MARKETING MINOR CROPS:

THE DETERMINANTS OF CONTRACTING DECISIONS

by

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ABSTRACT

The use of contracts in marketing agricultural production has expanded substantially over the past 30 years. In 2001, around 36 percent of the value of United States agricultural production was marketed under contractual arrangements, compared with 28 percent in 1991 and only 12 percent in 1969. The determinants of contract use are not well understood, especially for row crops. The purpose of this thesis is to examine why contract use for marketing specialty crop production varies among producers and specialty crops. This thesis uses a new data set obtained from a survey of Montana Grain Growers Association members in eight Montana counties to investigate how farmers make their marketing decisions for specialty crop production. A theoretical model is developed to form the basis of an empirical model of how producers make two independent decisions: adopting contracts and determining the proportion of specialty crop production to be marketed by marketing contract. A probit model is used to obtain parameter estimates for the contract adoption decision. A truncated regression model is used to explain the proportion of specialty crop production to be marketed under marketing contract. The results indicate that a variety of personal, farm-specific, and crop-specific characteristics affect the contract adoption decision. However, a smaller number of farm and crop-specific characteristics affect the decision about what proportion of production will be contracted. An important contribution of this study is its examination of the effects of crop-specific variables on marketing decisions. The results indicate that contracting decisions are influenced by crop-specific conditions such as the thinness of the spot cash market and production-related phenomena such as whether the crop is irrigated.

CHAPTER 1

INTRODUCTION

The purpose of this study is to understand why the use of contracts varies across individual producers and individual crops by examining the marketing of specialty crops by Montana producers. The determinants of marketing channel use and the use of contracts in general are not well understood. This study examines how producers make marketing decisions and how a variety of characteristics affect the use of contracts for the marketing of agricultural production. An improved understanding of producer behavior and the characteristics that influence the use of contracts enhances the ability of policy makers to provide information and programs that would improve economic welfare and economic efficiency. It also facilitates the ability of producers to make effective marketing decisions.

The objective of this research is to advance our understanding of producer behavior in general and why certain crops are marketed more frequently with contracts over other methods such as the spot cash market. Previous studies in this research area have focused on the effects of personal and farm-specific characteristics on marketing decisions. The effects of personal characteristics such as producer age, experience, education, and use of various pricing information sources have been examined in previous studies. Farm-specific characteristics have been accounted for by variables measuring crop specialization, gross farm income, debt-to-asset ratios, use of futures, options, and insurance, and use of various inputs. This study incorporates similar variables to capture the effects of personal and farm-specific characteristics, but also investigates the effect of a third category of crop-specific characteristics through the use of variables such as crop-specific dummy variables, distance to the market for delivery of production, and the investment of resources into the production process of a particular crop.

The effects of the three categories of characteristics on marketing decisions are examined in the context of a model for the adoption of marketing contracts and the decision of what proportion of production to contract. The two decisions are modeled in a utility of profit maximization framework for individual producers and the effects of specific variables that proxy for the three general categories of characteristics are modeled independently for each of the two decisions.

This thesis proceeds as follows. Chapter 2 presents background information on the use of contracts within the agricultural industry. Chapter 3 reviews the theoretical and empirical literature on contract theory and the determinants of contract use, including Katchova and Miranda's (2004) study on the determinants of contract use by corn, soybean, and wheat producers from which this study draws heavily. Chapter 4 develops and presents a theoretical model of how producers decide whether to adopt marketing contracts and what proportion of their production to market with contracts. This model allows the three general categories of characteristics to influence each marketing decision independently and therefore several hypotheses were developed from this theoretical framework and data were collected to test them. Chapter 5 describes the data and the survey methodology utilized to collect the data. This study examines a new dataset obtained by surveying members of the Montana Grain Growers Association residing in Montana counties with the highest levels of specialty crop production. Questions for the survey were drafted to provide variables that proxy for the three general categories of characteristics important in this study. Two survey forms were collected from each individual producer. The first survey provided information on the general farming operation and the second survey provided information for the production of specific specialty crops. Chapter 6 presents the empirical models used to estimate the effects of personal, farm-specific, and crop-specific characteristics on both the adoption of marketing contracts and the contracted proportion of production decision. The inclusion of crop-specific variables extends previous research and provides new results for crop-specific characteristics as well as additional insights about the effect of personal and farm-specific characteristics. In addition, Chapter 6 also presents the results from the empirical models. Chapter 7 summarizes the major findings of this thesis, the implications of the results, limitations of the thesis, and possibilities for future research.

CHAPTER 2

CONTRACTS IN AMERICAN AGRICULTURE

In economics, the simple activity of exchanging goods and services, whether on organized exchanges or outside a market setting, is the basic first step in any production or allocation of resources (Bolton and Dewatripont 2005). The production and sale of commodities, either crops or livestock, can be broken down into a series of simple exchanges of goods or services. Although a variety of arrangements between the parties involved in the exchange may be established, contracting of agricultural production has become more common and the subject of an increasing area of research.

Spot market or cash sales for crops can be defined as arrangements in the agricultural industry where farmers sell products directly to the marketing agent or firm either immediately after harvest or at some other time during the crop year. The key dimension is that both parts of the exchange occur at the same moment in time, without any prior agreements about the nature and structure of the transaction. A contract, generally speaking, is a written or oral agreement between parties that involves an enforceable promise to do, or to refrain from doing something (Agriculture 1996). In the context of agricultural production, contracting a series of exchanges can be defined as a means to coordinate successive stages in a commodity system (Schrader 1986), or as a mechanism that specifies a stable price or pricing formula in order to provide security to the producer and buyer involved in the transaction.

Economics of Contract Use

Contractual arrangements may be preferred to other marketing mechanisms such as the spot cash market for many reasons. Contracts may offer any or all of the following potential benefits to the producer involved in the transaction: reduced income risk, reduced price risk, improved access to capital and credit, improved efficiency, provision of inputs, and providing a guarantee that a market exists for the commodity being produced. The contractor, or buyer, may also enter into contracts for various reasons. These include controlling the supply of inputs in agricultural production, increasing the reliability of commodity quality, sharing price risk with producers, increasing the predictability of costs, improving response to consumer demands and preferences, expanding or diversifying operations, and ensuring a steady supply of the commodity from producers.

There are also potential drawbacks or costs of entering into contracts for both producers and buyers. The costs associated with contracts for agricultural producers range from the costs of information gathering, searching for a buyer, negotiating with potential buyers, physically arranging the contractual elements with the buyers, risk of buyer default, restrictions on input use imposed by the buyer, quality discounts associated with the contract, and the risk of failure to deliver the crop to the buyer due to unforeseen circumstances. There are also costs associated with contracts for buyers as well. The costs of contracting for buyers include the financial commitment to purchase specific quantities of the crop, a risk of quantity shortfalls if the producer is unable to deliver, and the risks associated with locking in a price that may continue to fluctuate after the contract is established. Thus, there are both costs and benefits for both parties entering into contracts and the relative magnitudes of each must be examined by both the producer and buyer before entering into the contractual arrangement.

Types of Contracts

Two broad categories of contracts, marketing contracts and production contracts, are most commonly found in American agriculture. Utilizing previous work by Harwood, Katchova and Miranda (2004) define a marketing contract as an agreement between a producer and a buyer that sets a price or price formula for a commodity to be delivered at a later time. Often, in a marketing contract, the farmer or producer of the commodity retains ownership of the commodity during production, maintains substantial control over management decisions, and requires limited direction from the contractor or purchaser of the commodity. Production contracts, however, often specify in detail the production inputs supplied by the contractor, the quality and quantity of the particular commodity being produced, and the form of payment or compensation from the contractor to the producer (Agriculture 1996).

In 2001, around thirty-six percent of the value of United States agricultural production was produced and/or marketed under contractual arrangements, compared with twenty-eight percent in 1991 and only twelve percent in 1969 (Agriculture 2004). The expansion of the use of contractual arrangements has been profound, but also varied among agricultural commodities. McLeay and Zwart (1998) found that over ninety percent of production in the egg, broiler, processed vegetable, and turkey industries is marketed using contracts or other forms of vertically integrated channels. In addition, over the past decade, hog and tobacco production has rapidly moved away from spot market-oriented transactions to contract production. In 1991-1993 contracts covered only one-third of livestock production. Now, contracts cover nearly one-half of total livestock production. In contrast, contracts currently only cover twenty-five percent of crop production. The type of contract used also varies by industry. Marketing contracts are used in both crop and livestock marketing. However, production contracts are common in the livestock sector, but rarely used in the crop sector.

The theoretical and empirical literature examines contract theory, the use of contracts in different industries, and issues regarding contract adoption, optimal contracts, and behavior of contracting parties. Empirical applications of theoretical developments in contracting have been limited in their scope and often relate to specific issues and problems such as tenancy arrangements used in contract hog production, sharecropping, or the egg, broiler, and turkey industries (McLeay and Zwart 1998). Early research on contracts and a large portion of the subsequent contracting literature deals with issues such as principal-agent theory and the arrangement of incentives, loss of autonomy, post-contractual opportunism, and other behavioral considerations that concern legal issues between contracting parties. An important strand of the contracting literature extends insights on contracting use to sharecropping and tenancy arrangements in agriculture (Cheung 1969; Stiglitz 1974). These issues are not the focus of this study.

Research on the shift in American agriculture from reliance on the spot market to the now widespread use of contracts was initiated in the early to mid 1980's. The expansion of contracting was seen both as a structural change in various markets in the agricultural industry along with a change in the structure of the internal organization of the firm (Schrader 1986). Risk mitigation is also a central element of the current increase in contracting for both producers and buyers of agricultural production. Variability in prices, weather, and market conditions cause producers, assumed to be risk-averse, to utilize contracts as a way to reduce risks and to shift risk to the buyer, who is typically assumed to be risk-neutral. Studies of contracts not related to sharecropping, tenancy, or strictly risk-related issues widely recognize that contractual production and even vertical integration is more common with livestock, broilers, turkeys, fruits, vegetables, and dairy in the United States but less common in grain production (Lajili et al. 1997). Beginning in the mid to late 1990's, however, researchers began to examine the causes of shifts toward contracting in the production of commodities ranging from livestock to grains. These studies focused on separating marketing practices into categories such as the spot cash market, forward contracts, and futures/options. Several studies discussed factors affecting the choice of one marketing practice over another with the overriding assumption that a "forward contract" is essentially a marketing contract.

