coverage; they should search for funding to have an antenna closer to their communities, so cell phone signal can improve. Furthermore, due to widespread access to cellular technology, FDTA-Valles, i.e. the institution responsible for Market Information System, should consider cell phones as a new tool to disseminate market data on a larger scale.

Finally, another important lesson of the study is that there are many exogenous variables that could explain farmer selection of marketing outlets and they should be properly explored. Examples go beyond market-level and farm-level constraints such as limited access to inputs, human capital, financial capital, and so forth. Apparently, even though farmers are profit maximizers they also have varied and contrasting objectives (e.g. their relationship with wholesalers). Thus, the nature of farmer decision-making with regards the selection of markets is

complex. A useful contribution to the Tiraque watershed economy could result from institutions working in the area developing a farmer decision-making model that successfully incorporates significant variables from across disciplines (demographic, cultural, economic, social and institutional). In conclusion, the findings that market level constraints influence farmers' choice of market outlet and thus the price they received point to the importance of extending the discussion of access to technology as incentives to market development, especially in less developed markets.

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Appendix A. Key Informant Interview Guideline (RMA)

Descripción de los actores: Características, actividades, funciones, papel y participación en la cadena (grado de involucramiento, papel de las mujeres).

I.   Agricultor

Producción

1. Identificación del entrevistado y actividades productivas que realizan.
2. Cultivos producidos: toma de decisiones y participación de los miembros del hogar, destino de la producción (volúmenes).
3. Condiciones para desollar la actividad: Compra de insumos, disponibilidad y uso de recursos físicos, humanos.

Comercialización

1. Características del producto comercializado: quien vende y por que, toma de decisiones y participación de los miembros del hogar.
2. Lugar de venta: características, motivos de elección (preferencia), ubicación, frecuencia, funcionamiento del mercado (horario, costo de participar), percepciones/opiniones de los mercados (cambios, participación de hombres y mujeres, situación del mercado), acceso.
3. Transporte al mercado: tipo de transporte, costo, responsabilidad, tipo de apoyo (ayni).
4. Descripción de las actividades en el proceso de comercialización (diferenciadas por genero) y problemas/oportunidades de acceso al mercado.
5. Clientes: tipo de cliente (diferenciados por genero) por mercado, requisitos de calidad, variación es de volúmenes y precios por época y mercado, fijación de precios, forma de pago, factores afectan los resultados de la negociación, naturaleza, tipo y riesgos de la relación.
6. Tipos de vínculo entre actores - flujo de recursos: (productos e información).
7. Acceso a información existente entre los actores: tipo de información, fuente, medio, costo, utilidad, quien tiene acceso, difusión de información, problemas de acceso y acciones.
8. Cambio de los roles en los últimos años en los mercados.
9. Analisis FODA: Características de las actividades realizadas de comercialización y acceso al mercado.
10. Actores indirectos: la información se deberá diferenciar por tipo de actor (público, privado, con fines de lucro, sin fines de lucro). Instituciones/organizaciones que trabajan en la zona (tipo de organización, apoyo y participación).

II. **Intermediario: Mayorista y minorista**

Caracteristicas generales

1. Identificación del entrevistado y actividades productivas que realizan.

2. Cultivos comercializados: toma de decisiones y participación de los miembros del hogar, destino de la producción (volúmenes).

3. Condiciones para desollar la actividad: disponibilidad y uso de recursos físicos, humanos.

Comercializacion

1. Características del producto comercializado: quien vende y por que, toma de decisiones y participación de los miembros del hogar.

2. Lugar de compra.

3. Oferta del Mercado.

4. Lugar de venta: características, motivos de elección (preferencia), ubicación, frecuencia, funcionamiento del mercado (horario, costo de participar), percepciones/opiniones de los mercados (cambios, participación de hombres y mujeres, situación del mercado) , acceso.

5. Transporte al mercado: tipo de transporte, costo, responsabilidad, tipo de apoyo (ayni).

6. Tipos de vínculo entre actores - flujo de recursos: (productos e información). Relaciones sociales.

7. Acceso a información existente entre los actores: tipo de información, fuente, medio, costo, utilidad, quien tiene acceso, difusión de información, problemas de acceso y acciones.

8. Descripción de las actividades en el proceso de comercialización (diferenciadas por genero) y problemas/oportunidades de acceso al mercado.