As discussed earlier, there are both benefits and costs to contracting for producers and buyers, and therefore the reasons for contracting specific crops by individual producers can vary substantially. However, previous studies have focused on specific reasons for contracting including marketing contracts that reduce price risk (which can be done with other mechanisms such as the futures market in some industries), coordinating a market for a task such as processing, as a means to try and utilize market power (such as in the poultry industry), for efficiency gains, and for producers' improved access to capital.

The dataset utilized in this study involves contracts that serve the purpose of providing structure for marketing decisions made for the production of specialty crops. A majority of the contracts utilized in the specialty crop sector are marketing contracts. Only recently have researchers begun to examine the factors affecting the use of contracts or the spot cash market for various commodities and individual producers. The main questions to be investigated are: (a) why certain commodities are dominated by contract-oriented transactions while others rely upon spot markets, and (b) why, within an industry, some producers choose to market their production with a contract while others prefer the spot market. Approximately sixty percent of the value of agricultural production within the United States is still sold on spot markets, and thus it is important to try and understand why certain industries and individuals are beginning the transition away from the spot market to contracted production.

Summary

There are costs and benefits involved in entering into contracts, and the increasing use of contracts within the agricultural industry has been an area of focus within economic research over the past two decades. There are two main categories of contracts, production and marketing, and the use of marketing contracts within grain production has been increasing over the past fifteen years. This study will attempt to enhance our understanding of why producers of specialty crops utilize marketing contracts to market their production with an emphasis on trying to understand the specific characteristics that significantly influence the use of contracts. The next chapter will review the theoretical and empirical literature on contract theory and the determinants of contract use.

CHAPTER 3

LITERATURE REVIEW

In 1969, Cheung argued that, "every transaction involves a contract." Since then, the analysis of contracts has come to occupy a central place in economic theory. Two primary approaches, principal-agent theory and transactions cost theory, have informed the analysis of various issues surrounding the concepts of contracting which include efficient and optimal contract design, characteristics influencing contract use, and other issues such as post-contractual opportunistic behavior and default.

The economic analysis of contracts in agriculture was initiated in the early 1980's. Agricultural contracts have been examined in both the theoretical and empirical literature to determine how issues from general contracting theory, such as efficient and optimal contract design along with the other issues previously mentioned, affect the use and design of contracts within the agricultural industry.

This chapter presents a review of contract theory that is relevant to the literature of agricultural contracts. Both the theoretical and empirical work on the economics of agricultural contracts will be reviewed to determine the issues most pertinent to the focus of this study, the use of marketing contracts in the production of specialty crops within the agricultural industry.

Contract Theory

Jensen and Meckling (1976) develop the principal-agent problem in the context of one or more principals engaging an agent to perform some service on their behalf, and this transaction involves delegating some decision making authority to the agent. Under the assumption that both the principal and agent are utility maximizers, they further develop the principal-agent problem to show how the agent may not always act in the best interest of the principal and that the principal may undertake actions in an attempt to provide the agent with behavior-modifying incentives. Holmstrom (1979) showed how imperfect information can create moral hazard or dysfunctional behavior in the principal-agent problem which can be alleviated by the investment of resources into monitoring or other activities. These additional investments, or the creation of additional information systems to mitigate the moral hazard actions of the agent, can help to improve contracts between the principal and the agent. Stiglitz (1974) approached agricultural sharecropping from a principal-agent standpoint, under the assumption that the principal (landlord) is risk-neutral while the agent (producer) is risk-averse, and the relationship is modeled to capture the importance of risk sharing in sharecropping contracts. Stiglitz concluded that the main advantage of a share contract is to reduce the moral hazard problem in the presence of a risk-averse tenant.

Risk-sharing and the effects of risk preferences among the contracting parties are standard considerations in principal-agent analyses. Cheung (1969) began his analysis with risk -verse producers (agents) avoiding risk if the cost of doing so is less than the gain from the risk averted. In the context of agricultural production and marketing, Hudson and Lusk (2004) extend this insight to claim that, as risk-averse agents, producers should be willing to give up some income to shift the risk to the buyer of agricultural production, creating a risk premium. Risk has been analyzed as an important factor in the production choices made by small farmers for quite some time (Sandmo 1971). The importance of risk is traced to the fact that agricultural producers typically face considerable production and price risk in their operations and in the various economic and business environments under which they operate (Hueth and Ligon 1999). The assumptions of risk preferences for principals and agents along with the role of risk-sharing and moral hazard reduction in contracts serve as two of the main tools by which contracts are investigated in principal-agent analyses.

Transactions cost theory often relaxes the assumption of a risk-averse agent and instead focuses on the costs inherent in every transaction and the incentives these costs create for both the principal and the agent, regardless of attitudes toward risk. Arrow (1969) provides a broad definition of transaction costs as, “(the) costs of running the economic system.” Coase (1937) provided the foundational work of transactions cost theory through his investigation of why a firm emerges to take on the coordinating tasks typically left to the price mechanism in the market. He recognized that there are costs to use the price mechanism. These include costs of discovering what prices are, along with negotiating and concluding separate contracts for each transaction. Cheung (1969) extended Coase’s insight by stating that one reason for the existence of different contractual arrangements stems from differences in transactions costs that are associated with them. Cheung also claimed that transaction costs differ, "because the physical attributes of input and output differ, because institutional arrangements differ, and because different sets of stipulations require varying efforts in enforcement and negotiation." Williamson (1979; 1981; 1991) extended the work of both Coase and Cheung by focusing on how the presence of transactions costs significantly affects the organization of economic activity, and differing transaction costs provide incentives to utilize various institutions for transactions from the open market to internal organization of vertical coordination in a firm.

Klein, Crawford, and Alchian (1978) investigated one particular transaction cost of using the market system: post-contractual opportunism that arises through the pursuit of quasi-rents which are created after a specialized investment into the production of the particular asset to be exchanged. They conclude that as the amount of asset-specific investment increases, quasi-rents increase and, accordingly, the threat of reneging on the contract by the buyer increases. Alternative arrangements through contracting or vertical integration can be undertaken to reduce the possibility of post-contractual opportunistic behavior. Transactions costs can be defined by the investments undertaken in post-contractual behavior or the prevention of opportunistic behavior. Therefore, transactions cost theory focuses on monitoring costs, enforcement costs, and the costs of the post-contractual opportunistic behavior as defined by Klein, Crawford, and Alchian. Leffler and Rucker (1991) extend Klein, Crawford, and Alchian's insight by demonstrating that individuals and firms are shown to develop institutions and contractual arrangements to minimize dissipation from transaction costs. They state that the specific nature of the transaction costs can be related to the physical properties of the goods being exchanged and the characteristics of the particular buyers and sellers.

Principal-agent theory and transactions cost theory are often at odds with one another in the assumptions that they place on the behavior and incentives of individuals involved in a transaction and the nature of the relationship among those individuals. Hudson and Lusk (2004) distinguish principal-agent theory from transactions cost theory by stating that standard principal-agent models assume contracts are costless to write and complete, while transactions cost theory assumes that contracts are both costly to write and costly to fulfill. However, recent works by Ackerberg and Botticini (2002) along with Hudson and Lusk (2004), have approached contracting issues by investigating the effects of both risk and transactions costs in a contractual relationship and have presented evidence that both are important in explaining various aspects of contracting.

Empirical Literature

Contract theory has been applied to various aspects of the agricultural industry and has served as the rationale for empirical investigations of various issues concerning forms of agricultural organization and agricultural contracting relationships[1]. The

[1] Numerous applications of contract theory to agricultural applications will not be addressed within the context of this thesis. Input and management control, moral hazard, and efficient contracts within broiler and overall livestock production contracts in the agricultural industry are investigated by Goodhue (1999), Ward et al. (2000), Morrison-Paul et al. (2004), Vukina and Dubois (2004), and Vukina and Levy (2004). Cheung (1969), Stiglitz (1974) and others perform their analyses of contracting with respect to a specific sharecropping application. Issues such as moral hazard, risk sharing, imperfect capital markets and the overall function of contracts are investigated by Allen and Lueck (1999), Ackerberg and Botticini (2000) and others. Applications of optimal risk and various contractual provisions regarding quality, identity preservation, multitasking, and policing mechanisms are examined in an optimal contract framework with a specific application to fresh produce include work by Hueth and Ligon (1999), Ligon (2002; 2003), Wolf et

insights of both principal-agent and transactions cost theories are relevant in the analysis of whether or not marketing contracts are utilized for the production of agricultural commodities. The overriding questions are what characteristics influence individual producers to use marketing contracts and what characteristics of crops make them more likely to be subject to marketing contracts. These issues have been investigated in the empirical literature through both principal-agent and transactions cost approaches.

The rationale for marketing contract adoption by agricultural producers is supported in various ways from contract theory. Principal-agent theory identified the importance of risk-reduction in contracting relationships and transactions cost theory highlighted the importance of transactions cost minimization in contracting. Extensions of both approaches can help to explain the use of marketing contracts for agricultural commodities. Schrader (1986) examined the use of agricultural marketing contracts to coordinate successive stages of agricultural production, as opposed to open production and pure market exchange. He identified four reasons for coordinating agricultural production by non-market means: to increase efficiency, to gain market advantage, to reduce uncertainty, and to obtain or reduce the cost of financing.

Fletcher and Terza (1986) provided an empirical application of contract theory by utilizing principal-agent theory to investigate how risk-averse farmers deal with increasing risk from cost inflation and higher variability in commodity prices. Fletcher and Terza, along with McLeay and Zwart (1998), tried to identify the farmers' characteristics that make them most likely to diversify in response to increasing risk,

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al. (2001), and Hueth and Melkonyan (2004). Other applications of contract theory exist and are not considered within the contexts of this thesis.

along with the characteristics of industries that support the use of particular marketing channels. Edelman, Schmiesing, and Olsen (1990) identify income and price variability stemming from the trend toward less government involvement in agricultural programs to motivate an investigation into the specific characteristics of producers that could be targeted with information and management assistance to deal with the deregulated agricultural environment.

Shapiro and Brorsen (1988), Asplund, Forster, and Stout (1989), Goodwin and Schroeder (1994), and Musser, Patrick and Eckman (1996) all utilized portfolio theory to show that, with increasing price and income risk, farmers should be utilizing futures markets or forward contracts. However, fewer producers utilize such risk-reducing mechanisms than portfolio theory predicts (Shapiro and Brorsen 1988). All of the portfolio theory-based empirical applications investigate producer characteristics that influence the use of forward contracts or hedging with the futures market. In these applications, the authors attempt to identify characteristics that might be responsible for why hedging and forward contracts are used less than the efficient rate predicted from portfolio theory. Sartwelle et al. (2000) along with Katchova and Miranda (2004) extended portfolio models to incorporate an analysis of how personal and farm characteristics affect pre and post-harvest marketing practices with separate decisions for contract adoption, quantity contracted, frequency of contracting, and contract type.

Even though the empirical literature utilizes various theoretical assumptions to investigate the characteristics that influence the use of contracts, all of the studies utilized survey data from a variety of sources. All of the most relevant empirical studies utilized survey data with maximum likelihood econometric estimation for limited dependent variables, and differences only come in the use of econometric method utilized. See Appendix A for a table of the various methods utilized and key findings in the empirical literature.

The empirical estimation techniques identified in Appendix A are utilized to obtain estimates on the effects of various characteristics influencing the use of contracts for the marketing of agricultural production. The decision-making process of producers is modeled in various ways in the empirical literature. Edelman, Schmiesing, and Olsen (1990), McLeay and Zwart (1998), and Sartwelle et al. (2000) each develop general models of producer decisions that investigate specific factors and characteristics influencing the choice of marketing practices. Shapiro and Brorsen, along with Asplund, Forster, and Stout, model the decision-making process in a technology adoption framework where specific producer characteristics influence whether or not a producer is likely to adopt a new technology, such as a marketing contract. Fletcher and Terza, Goodwin and Schroeder, and Katchova and Miranda model the decision-making process as a utility maximization problem for producers. Fletcher and Terza assume that producers maximize utility in general and develop assumptions about the effects of specific characteristics from that foundation, while both Goodwin and Schroeder and Katchova and Miranda assume that producers maximize the expected utility of profits. All of the above studies investigate the effects of characteristics on the use of marketing contracts and other marketing mechanisms in the agricultural production process, but the various modeling techniques and assumptions lead to slightly different estimation mechanics and predicted effects.

In addition to various models and assumptions utilized throughout the empirical literature, the specific characteristics and factors influencing producers' use of marketing contracts vary widely. Specific characteristics of individual producers influence how individuals deal with risk, along with how individuals deal with transactions costs that exist for use of particular marketing mechanisms. The characteristics that influenced marketing decisions and the use of forward contracts in the empirical literature fall into three categories: personal characteristics (descriptive characteristics, preferences, opinions, actions, etc.) of the producer, farm-specific characteristics, and crop/industry characteristics.

The characteristics most thoroughly investigated in the empirical literature are the personal characteristics of individual producers. Age and experience are two of the most frequently utilized personal characteristics. However, Asplund, Forster, and Stout and others have found age and experience are highly correlated and therefore empirical investigations typically utilize either age or experience and not both. Although some studies found that age and experience are not significant, Shapiro and Brorsen reported that more experienced producers are less likely to hedge and use other price risk-reducing strategies such as forward contracting, a finding consistent with results reported by Asplund, Forster, and Stout, Sartwelle et al., and Goodwin and Schroeder[2]. Katchova

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[2] Fletcher and Terza and Musser, Patrick, and Eckman used age as a proxy for experience and they expected that producers with more experience (older) have shorter planning horizons and thus younger farmers would be more likely to recover the costs associated with the adoption of forward pricing

and Miranda, however, reported that older farmers are more likely to adopt forward contracting.

The effect of education on the use of contracting and other marketing strategies has also been examined. Fletcher and Terza, Goodwin and Schroeder, Musser, Patrick, and Eckman, and Katchova and Miranda all found that increased education increased the use of forward contracts and other forward pricing mechanisms[3]. Similarly, Fletcher and Terza, Asplund, Forster, and Stout, Goodwin and Schroeder, and Katchova and Miranda provide evidence that producers using farm associations and attending educational seminars are more likely to adopt marketing contracts. In contrast, Shapiro and Brorsen found that highly educated producers were less likely to participate in forward pricing marketing mechanisms[4].

The use of crop insurance and producer risk preferences are two additional personal characteristics examined in the empirical literature. Goodwin and Schroeder and Sartwelle et al. reported that producers who use crop insurance also were more likely to use forward contracts, but Katchova and Miranda found just the opposite[5]. Risk-related variables are also widely used, but few empirical studies find them to be significant in the decision of whether or not to use forward contracts. Goodwin and

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mechanisms. Likewise, from a technology adoption standpoint, Asplund, Forster, and Stout expected that adopters of innovation are likely to be younger.

[3] Technology adoption theory, according to Fletcher and Terza and Goodwin and Schroeder, provides the rationale that highly educated producers are expected to have advantages in using new technology and are thus more likely to adopt technology. Likewise, Musser, Patrick, and Eckman utilize human capital theory to argue that a higher level of human capital attained through education facilitates the successful use of forward pricing strategies.

[4] Shapiro and Brorsen reported that more educated producers are more likely to be less risk-averse, and thus less likely to adopt forward contracts to reduce price and income risk.

[5] Goodwin and Schroeder and Sartwelle et al. suggest that insurance and forward contracting are complements, but Katchova and Miranda consider them to be substitutes.

Schroeder found that producers with a preference for risk were more likely to use forward pricing mechanisms, while Musser, Patrick, and Eckman found that producers more concerned about the potential for losses were most likely to use forward contracts. Thus, the empirical evidence concerning the effects of risk is mixed. The empirical results obtained with measures of risk must be viewed with caution, however, as mechanisms for measuring risk and incorporating its effects into a decision-making model were not consistent across empirical studies.

Farm-specific characteristics are also utilized widely in the empirical literature. Income-related variables and variables concerning farm/operation acreage are some of the most commonly used variables to proxy for farm-specific characteristics[6]. Asplund, Forster, and Stout, Edelman, Schmiesing, and Olsen, and Katchova and Miranda all present evidence that farms with higher incomes (gross sales, gross receipts, gross farm income) are more likely to use forward contracts. Musser, Patrick, and Eckman, however, propose that lower farm income leads to increased use of forward contracts, but only for short-term corn marketing. Their empirical results concerning farm size characteristics supported the hypothesis that larger farmers were more likely to use forward contracts, thus also providing support for the economies of size argument in terms of farm acreage[7].

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[6] Both farm income and acreage are utilized to proxy for "economies of size" that may exist in the farming operation with reference to forward contract use. Asplund, Forster, and Stout, drawing upon transactions cost theory to explain economies of size in relation to income, argue that a minimum level of gross sales may be required to justify the time, effort, and expense incurred from forward contracting. Sartwelle et al. also argue that larger farms (in acreage) have lower per-unit costs than smaller farms in terms of learning how to use marketing tools and collecting marketing information.
[7] Fletcher and Terza, Shapiro and Brorsen, Goodwin and Schroeder, McLeay and Zwart, and Sartwelle et al. all report that forward contract use increases as farm acreage increases.

Some empirical studies also included measures of how reliant on a particular crop farm operators are through measures of specialization or dependence. Edelman, Schmiesing, and Olsen, Sartwelle et al., and Katchova and Miranda all include measures of specialization, defined as the percentage of overall income coming from the particular crop of interest. All of the studies report that as the percentage of income from a particular crop increases so does the use of forward contracts. McLeay and Zwart also include a measure of dependence based on the percentage of the total effective crop area that the relevant crop utilized. They report that as the farm's dependence on a crop increases, so does the likelihood of contracting[8].

Some empirical studies included measures of financial leverage, typically in the form of debt-to-asset ratios[9]. Shapiro and Brorsen, Asplund, Forster, and Stout, Edelman, Schmiesing, and Olsen, Goodwin and Schroeder, and Katchova and Miranda all report that higher leveraged producers are more likely to adopt forward marketing contracts.

Other variables are also utilized in some studies. Goodwin and Schroeder and McLeay and Zwart report that farm operations with larger investments in inputs and physical capital (as measured by input intensities) are more likely to utilize forward pricing mechanisms[10]. Variables accounting for the presence of storage facilities on the farm provided mixed results. Fletcher and Terza find that the presence of storage

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[8] McLeay and Zwart offer the rationale that as the level of dependence on a product increases, so does the exposure to falling prices and therefore contracting is more likely to avoid sales risk. This theory of risk-reduction can also be related to the income specialization variables utilized by Edelman, Schmiesing, and Olsen, Sartwelle et al. and Katchova and Miranda.

[9] The argument concerning financial leverage is based on theory described by Asplund, Forster, and Stout. They argue that highly leveraged producers utilize forward contracts to reduce downside price risk. Also, farm lenders require highly leveraged producers to use forward pricing mechanisms.

[10] Goodwin and Schroeder state that firms with a larger investment in inputs face greater exposure to risk and therefore are more likely to utilize forward contracts to deal with the increased risk.

increases the use of forward contracts, but Sartwelle et al. finding that farmers without storage are more likely to forward contract[11].