9. Clientes: tipo de cliente (diferenciados por genero) por mercado, requisitos de calidad, variación es de volúmenes y precios por época y mercado, fijación de precios, forma de pago, factores afectan los resultados de la negociación, naturaleza, tipo y riesgos de la relación.

10. Lugar de compra: características, preferencia del mercado, frecuencia de visita, acceso.

11. Proveedores: tipo de proveedor (diferenciados por genero) por mercado, requisitos de calidad, variación es de volúmenes y precios por época y mercado, fijación de precios, forma de pago, factores afectan los resultados de la negociación, naturaleza, tipo y riesgos de la relación.

12. Factores que afectan los resultados de la negociación.

13. Análisis FODA.

14. Actores indirectos: la información se deberá diferenciar por tipo de actor (público, privado, con fines de lucro, sin fines de lucro). Instituciones/organizaciones que trabajan en la zona (tipo de organización, apoyo y participación).

19. Percepciones del negocio de comercialización de papa en general.

III. Actores Claves

Descripcion de los mercados de Tiraque, Punata, Cochabamba y Santa Cruz

1. Identificación del entrevistado: por tipo de mercado, rol desempeñado en la misma (años de conocimiento del mercado.

2. Características generales del mercado: días de realización, horario, tipo de participantes (roles), costo de participar en el mercado (monto, tipo de pago), percepciones (problemas, oportunidades, situación del negocio, dominio de mercado según género, poder de negociación entre actores).

3. Actores del mercado: tipo de participantes, origen, principales productos comercializados (priorizados), participación diferenciada por genero (roles, toma de decisiones, distribución física), poder de negociación (fijación de precios), requisitos de calidad, naturaleza, tipo y riesgos de la relación (cliente-compradores).

4. Descripción del desarrollo de las actividades en el mercado (diferenciando por tipo de actor: agricultores, intermediarios, minoristas). Específicamente papa.

5. Movimiento del mercado: flujo de dinero y volúmenes por época , variaciones del precio

6. Mercado de trueque: características, tipo de actores diferenciados por genero y roles, productos comercializados (importancia).

7. Actores indirectos: la información se deberá diferenciar por tipo de actor (público, privado, con fines de lucro, sin fines de lucro). Instituciones/organizaciones que trabajan en la zona (tipo de organización, apoyo y participación).

8. Observaciones.

IV. Actores Indirectos

1. Identificación del entrevistado: tipo de institución, zona de acción, años de trabajo.

2. Actividades realizadas: tipo de trabajo que realizan (funciones), población beneficiada (grupo meta diferenciada por genero), costo.

3. Tipo de relación con otras instituciones y/u organizaciones de la zona.

4. Comercialización: tipo de apoyo, demanda de nuevos servicios en esta área.

5. Percepción de la situación de la producción y comercialización de papa en la zona de Tiraque (problemas, oportunidades, riesgos, situación del negocio, cambios de roles).

6. Análisis FODA.

7. Observaciones.

Appendix B. Case Studies' Protocol

1.   Identification of case studies (action scope):

- Study case type: It will be used multiple case studies of holistic nature. Logic of "literal replication" will be followed (similar to the multiple experiments).

- Universe of study: The population, from which the families will be chosen, is composed of 389 farmers (who participated in the baseline data collection for the project SANREM).

- Analysis Unit: farmers' families.

- Selection of participants for the case study (sample): The selection of the case study will be based on theory and logical sampling. The sample to be chosen will be intentional, the choice will depend on the purpose of the study and the criteria defined for this purpose.

- Case studies objectives: Understand how decisions about marketing are made within the household and the influence that access to information has on this process (through access to information technology, with especial focus in cellular-phone); also to know the variables that affect or might affect the decision making process (i.e. production cost, in puts requirements, information and market information, etc). Additionally, this tool will allow us to know clearly how farmers' dynamic marketing process works (characteristics). Thus, we will have a better understanding of how farmers' economy works, which will contribute to understand their decision model oriented to markets.

- Sample size (criteria to select families): The choice will be determined by the compliance of the following criteria that will define the analysis unit.