After personal and farm-specific characteristics, crop/industry characteristics have been utilized much less in the empirical literature. McLeay and Zwart investigate specific crop characteristics that influenced the adoption of contracts. They find that traditional crops and crops whose markets are not influenced by international market conditions are less likely to be contracted[12]. Sartwelle et al. find that being near a major grain demand center significantly increases the use of futures and options but has no effect on forward contracting[13].

Summary

Contract theory has been shaped around the two theoretical strands of principal-agent theory and transactions cost theory. From these two theoretical approaches, issues of risk-reduction and transactions cost mitigation emerged into the literature surrounding various contracting relationships and issues. Contract theory has had a variety of applications in agriculture, one of which is the effect of risk and transactions cost on the

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[11] Although Fletcher and Terza offer no rationale for their results, Sartwelle et al. provides a transactions cost justification. Farmers with storage can retain ownership of their crop after harvest to try and benefit from post-harvest price increases, and farmers without storage must be more aggressive pre-harvest marketers.

[12] McLeay and Zwart describe how crops only sold domestically may have a free market with a built-in stabilizing or risk-adjustment aspect. Also, with respect to traditional crops, producers may have accumulated production knowledge and therefore production and marketing requires less human capital and leads to more market sales. The prevalence and availability of government payments may also reduce the need for marketing contracts among traditional crops.

[13] Sartwelle et al. hypothesize that being near a grain demand center would increase the use of forward contracts, presumably due to lower transactions cost in finding and dealing with buyers, but the opposite effect could also exist because producers who are farther away face increased risk of not finding a buyer and therefore would be more likely to use a forward contract.

choice of utilizing a contract for the marketing of agricultural production. Various characteristics of producers and commodities are examined throughout the empirical literature. Drawing upon the econometric methodology utilized throughout various empirical applications, this study will investigate the effects of characteristics such as farm size, specialization, leverage, but also additional producer and commodity-specific characteristics. These efforts will attempt to identify those characteristics that significantly affect the use of various marketing mechanisms for the production of specialty crops such as malting barley, mustard seed, safflower, flax, lentils, canola and dry edible peas. In the next chapter, theories are presented to develop hypotheses about the specific effects of the various characteristics of which data has been obtained for the purposes of this study.

CHAPTER 4

THEORETICAL MODELS

Specialty crop producers make many decisions concerning production and marketing of these crops. Producers of more common small grains such as wheat or barley can utilize a variety of marketing mechanisms ranging from marketing contracts and the spot cash market to futures and options. Specialty crops, however, do not have futures or options markets and thus specialty crop producers generally choose between the spot cash market or marketing contracts in selling their production, although some specialty crops may be utilized on the farm and ranching operation for livestock feed. The purpose of this chapter is to investigate the economic decisions involved in specialty crop production and to identify the factors or characteristics that influence the producer's marketing decisions. The theoretical framework used to examine these issues is one in which producers are assumed to maximize their expected utility of profits from the production and marketing of specialty crop production.

Goodwin and Schroeder (1994) develop a one-step expected utility maximization model to investigate the decision of how producers market agricultural production. They assume that the adoption of marketing contracts has previously been made and the subsequent decision of interest is what proportion of agricultural production to market with marketing contracts. Katchova and Miranda (2004) extend Goodwin and Schroeder's model to a two-step environment in which decisions about marketing agricultural production are conditional upon the decision to adopt marketing contracts.

This study will extend Katchova and Miranda's two-step theoretical framework for a specialty crop producer maximizing the expected utility of profits by modeling the decision to adopt marketing contracts and the decision about what proportion of specialty crop production to market with marketing contracts.

The Expected Utility of Profits Model

A specialty crop producer's marketing decision is examined under the assumption that the decision to plant the specialty crop has been made and that a producer's subsequent decision is how to market the resulting output. The outcome of the producer's marketing decision is uncertain. However, producers are assumed to market specialty crops in order to maximize their expected utility of profits. In addition, marketing contracts are assumed to be available; that is, buyers of specialty crops are willing to offer marketing contracts to producers.

A marketing contract provides a producer with a specific, and often a guaranteed, price for the specialty crop production based on a variety of factors[14]. In adopting marketing contracts, however, producers must also incur costs associated with their adoption. The fixed and variable costs associated with marketing contracts could range from costs of information gathering, searching for a buyer, negotiating with potential buyers, and arranging the contractual elements with the buyer. The spot cash market also

[14] There are a variety of different types of price guarantees. Examples of price guarantees include a set price based upon the spot cash market price at the time of signing, a pre-determined price negotiated by buyer and seller alike, and a price that is determined solely by the buyer at the time of the signing.

transmits a price to the specialty crop producer. This study assumes that, ex ante, the spot cash market price is distributed as a random variable.

Thus, using the above assumptions, the producer's optimization problem can be defined. Following Goodwin and Schroeder (1994), this study assumes, for simplicity, that both the discrete adoption of marketing contracts decision and the decision about the proportion of production to contract are made at the same time. Thus, a proportion of production, α (where $0 \leq \alpha \leq 1$), will be sold with a marketing contract and the remaining proportion, (1- α), will be sold in the spot cash market. The producer's profit function can then be written as:

(3.1) $\pi_i = p^{mc}\alpha_i y_i + p^s(1- \alpha_i)y_i - b_i^v(y_i) - b_i^f - d_i^v(\alpha_i y_i) - d_i^f$.

In equation (3.1), p^{mc} is the price of the commodity received under a marketing contract, p^s is the price in the spot cash market, y_i is the output of specialty crop production, $b_i^v(y_i)$ and b_i^f are, respectively, the variable and fixed specialty crop production costs, and $d_i^v(\alpha_i y_i)$ and d_i^f are the variable and fixed costs associated with marketing contracts. The marketing contract price, the spot cash market price, and specialty crop output are all unknown at the time producers make their marketing decisions. Therefore, p^{mc}, p^s, and y_i are all random variables and profits are stochastic. Given that profits are stochastic, Goodwin and Schroeder argue, under the assumption that producers are risk-averse, that a Taylor's series expansion of the unknown utility of profits function implies an expected utility of profits maximization where the producer's profit function can be decomposed into a set of observable factors related to its mean and variance[15].

Katchova and Miranda (2004) formally extend the producer's maximization problem to a framework where producers maximize their expected utility of profits through the production and marketing of crops through various mechanisms. They also extend the theoretical framework to a two-step process which considers the proportion of production contracted conditional upon the decision to adopt marketing contracts. The initial decision for the producer is whether or not to adopt marketing contracts. The producer also decides how much production to allocate to marketing contracts and how much to allocate to the spot cash market. Drawing upon this two-step framework provided by Katchova and Miranda, a specialty crop producer, indexed by *i*, decides whether to adopt marketing contracts ($c_i = 1$) and what proportion of his/her production to contract, α_i, to maximize the expected utility of profits. This decision process is provided in an expected utility function as:

$$\text{(3.2)} \quad \underset{c_i,\,\alpha_i}{\text{Max}}\ EU\left\{(1\text{-}c_i)[p^s y_i - b_i^v(y_i) - b_i^f] + (c_i)[p^s(1\text{-}\alpha_i)y_i + p^{mc}(\alpha_i y_i) - b_i^v(y_i) - b_i^f - d_i^v(\alpha_i y_i) - d_i^f]\right\}$$
$$\text{Subject to: } c_i = 0 \text{ or } 1 \text{ and } \alpha_i > 0$$

In equation (3.2), p^s and p^{mc} again represent the price in the spot cash market and the price from marketing contracts respectively, y_i represents specialty crop production output, and $b_i^v(y_i)$ and b_i^f represent the variable and fixed specialty crop production costs.

[15] Goodwin and Schroeder (1994) develop a one-step model for the maximization of expected utility of profits, which Katchova and Miranda (2004) extend the analysis to a two-step model. The one-step model assumes that the decision about the proportion of production to place in marketing contracts is the same as the decision of adopting contracts. In addition, variables and characteristics affect each marketing decision the same way in a one-step model.

In addition, $c_i = 0$ indicates the decision not to adopt marketing contracts and is associated with the first term in the discrete maximization operation, and $c_i = 1$ indicates the adoption of marketing contracts and is associated with the second term. The costs associated with marketing contracts, $d_i^y(\alpha_i y_i)$ and d_i^f, are only incurred if the specialty crop producer decides to adopt contracts and are therefore only included in the second term of the optimization problem. Specialty crop producers therefore compare the benefits of changes in the price distribution associated with marketing contracts with the costs of entering into the marketing contracts. The producers then compare the expected utility of profits from adopting marketing contracts for a utility-maximizing proportion of their specialty crop production to the expected utility of profits utilizing only the spot cash market and its distribution of prices. Producers will adopt a marketing contract if the expected utility of profits from using a marketing contract and marketing an optimal proportion of their production with contracts exceeds the expected utility of profits from using only the spot cash market.

A Taylor's series expansion of equation (3.2)'s expected utility of profits function, similar to that of Goodwin and Schroeder (1994), can be applied to this model to yield expressions relating producer's choices of adoption (c_i) to $\mathbf{z}_i$, a set of observable personal, farm-specific, and crop-specific characteristics. In addition, the model allows the producer's choice of the proportion of his/her production to contract (α_i) to be related to a set of the same or different characteristics, $\mathbf{x}_i$.

Maximizing the expected utility of profits therefore yields an expression relating a producer's decision of whether or not to adopt a marketing contract, represented by c_i, to a matrix of observable personal, farm, and crop characteristics ($\mathbf{z}_i$). Formally, $c_i = h(\gamma'\mathbf{z}_i, \varepsilon_{ci})$, where γ is a parameter vector and ε_{ci} is the error term that represents unmeasured factors relating to adoption. Also, this model allows for either the same or a different set of observable personal and farm characteristics, $\mathbf{x}_i$, to be related to the producer's decision of what proportion of their specialty crop to contract (α_i). Thus, $\alpha_i = g_\alpha(\beta_\alpha'\mathbf{x}_i, \varepsilon_{\alpha i})$ where β_α is a parameter vector and the error term, $\varepsilon_{\alpha i}$, represents unmeasured factors relating to the decision of what proportion to contract. This framework allows some characteristics to affect both the adoption and the proportion of production contracted decisions in the same or different ways and it also allows some characteristics to only enter one decision or the other.

Empirical Application of Theoretical Model

Within this theoretical framework, this study will utilize three general categories of characteristics: personal characteristics, farm-specific characteristics, and crop-specific characteristics. Goodwin and Schroeder, Katchova and Miranda, and others all utilize two general categories of characteristics, personal and farm-specific, to model producers' marketing decisions. Personal characteristics used in prior studies range from producer age, experience, education, and use of various pricing information sources. Farm-specific characteristics include measures of crop specialization, gross farm income, debt-to asset ratios, use of futures, options, and insurance, and use of various inputs. This study incorporates specific and varied farm and personal characteristics as well as a third general category of characteristics related to crop-specific characteristics. Crop-specific characteristics are included to attempt to explain differences in the use of marketing contracts and spot markets among specific specialty crops or categories of specialty crops. Hypotheses are developed about the effect particular producer, farm-specific, and crop-specific characteristics have on the decision to adopt contracts along with the decision of what proportion of production to contract.

The effects of all three categories of characteristics (personal, farm-specific, and crop-specific) on the adoption and use of marketing contracts by individual producers are examined under the assumption that producers are risk-averse. Although the assumption that producers are risk-averse is common in previous research (Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Musser et al. 1996; McLeay and Zwart 1998; Sartwelle et al. 2000; Katchova and Miranda 2004), accounting for possible changes in risk preferences is difficult because risk preferences are unknown and unobservable. Therefore, addressing risk-aversion and the effects of characteristics on a producer's unknown preference for risk is problematic. In addition, the production of specialty crops can be viewed as diversifying a farm operation from the production of traditional crops, but whether or not the production of specialty crops necessarily represents income diversification is unclear (Johnson and Tefertiller 1964).

Personal Characteristics

Producer-specific personal characteristics such as producer age and experience, human capital accumulation through education, and the adoption of technologies such as computers in general and for use in various tasks such as bookkeeping may explain why some producers utilize marketing contracts and others do not. As a producer's level of experience with a specific market increase, the producer's familiarity with and ability to effectively utilize a spot cash market for a specific crop may also increase, and therefore the use of marketing contracts is potentially inversely related to experience. However, younger farmers may have less equity and less to lose from taking risks along with a longer planning horizon over which to recover costs and losses from risks, and therefore more experienced producers could be considered more risk-averse than younger producers and experience would be positively related to the use of marketing contracts. Thus, the expectation for the effect of experience on marketing contract adoption and the proportion of production contracted is unclear.

Producers with more human capital have lower costs of understanding and interpreting the terms of the marketing contracts and are therefore more likely to adopt marketing contracts and utilize contracts for a larger proportion of their production. Thus, producers with higher levels of education, such as undergraduate or graduate college degrees, are hypothesized to be more likely to adopt marketing contracts. However, producers with higher levels of education may also be less risk-averse and less likely to utilize contracts or contract a lower proportion of specialty crop production leaving the effects of education ambiguous.

A producer who adopts other technologies, such as a computer, and utilizes the new technologies within his/her farming operation through tasks such as bookkeeping with a computer may be more likely to adopt other technologies in the farming operation. If marketing contracts can be considered a form of new technology which the producer can adopt, then producers who adopt other forms of technology such as utilizing computers for bookkeeping will be more likely to adopt marketing contracts as well.

Farm-Specific Characteristics

Farm-specific characteristics may also influence whether or not producers adopt marketing contracts as well as the proportion of production which is marketed with marketing contracts. Farm-specific characteristics include farm size, gross farm revenues, whether or not livestock sales are a part of farm revenues, whether or not additional income for the farm comes from off-farm sources, and general regional geographic characteristics.

Producers operating a large farm, in terms of either acres or gross farm income, may have economies of size in the ability to spread the costs incurred from contracting over a large number of acres or a large amount of gross farm income. Therefore, farm size and gross farm income may both be positively related to the adoption of marketing contracts and would lead to an increased proportion of production marketed with marketing contracts. However, as gross farm income increases, producers may become less-risk-averse and thus both marketing decisions may be negatively related to gross farm income. Thus, the effect of gross farm income on the use of contracts is uncertain.

Livestock sales and off-farm income can be viewed as a proxy for enterprise diversification. Diversified farms have alternative sources to manage risk through off-farm income or the sale of commodities other than the crop of interest. Therefore, producers of a diversified operation may be less risk-averse than non-diversified producers with respect to marketing specialty crop production, and thus more willing to utilize the spot cash market and to contract a lower proportion of production. Also, producers of more diversified operations have less time to spend on the marketing of specialty crops and may be unable to invest the time and energy into searching for and learning the methodology behind utilizing marketing contracts and would therefore be more likely to use the spot cash market.

Geographic characteristics may also affect contracting decisions. If there are regional characteristics that are unobserved which influence an individual producer's use of marketing contracts, regional dummy variables could help capture the unobserved influences. Regional variables also capture unknown, random characteristics that affect a producer's expectation of the yield for a particular crop. Yield expectations are assumed to influence the proportion of production a producer is willing to contract. Regional variables may capture random characteristics that affect yield expectations.

Crop-Specific Characteristics

Examples of crop specific characteristics include whether or not the specialty crop is an oilseed or a crop used for livestock feed purposes, whether the crop is irrigated, and the distance from the buyer to the delivery point for the specialty crop production. Crops that have multiple uses in terms of the markets available to deliver the production may be less likely to adopt marketing contracts. For instance, a crop that can be used as feed for livestock may be marketed to a buyer for processing of the crop, used on the farm or ranch operation for livestock feed in the operation, or sold to a different buyer in the market for livestock feed. This multi-faceted or multi-use crop would be expected to be associated with a lower proportion of production contracted due to the number of uses and markets available for its marketing. Crop-specific variables may also capture the effects of unknown, random characteristics that influence crop yields. As with regional variables, crop-specific variables that affect a producer's expectation of crop yield are directly related to the producer's decision of what proportion of production to contract.

The variability in yield of specialty crop production and buyer preferences for specific qualities of a specialty crop may be identifiable in whether or not the specialty crop is irrigated. There is typically less variability in production from irrigated crops, and therefore the risk of defaulting on a marketing contract decreases, leading to a higher proportion of production contracted. Buyers of specialty crops may want to secure a higher proportion of irrigated specialty crop production to ensure a predictable supply of the specialty crop. In addition, irrigated specialty crop production may also be more consistent in quality which is a desirable attribute to buyers as well. Irrigated crops are, therefore, likely to be contracted more frequently and in higher proportions than non-irrigated crops.

The distance from the producer's farm to the delivery point or buyer of the specialty crop production may have conflicting effects. From a transaction cost perspective, the costs of delivery will be higher as the distance from the buyer increases and therefore producers would be expected to cover the additional costs with price risk-reducing mechanisms such as marketing contracts. However, the relevant distance measure is the distance between the market for specialty crop production sold under marketing contract and the market for production sold in the spot cash market. As the relative distance decreases for production marketed with marketing contracts compared to the spot cash market, transportation costs are relatively lower and therefore marketing contracts will be utilized more frequently and for a higher proportion of production.

Empirical Contract Adoption and Proportion of Production Contracted Decisions

In the theoretical model of contract adoption, the decision is represented by $c_i = h(\gamma'\mathbf{z}_i, \varepsilon_{ci})$ where c_i equals one if adopting marketing contracts or zero if not, and $\mathbf{z}_i$ is a matrix of characteristics influencing the adoption decision. This discrete decision of contract adoption is modeled:

$$(3.3)\quad c_i = h\left\{ \begin{pmatrix} \gamma_0 & \gamma_1 & \gamma_2 & \ldots & \gamma_p \end{pmatrix} \begin{pmatrix} 1 & 1 & \ldots & 1 \\ z_{11} & z_{12} & \ldots & z_{1n} \\ z_{21} & z_{22} & \ldots & z_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ z_{p1} & z_{p2} & \ldots & z_{pn} \end{pmatrix} + \left(\varepsilon_{ci}\right) \right\}$$

Equation (3.3) shows that for the discrete contract adoption decision, there are p variables representing personal, farm, and crop-specific characteristics and n observations for each variable. In addition, (p + 1) different parameters are associated with each variable such that γ_0 represents the intercept and γ_1 through γ_p represent the coefficients for the remaining variables. In addition, ε_{ci} represents the unmeasured factors or characteristics also related to the adoption decision.

The proportion of production contracted decision is defined as $\alpha_i = g_\alpha(\beta_\alpha'\mathbf{x}_i, \varepsilon_{\alpha i})$ where:

$$(3.4)\quad \alpha_i = g_\alpha\{\begin{pmatrix}\beta_{\alpha 0} & \beta_{\alpha 1} & \beta_{\alpha 2} & \dots & \beta_{\alpha r}\end{pmatrix}\begin{pmatrix}1 & 1 & \dots & 1\\ x_{11} & x_{12} & \dots & x_{1n}\\ x_{21} & x_{22} & \dots & x_{2n}\\ \dots & \dots & \dots & \dots\\ x_{r1} & x_{r2} & \dots & x_{rn}\end{pmatrix} + \begin{pmatrix}\varepsilon_{\alpha i}\end{pmatrix}\}$$

The r explanatory variables, represented by x_1 through x_r, consist of personal, farm, and crop-specific characteristics. The parameter vector, β_α, will contain an intercept term $\beta_{\alpha 0}$ and then coefficients for each of the explanatory variables $\beta_{\alpha 1}$ through $\beta_{\alpha r}$.