Criteria	Location				Total
	Inside watershed			Outside watershed	
Total Families surveyed	285			104	389
Geographic location	High	Middle	Low	Outside	4
Number of communities	2	10	2	4	18
# of surveys per zone	35	207	43	104	389
Potato producers	38	190	30	98	356
Extended family (5 to 8 members)	10	92	8	43	153
# of families to be selected	**1**	**2**	**1**	**2**	**6**

The families identified are presented in the following table:

Family No.	Market	Community	Zone
1	Tiraque	Sankayani Alto	High (1)
2	Santa Cruz y Cbba	Cebada Jich'ana	Middle (2)
3	Tiraque y Punata	Damy Rancho	
4	Tiraque	Toralapa Baja	Low (1)
5	Tiraque, Punata y Santa Cruz	Koari Alto	Outside of the watershed (2)
6	Tiraque y Punata. Sometimes on at farm-gate	Kayarani	

2. **Intervention of the proposal (studios case):** To start gathering data with such cases, first it will be necessary to talk to the representative of the communities of interest, where it must be explained the purpose of the investigation, and the way families were elected as part of the case studies. It will be asked for consent from both, the community and families (this could be an oral agreement). Case studies typically rely on multiple sources of information and methods to provide as complete a picture as possible. Therefore a set of different techniques will be applied to the cases previously identified.

3. **Tools**

3.1. Secondary data:

- Background information: Among the records to be reviewed, were both internal sources (project SANREM information), as well as external sources (articles, books, magazines, other projects, etc.)
- Analysis of baseline data

3.2. Semi-structured interviews:

- Interview guide: First, an interview guide will be elaborated, where the questions will be grouped by topics of interest (household, the process of marketing and decision making).
- Time: It is estimated that the collection of data will last three months, making follow-up visits to the farm at least 1 time per week. Each visit of approximately 1.5 hour (per family). The information obtained will be compared with information from other sources (other interviews, secondary information, and analysis of the baseline data).

In order to make the data recollection more dynamic, other tools will be used for the collection of certain data, as follows:

3.3. <u>Regenerative cycles</u>: It will allow generating a production and commercialization seasonal schedules of potato activities with a focus on gender. The objective is to generate a description of the activities of marketing (including production) that performs each actor (family member) from the harvest to reach the market and the type of participation that they have (who goes to the market and who does what). The estimated time need in order to applied the regenerative cycles is 1.5 hours

3.4. <u>Crop Marketing budget</u>: In connection with the respective crop flowchart, all marketing costs and revenues will be assessing. The exercise allows producers to easily learn to make their own budgets. The estimated time in order to complete this exercise is approximately one hour.

3.5. <u>Conducting on-site study cases (direct observation):</u> Making a "field visit" allows the observation of some items that might not be collected through other means or sources of information. This type of data collection technique will be useful to complete the information collected through the interviews.

Appendix C. Data Set: Summary statistics

No.	Variable	Obs	Mean	Std. Dev.	Min	Max
1	qproduced	303	6896.667	7016.643	300	42500
2	location	303	0.768977	0.422184	0	1
3	gender	303	0.141914	0.349539	0	1
4	literacy	303	0.818482	0.386085	0	1
5	loan	303	0.184819	0.388792	0	1
6	cellphone	303	0.504951	0.500803	0	1
7	transport	303	0.135314	0.342624	0	1
8	nplots	303	5.240924	2.461231	1	15
9	irrigation	303	0.729373	0.445019	0	1
10	celllocation	303	0.455446	0.498835	0	1
11	htiraque	303	0.669043	0.186539	0.17	1.17
12	hpunata	303	1.313498	0.179404	0.93	1.63
13	hcbba	303	2.453399	0.246791	1.88	3.06
14	hscz	303	12.35086	0.265523	11.84	13.34
15	hpavedroad	303	0.051386	0.086343	0	0.86
16	nplotsgender	303	0.617162	1.712431	0	10
17	loanqprod	303	1452.743	4410.608	0	38000
18	cellgender	303	0.059406	0.236774	0	1
19	cellqprod	303	4337.611	7321.34	0	42500
20	age	303	47.24752	14.81122	20	89
21	agecell	303	22.9571	24.57563	0	78
22	irrigationprod	303	5667.241	7342.758	0	42500
23	hsize15	302	3.175497	1.682131	1	10
24	age2	303	2450.977	1511.108	400	7921
25	hpavedroadnplots	303	0.276073	0.531542	0	5.36
26	agecell2	303	1128.997	1422.507	0	6084

Appendix D: Case Studies: Summary of main results in relation to the propositions of the study (Patter matching)