In both the adoption decision and the decision about the proportion of the crop to contract, a functional form is specified for each decision. The functional form is represented by h{.} for the adoption decision and g_α\{.\} for the proportion contracted decision.

Summary

This chapter developed a model of the use of marketing contracts and the proportion of production contracted by specialty crop producers, similar to the two-step maximization of expected utility of profits model initially developed by Katchova and Miranda (2004). Several hypotheses are examined about how characteristics of the producer, farm, and crop affect both the decision of adopting marketing contracts and the proportion of production to contract decision. Personal characteristics, farm-specific characteristics, and crop-specific characteristics are the three general categories of characteristics considered. Utilizing these three general categories of characteristics, several hypotheses have been presented about differences in adoption of contracts and the proportion of production contracted decisions. The variables in the three general categories of characteristics include years farming, producer education, total farm acreage, gross farm revenues, and the number of uses or markets available for the specific crop.

CHAPTER 5

DATA & SURVEY METHODOLOGY

Data for this study were collected from a non-random survey of specialty crop producers located in the eight counties where specialty crop production is concentrated in Montana. The data were collected using a two-stage survey process. In the first stage, implemented in the spring and summer of 2003, a general survey was administered to 444 members of the Montana Grain Growers Association. The objective of this survey was to identify producers that produce specialty crops in their farming operation in the eight counties. The second stage, implemented in January of 2004, consisted of more detailed marketing surveys sent to respondents of the first survey who produced specialty crops and indicated that they would be willing to participate in a follow up survey about their marketing practices. This chapter describes the methods by which the data were obtained and the variables for which information was collected in order to investigate the key questions and hypotheses of this study.

Survey Methodology

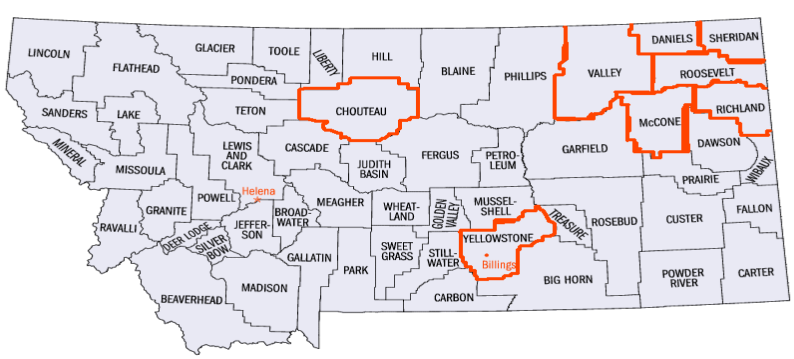
The survey's focus was to identify production and marketing strategies for specialty crop production[16]. Specialty crops were defined to be minor oilseeds, pulse crops, malting barley, alfalfa seed, and other crops with small acreage. The specialty

[16] The survey was designed by the author in cooperation with Dr. Vincent H. Smith and Dr. James B. Johnson, all of Montana State University's Department of Agricultural Economics & Economics, and was administered by the Montana Grain Growers Association.

crops of most interest are: alfalfa seed, Austrian winter peas, canola, chickpeas, crambe, dry edible peas, flaxseed, lentils, malting barley, mustard seed, pinto beans, safflower, and sunflower. Production of these specialty crops is concentrated in the northeast region of the state of Montana, centered in approximately six to eight counties in the Northeast statistical district as reported by the Montana Agricultural Statistics Service (MASS). Some production of specialty crops also occurred in other districts in Montana.

The sample for the survey was selected to maximize the number of Montana specialty crop producers included in the survey. Thus, the survey was sent to all Montana Grain Growers Association members whose operations were located in the six counties with the largest proportion of specialty crop production in the Northeastern district. In addition to the six Northeastern counties, producers were also surveyed in two additional counties, Chouteau and Yellowstone. A total of 444 agricultural producers in the eight selected counties received the initial survey. The eight counties surveyed were as follows: Chouteau, Daniels, McCone, Richland, Roosevelt, Sheridan, Valley, and Yellowstone. These counties are outlined in Figure 1.

Figure 1: Montana Counties in Survey Sample[17]



[17] The map of Montana counties was obtained from the United States Census Bureau (2005)

Thus, the first stage of the survey process consisted of a non-random, purposive sample whose respondents were chosen to increase the probability that individuals receiving and responding to the surveys were specialty crop producers. The non-random approach was adopted because, in the 2003 crop year, the acreage planted to specialty crops in Montana accounted for only two and a half percent of total Montana cropland acres. For any feasible sample size, a random sample was unlikely to result in a sufficient number of observations for specialty crop production and marketing.

In addition to the producers surveyed from the Montana Grain Growers Association sample, 26 additional American Indian producers in two of the eight counties of interest, Roosevelt and Valley, were surveyed by authorized members of the Fort Peck Community College. These respondents are members of the Fort Peck Indian Reservation and provided a second opportunity to target agricultural producers in two of the counties of interest in which specialty crops were produced.

The two-stage sampling approach was used for three reasons: to optimize the accuracy of the information received, to obtain the highest response rate possible, and to minimize respondent burden. The two-stage approach began with an initial one-page survey accompanied by a letter from the Montana Grain Growers Association explaining the purpose of the study[18]. The survey was mailed to all 444 members of the Montana Grain Growers Association located in the eight target Montana counties with a self-addressed stamped envelope for their return. The initial survey asked producers to respond to three sets of questions. First, they were asked to fill in a table listing how

[18] See Appendix B for a copy of both the authorized Montana Grain Growers Association letter and the Pre-Survey

many acres of each of the 13 specialty crops of interest that they had planted and harvested for the 2000, 2001, and 2002 crop years. Second, they were asked whether or not they were willing to participate in a more detailed follow-up survey related to their marketing practices for specialty crop production. Third, they were asked to identify the month that would be most convenient for them to respond to a follow-up survey.

From the initial survey, 199 of the 444 surveys were returned resulting in a response rate of forty-five percent. Ninety-nine of these 199 respondents produced at least one specialty crop from 2000 to 2002 and 73 respondents agreed to participate in a more detailed follow-up survey. Most of the 126 producers who did not wish to participate in the follow-up survey did not produce any specialty crops. Thirty-one of the 126 producers (about 25 percent) not participating had produced at least one specialty crop in the past three years, but 95 of the 126 had not produced any specialty crops. Among those who did produce specialty crops but chose not to participate, 68 percent produced only one specialty crop and 39 percent had not harvested any specialty crops in the year prior to the survey.

The follow-up survey was administered to the 73 producers who indicated that they were willing to participate in the second stage of the project along with the 26 additional producers from the Fort Peck Indian Reservation[19]. The follow-up survey consisted of two separate parts. The first component asked producers to list planted and harvested acreage for every crop in their farming operation and to provide general

[19] The second survey was also accompanied by a letter authorized by the Montana Grain Growers Association. See Appendix B for a copy of the Montana Grain Growers Association letter and the two components of the follow-up survey.

producer-specific information on characteristics such as producer age, education level, gross farm revenues, and other personal characteristics. The second component consisted of a series of crop-specific questions on pricing information, marketing strategies, and the use of contracts. Producers were asked to respond to the second set of questions for each specialty crop produced in the 2000, 2001, 2002, and 2003 crop years. The follow-up surveys were also coded and compiled by the Montana Grain Growers Association. Forty-five of the 73 follow-up surveys were received after the initial mailing for a response rate of approximately 62 percent. To increase the response rate and maximize the number of observations out of our sample, a second letter from the Montana Grain Growers Association was then drafted and mailed with identical producer-specific and crop-specific surveys to those producers who had not responded to the initial mailing[20]. The second mailing produced 18 new respondents, resulting in a total of 63 responses to the second survey and a total response rate of approximately 86 percent.

In addition to the 63 respondents from the Montana Grain Growers Association sample, 10 of the 26 Fort Peck Indian Reservation producers surveyed provided information on their production and marketing of specialty crops. Thus, 73 producers overall responded to both parts of the follow-up survey and provided information on specialty crop production and marketing practices used.

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[20] See Appendix B for a copy of the letter accompanying the surveys re-sent to producers that did not respond to the initial mailing.

Data Description

The data obtained from the 73 producers from the Montana Grain Growers Association and the Fort Peck Community College samples were used to create the variables used to test the key questions and hypotheses of this study. Of the 73 producers in the sample, 62 respondents provided crop-specific surveys for each specialty crop that they produced between 2000 and 2003. Although only 62 producers in the sample produced specialty crops, each producer had produced varying numbers of specialty crops between the 2000 and 2003 crop years and, therefore, the number of crop-specific follow-up surveys received increased our observation total to 110 overall observations of crop-specific components. The proportion of producers that produced specific numbers of specialty crops is shown in Table 1. Fifty percent of the respondents produced one specialty crop, 29 percent produced two specialty crops, 16 percent produced three specialty crops, and the remaining five percent produced four or five specialty crops.

Table 1: Number of Observations per Producer

Number of Specialty Crops	Producers Planting Specific Number of Specialty Crops	Percentage of Sample
1	31	50.00%
2	18	29.03%
3	10	16.13%
4	2	3.23%
5	1	1.61%

The focus of this study is to examine which characteristics of individual producers, farming operations, and the crop or industry affect the decision to utilize a marketing contract over other means of marketing specialty crop production. The survey provided a substantial amount of information on producer, farm-specific, and crop-specific characteristics along with other ancillary information. A comprehensive list of variables, definitions, and summary statistics is presented in Appendix C. The tables in Appendix C contain information on the acreage planted to a variety of both general crops (wheat, barley, etc.) and specialty crops. For each crop, data were collected on acres planted on re-cropped land (land used to produce a crop the year prior) and fallowed land (land that was placed in a fallow rotation the year prior). Thus, for example, the variable *DurumRecrop* gives the acreage of each producer's operation planted to Durum wheat on re-cropped land. Appendix C contains many variables from the producer-specific surveys that are not utilized in this study. However, the variables of most interest for the purposes of this study are presented in Tables 2 and 3. Variable definitions are provided in Table 2 and summary statistics are presented in Table 3.

Table 2: Producer-Specific Survey Variable Definitions

VARIABLE	VARIABLE DEFINITION
Chouteau	(0,1) Dummy for Chouteau as the county where farming operation is located
Daniels	(0,1) Dummy for Daniels as the county where farming operation is located
McCone	(0,1) Dummy for McCone as the county where farming operation is located
Richland	(0,1) Dummy for Richland as the county where farming operation is located
Roosevelt	(0,1) Dummy for Roosevelt as the county where farming operation is located
Sheridan	(0,1) Dummy for Sheridan as the county where farming operation is located
Valley	(0,1) Dummy for Valley as the county where farming operation is located
Yellowstone	(0,1) Dummy for Yellowstone as the county where farming operation is located
Northcentral	(0,1) Dummy for Northcentral as the geographic region where farming operation is located
Northeast	(0,1) Dummy for Northeast as the geographic region where farming operation is located
Southcentral	(0,1) Dummy for Southcentral as the geographic region where farming operation is located
Years Farming	Years of farming experience for farm operator
Age	Age of farm operator
Some High School	(0,1) Dummy for Some High School as highest educational level attained
High School Diploma	(0,1) Dummy for High School Diplomaas highest educational level attained
Trade School	(0,1) Dummy for Trade School as highest educational level attained
Associate Degree	(0,1) Dummy for Associates Degree as highest educational level attained
Some College	(0,1) Dummy for Some College as highest educational level attained

Table 2: Producer-Specific Survey Variable Definitions (Continued)

VARIABLE	VARIABLE DEFINITION
College Degree	(0,1) Dummy for College Degree as highest educational level attained
Graduate Degree	(0,1) Dummy for Graduate Degree as highest educational level attained
College Graduate	(0,1) Dummy combining College Degree and Graduate Degree
Any College	(0,1) Dummy combining Some College, College Degree, and Graduate Degree
Computer	(0,1) Dummy for ownership of a computer
Bookkeeping on Computer	(0,1) Dummy for performing of bookkeeping on a computer
Internet	(0,1) Dummy for internet access on the farm/ranch
Off-Farm Income	(0,1) Dummy for receipt of income from off-farm employment
Livestock	(0,1) Dummy for receipt of income from sale of livestock
<$10K GFI	(0,1) Dummy for Gross Farm Revenues less than $10,000
$10-49K GFI	(0,1) Dummy for Gross Farm Revenues between $10-49,999
$50-99K GFI	(0,1) Dummy for Gross Farm Revenues between $50-99,999
$100-249K GFI	(0,1) Dummy for Gross Farm Revenues between $100-249,999
$250-499K GFI	(0,1) Dummy for Gross Farm Revenues between $250-499,999
>$500K GFI	(0,1) Dummy for Gross Farm Revenues over $500,000
Contracts General Crops	(0,1) Dummy for use of marketing contracts for General Crop production (wheat, barley, etc.)
Contracts Specialty Crops	(0,1) Dummy for use of marketing contracts for Specialty Crop production (canola, etc.)
Crop Acreage	Total acreage of farming operation

Table 3: Producer-Specific Survey Variable Summary Statistics

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Chouteau	89	12.36%	0.00%	100.00%	33.10%
Daniels	89	4.49%	0.00%	100.00%	20.84%
McCone	89	4.49%	0.00%	100.00%	20.84%
Richland	89	6.74%	0.00%	100.00%	25.22%
Roosevelt	89	30.34%	0.00%	100.00%	46.23%
Sheridan	89	16.85%	0.00%	100.00%	37.65%
Valley	89	20.22%	0.00%	100.00%	40.40%
Yellowstone	89	4.49%	0.00%	100.00%	20.84%
Northcentral	89	12.36%	0.00%	100.00%	33.10%
Northeast	89	83.15%	0.00%	100.00%	37.65%
Southcentral	89	4.49%	0.00%	100.00%	20.84%
Years Farming	89	28.66	1.00	60.00	10.56
Age	88	51.72	29.00	85.00	9.82
Some High School	88	4.55%	0.00%	100.00%	20.95%
High School Diploma	88	11.36%	0.00%	100.00%	31.92%
Trade School	88	1.14%	0.00%	100.00%	10.66%
Associate Degree	88	1.14%	0.00%	100.00%	10.66%

Table 3: Producer-Specific Survey Variable Summary Statistics (Continued)

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Some College	88	38.64%	0.00%	100.00%	48.97%
College Degree	88	39.77%	0.00%	100.00%	49.22%
Graduate Degree	88	4.55%	0.00%	100.00%	20.95%
College Graduate	88	44.32%	0.00%	100.00%	49.96%
Any College	88	82.95%	0.00%	100.00%	37.82%
Computer	89	91.01%	0.00%	100.00%	28.76%
Bookkeeping on Computer	89	68.54%	0.00%	100.00%	46.70%
Internet	89	86.52%	0.00%	100.00%	34.35%
Off-Farm Income	89	65.17%	0.00%	100.00%	47.91%
Livestock	89	43.82%	0.00%	100.00%	49.90%
<$10K GFI	84	1.19%	0.00%	100.00%	10.91%
$10-49K GFI	84	3.57%	0.00%	100.00%	18.67%
$50-99K GFI	84	13.10%	0.00%	100.00%	33.94%
$100-249K GFI	84	38.10%	0.00%	100.00%	48.85%
$250-499K GFI	84	30.95%	0.00%	100.00%	46.51%
>$500K GFI	84	10.71%	0.00%	100.00%	31.12%
Contracts General Crops	89	35.96%	0.00%	100.00%	48.26%
Contracts Specialty Crops	89	52.81%	0.00%	100.00%	50.20%
Crop Acreage	89	3225.22	146.00	13840.00	2776.40

In this sample, the average producer has approximately 27 years of experience farming and is 52 years old. Among these producers, 83 percent have completed at least attended some college while approximately 44 percent have graduated with an undergraduate or graduate college degree. Computers are owned by 91 percent of the producers in the sample and 86 percent have access to the internet on their farm/ranch operation. Over 65 percent of the sample receives income from off-farm sources and approximately 44 percent of producers receive income from the sale of livestock. The highest proportion of producers, over 38 percent of the sample, has gross farm revenues in the range of $100-249,999. The second highest proportion of producers, approximately 31 percent of the sample, has gross farm revenues in the range of $250-499,999. The average total cropland acreage for producers in this sample is approximately 3,225.2 acres. Contracts were utilized by producers in the sample for approximately 36 percent of general crop production for crops such as winter wheat, spring wheat, barley, and durum wheat. Specialty crop production was contracted much more frequently than general crops with approximately 53 percent of specialty crop production marketed under some form of contract.

The variables of most interest in this study are presented in Tables 4 and 5. Variable definitions are presented in Table 4 and summary statistics for each of the variables are presented in Table 5. Tables 4 and 5 provide general insights about crop-specific characteristics and marketing strategies utilized by the producers in the sample for specialty crop production.

Table 4: Crop-Specific Survey Variable Definitions

VARIABLE	VARIABLE DEFINITION
Canola	(0,1) Dummy for Canola as the specialty crop of interest
Chickpeas	(0,1) Dummy for Chickpeas as the specialty crop of interest
Dry Edible Peas	(0,1) Dummy for Dry Edible Peas as the specialty crop of interest
Flax	(0,1) Dummy for Flax as the specialty crop of interest
Lentils	(0,1) Dummy for Lentils as the specialty crop of interest
Malting Barley	(0,1) Dummy for Malting Barley as the specialty crop of interest
Mustard	(0,1) Dummy for Mustard as the specialty crop of interest
Safflower	(0,1) Dummy for Safflower as the specialty crop of interest
Pulses	(0,1) Dummy for Pulses as the specialty crop category of interest
Oilseeds	(0,1) Dummy for Oilseeds as the specialty crop category of interest
Irrigated	(0,1) Dummy for irrigating crop of interest
Cooperative With Price	Percentage of specialty crop production priced to a marketing cooperative with a predetermined price

Table 4: Crop-Specific Survey Variable Definitions (Continued)

VARIABLE	VARIABLE DEFINITION
Cooperative No Price	Percentage of specialty crop production priced to a marketing cooperative without a predetermined price
Marketing Contract	Percentage of specialty crop production priced to a buyer under contract with a predetermined price
Contract No Price	Percentage of specialty crop production priced to a buyer under contract without a predetermined price
Spot Cash	Percentage of specialty crop production priced through the spot cash market
Basis Fixed Contract	Percentage of specialty crop production priced to a buyer with a basis-fixed contract
Production Contract Dummy	(0,1) Dummy for use of a production contract in producing crop of interest
Marketing Contract Dummy	(0,1) Dummy for use of a marketing contract in producing crop of interest
Other Contracts Dummy	(0,1) Dummy for use of other types of contract in producing crop of interest
No Contract Dummy	(0,1) Dummy for not using any type of contract in producing crop of interest
Montana	(0,1) Dummy for contracting with a firm in Montana
North Dakota	(0,1) Dummy for contracting with a firm in North Dakota
Colorado	(0,1) Dummy for contracting with a firm in Colorado
Saskatchewan	(0,1) Dummy for contracting with a firm in Saskatchewan
Other USA Unknown State	(0,1) Dummy for contracting with a firm in an unknown US state
Idaho	(0,1) Dummy for contracting with a firm in Idaho
Minnesota	(0,1) Dummy for contracting with a firm in Minnesota
North Carolina	(0,1) Dummy for contracting with a firm in North Carolina
Alberta	(0,1) Dummy for contracting with a firm in Alberta
California	(0,1) Dummy for contracting with a firm in California
Wyoming	(0,1) Dummy for contracting with a firm in Wyoming
Distance	Distance in miles from the point of delivery for the crop of interest