Hypothesis/Prepositions	Empirical results
Household characteristics	
H1: The decision of where to sell and the price farmers receive may be influenced and constrained by farmers' characteristics (i.e. age, size of the household), human capital (e.g. education), financial capital (e.g. loan) and location (i.e. cell phone signal).	Age of the household can affect the market chosen since older people are more likely to prefer closer markets. The household size will affect the quantity to be sold, since farmers always keep part of the production for their own consumption. Education does not have any effect on their decision, since all farmers are literate. Loans have some effect, since it will influence the quantity sold (all farmers have loans to cover production costs). Location does not affect access to cell phones, and therefore market choices.
H2: Female farmers, as access to information, can influence the decisions of where to sell. Their participation may depend on who is the head of the household.	True. Women are very important in the marketing process, and even tough the decision of where to sell is taken by men, women influence it. In some cases farmers choose market according to gender.
Production characteristics	
H3: Farmers who have a large quantity of potato produced, are more likely to sell it to more and farther markets, even though total cost of transportation increases with quantity	Confirmed, quantity does affect their choices. Farmers expect higher prices in urban markets than in rural ones; so it is worth to spend more money on transportation cost, which varies with quantity and distance as well.
H4: Farmers who have higher income can have access to better transport infrastructure, thus the probability that wealthy farmers go to farther and more than one market increases, since the marginal cost of transporting decreases.	Not completely true, since public transportation is the most important mean used by all farmers; even for the ones who own a truck. However these farmers are able to pay higher transportation costs to go to farther markets. Additionally, wealthy farmers can produce more.

Hypothesis/Prepositions	Empirical results
Access to information	
H5: Farmers, who have cell phones, are assumed to have a higher probability of selling to the market that offers a better price (i.e. urban markets) and to more than one market. Thus, using a cell phone will influence the quantity offered in the markets	Partially true. Farmers who have cell phones have access to market information (mostly prices), which will affect their decision of where to sell and how much. Nevertheless, they have to have enough production and time to travel to these markets, which are normally farther from the watershed. The transaction costs incurred have to be worth it.
H6: Access to information through the use of cell phones depends on the location of the household (i.e. if the farm is inside or outside of the Watershed)	Not confirmed, because even though farmers who live outside of the watershed have limited access to cell phone signal, they do have cell phones and have different strategies to improve the signal coverage. Thus, location with respect to the watershed does affect access to this tool.
H7: The decision to buy a cell phone will be influenced by the age and gender of the head of the household, and also by the quantity produced (i.e. it will determine if farmers can afford a cell phone).	Confirmed, because older people are more reluctant to use new technology and also from the interviews it was observed than female are the ones who most of the time suggested to buy a cell phone.
Access to markets	
H8: The more isolated farmers are; the higher probability for them to choose rural markets and not more than one	Partially true, since farmer's location in the watershed does not really make a big difference in their transportation costs. All of them have to reach the paved road to go to any market.
H9: It is expected that farmers who have access to motorized transport go farther and more than one market to sell their production, and so be able to achieve higher prices.	Not confirmed, since any farmer can access to public transportation. Even farmers who own a truck prefer to use public transportation; it is more convenient for them.

Appendix E. Farmers' market preferences: Reasons to choose a specific market

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Tiraque (100% attend)

- ✓ Close to the study area. It is one of the biggest markets in the rural area regarding infrastructure and services (better parking, bigger spaces, and municipality control). Farmers purchase goods for their household there.
- ✓ Transportation costs and cost to participate in the market are the lowest
- ✓ Preferred over Punata because the measure unit used is different i.e. in Tiraque 1 carga*= 96 Kg and in Punata 1carga=108 Kg, but the price paid is almost the same.

Punata (50% attend)

- ✓ Close to the study area. Opens only Tuesday (sometimes also Monday)
- ✓ Lower sales price than Tiraque. Farmers prefer to go to Tiraque first (on Friday) and if they have some potato leftovers' they go to Punata on Tuesday.

Cochabamba (30% attend)

- ✓ Farmers, who prefer Santa Cruz, go to Cochabamba only when their production is small (less than 2000 kg) or the roads are in bad conditions.
- ✓ Farmers who prefer to go to Tiraque go to Cochabamba when the former is too full

Santa Cruz (50% attend)

- ✓ Best market organization, management and services provided. It is open every day
- ✓ Prices are higher than in other markets and are paid for the exact weight (a scale is always used.
- ✓ Quality control is less strict than in the other markets
- ✓ Farmers prefer this market when they have large quantities of potatoes (over 2000 Kg)
- ✓ Even tough this is the farthest market (at least two days' travel time) with the highest transportation cost farmers prefer it.

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* General measure unit used in the markets (normally 1 carga=100 Kg, but it can varies by market)