Table 5: Crop-Specific Survey Variable Summary Statistics

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Canola	110	17.27%	0.00%	100.00%	37.97%
Chickpeas	110	5.45%	0.00%	100.00%	22.81%
Dry Edible Peas	110	14.55%	0.00%	100.00%	35.42%
Flax	110	4.55%	0.00%	100.00%	20.93%
Lentils	110	9.09%	0.00%	100.00%	28.88%
Malting Barley	110	13.64%	0.00%	100.00%	34.47%
Mustard	110	13.64%	0.00%	100.00%	34.47%
Safflower	110	14.55%	0.00%	100.00%	35.42%
Pulses	110	29.09%	0.00%	100.00%	45.63%
Oilseeds	110	50.00%	0.00%	100.00%	50.23%
Irrigated	110	8.18%	0.00%	100.00%	27.53%

Table 5: Crop-Specific Survey Variable Summary Statistics (Continued)

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Cooperative With Price	110	3.64%	0.00%	100.00%	18.80%
Cooperative No Price	110	4.55%	0.00%	100.00%	20.93%
Marketing Contract	110	57.00%	0.00%	100.00%	44.42%
Contract No Price	110	2.45%	0.00%	100.00%	14.28%
Spot Cash	110	30.73%	0.00%	100.00%	41.21%
Basis Fixed Contract	110	1.64%	0.00%	100.00%	10.97%
Production Contract Dummy	109	8.26%	0.00%	100.00%	27.65%
Marketing Contract Dummy	109	68.81%	0.00%	100.00%	46.54%
Other Contracts Dummy	109	3.67%	0.00%	100.00%	18.89%
No Contract Dummy	109	23.85%	0.00%	100.00%	42.82%
Montana	83	48.19%	0.00%	100.00%	50.27%
North Dakota	83	21.69%	0.00%	100.00%	41.46%
Colorado	83	3.61%	0.00%	100.00%	18.78%
Saskatchewan	83	33.73%	0.00%	100.00%	47.57%
Other USA Unknown State	83	2.41%	0.00%	100.00%	15.43%
Idaho	83	4.82%	0.00%	100.00%	21.55%
Minnesota	83	2.41%	0.00%	100.00%	15.43%
North Carolina	83	3.61%	0.00%	100.00%	18.78%
Alberta	83	6.02%	0.00%	100.00%	23.94%
California	83	8.43%	0.00%	100.00%	27.96%
Wyoming	83	1.20%	0.00%	100.00%	10.98%
Distance	81	78.80	0.00	500.00	94.10

Approximately eight percent of specialty crop production is irrigated, and 83 percent of producers planted and harvested a specialty crop in the 2002 crop year, a year prior to the survey. Ninety-one percent of the sample planted a specialty crop in the 2003 crop year, and producers planted an average of 382.6 acres to a specialty crop. Specialty crop production averaged approximately 12 percent of total farm cropland, and ranged from two percent to 58 percent among producers. About 57 percent of producers sold specialty crops under a marketing contract that priced production. Approximately 31 percent of specialty crops produced were sold in the spot cash market. The average distance to a delivery point for specialty crops was approximately 79 miles.

Specialty crop acreage accounted for approximately 14 percent of total cropland acres in the sample. Overall specialty crop acres in the state of Montana for the 2003 crop year accounted for two and a half percent of total cropland acres. Approximately 71 percent of the entire specialty crop acreage produced in the sample was sold under some form of contract, while 29 percent was not sold under contract.

Contracting also varied across individual crops. Among crops grown by at least five producers, safflower was the most frequently contracted crop with over 97 percent of safflower acreage contracted. Approximately 81 percent of malting barley acres were contracted, 76 percent of dry edible pea acreage was contracted, 73 percent of mustard seed production was contracted, and approximately 72 percent of lentil acreage was contracted. The three crops with the lowest percentage of total sample acreage contracted were chickpeas (57 percent), canola (47 percent), and flaxseed (12 percent).

Individual producers within crops also utilized contracts at various rates as well. For malting barley and mustard seed, 15 respondents produced both crops and 14 of the 15 utilized contracts in the production of both crops. Safflower was contracted by 12 of 13 respondents, and lentils were contracted by 7 of 8 respondents. Canola was contracted by 12 of 19 respondents, chickpeas by three of five respondents, dry edible peas by five of 10 respondents, and flaxseed was contracted by two of five respondents.

Summary

The use of contracts varies among all producers and all crops, but it is also apparent that the use of contracts for marketing specialty crop production varies substantially across individual crops and among producers of each specific specialty crop. The data described in this chapter will be used to test the key hypotheses of this study about the determinants of marketing contract use by specialty crop producers. The data obtained from both of the follow-up surveys of Montana Grain Growers Association members provides information to investigate the effects of specific personal, farm-specific, and crop-specific characteristics on the adoption of marketing contracts and the proportion of production contracted decision. The next chapter will outline the empirical models utilized to test the hypotheses with the data outlined in this chapter and present results of those tests and hypotheses.

CHAPTER 6

EMPIRICAL MODELS AND RESULTS

The purpose of this study is to examine empirically the characteristics that affect the adoption of marketing contracts and the proportion of production contracted by specialty crop producers. This chapter describes the estimation procedures used to obtain parameter estimates for models of adoption and the proportion of production contracted by specialty crop producers. In addition, this chapter presents the results of the empirical analysis.

Empirical Estimation Setup

In Chapter 3, several hypotheses were developed about how specific characteristics influence a producer's specialty crop marketing decisions. Personal, farm-specific, and crop-specific characteristics comprise the three general categories of variables that influence a producer's decision about whether to adopt marketing contracts and their decision about what proportion of output to sell under these contracts.

A producer's decision about whether or not to adopt a marketing contract is represented by c_i, where $c_i = 0$ represents a decision not to adopt marketing contracts and $c_i = 1$ represents a decision to adopt marketing contracts. The adoption decision is formally related to a matrix of observable personal, farm, and crop characteristics, $\mathbf{z}_i$, through the function,

(5.1) $P(c_i = 1) = h(\gamma'\mathbf{z}_i, \varepsilon_{ci})$

In equation (5.1), $P(c_i = 1)$ is the probability that marketing contracts will be adopted, γ is a parameter vector and ε_{ci} is the error term representing unmeasured factors relating to adoption of marketing contracts.

Probability models such as equation (5.1) are typically estimated empirically using either logit or probit models. Both are binary probability models in which the dependent variable is distributed between 0 and 1. The functional form of h in equation (5.1) is determined by the assumptions placed upon the distribution of the error term, ε_{ci} (Liao 1994; Greene 2000). Two alternative assumptions are made about the distribution of error terms in binary probability models. The first is that the error term follows a logistic distribution, which yields a logit model. The second is that the error term follows a normal distribution, which yields a probit model. Liao (1994) notes that these assumptions will often yield similar parameter estimates. Greene (2000) also states that it is difficult to justify the choice of one distribution over the other on theoretical grounds. The logit distribution is fatter in the tails and therefore may be more appropriate with an extremely large number of observations. Previous studies of the marketing contract adoption decision have utilized the normality assumption for the error term distribution. In addition, the number of observations available for analysis in this study is relatively small. Thus, probit models are used to estimate equation (5.1).

Conditional upon the decision to adopt marketing contracts, the i^{th} producer must determine the proportion of specialty crop production to be contracted, α_i, where $\alpha_i > 0$[21].

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[21] A producer can contract more than their actual post-harvest production, and therefore α_i is not constrained from above. See Katchova and Miranda (2004) for a more detailed explanation of the proportion of production to be contracted decision and the bounds of α_i.

This decision is also a function of a set of personal, farm-specific, and crop-specific characteristics, $\mathbf{x}_i$, which may be the same or a different set of variables than the set that influence the adoption decision, $\mathbf{z}_i$; that is, $\mathbf{x}_i$ and $\mathbf{z}_i$ may or may not be the same matrix of variables. Formally, the decision about what proportion of production to contract can be represented as follows:

(5.2) $\alpha_i = g_\alpha(\beta_\alpha' \mathbf{x}_i, \varepsilon_{\alpha i})$

In equation (5.2), β_α is a parameter vector and the error term, $\varepsilon_{\alpha i}$, represents unmeasured factors relating to the decision of what proportion to contract. Equation (5.2) is often estimated empirically using a Tobit model in which the data is assumed to be censored. Censored observations imply that there are known values of the explanatory variables, but the corresponding values of the dependent variable are unobservable. A second empirical method is to utilize a truncated regression that truncates the sample, implying that values of the explanatory variables are known only when the dependent variable is observed. Either a Tobit regression model or a truncated regression could be utilized to estimate equation (5.2).

Kennedy (2003) notes that one drawback to using a Tobit model is the assumption that the equation determining whether or not an observation is included in the sample is the same as the equation that yields the value of the dependent variable. In the context of the maximization problem for specialty crop producers, a Tobit model would imply that the same set of characteristics affects both the adoption and the proportion of production contracted decisions in the same way, yielding a one-step maximization process. Lin and Schmidt (1984) discuss the restrictive nature of the assumptions of a Tobit model in their example of a Tobit model for the loss due to fire in buildings. They argue that older buildings are more likely to have fires, but because newer buildings are more valuable, fires in older buildings would result in smaller financial losses than would fires in newer buildings. Therefore, the coefficient on "Age" would have a different sign in a probit or logit model explaining whether or not a building would experience a fire than in a truncated regression explaining the size of the subsequent financial loss. Accounting for these differences is impossible in a Tobit model because of the restriction it places on the coefficients that affect both the probability of a fire and the size of the loss.

In the context of this study, a Tobit model would imply that in equations (5.1) and (5.2), the characteristics which influence the decision to adopt contracts, $\mathbf{z}_i$, would be identical to those characteristics which influence the decision of what proportion of production to contract, $\mathbf{x}_i$. In addition, the characteristics would also influence each decision in the same way, implying that the estimated parameter vectors would also be identical. A characteristic that significantly increases the probability of marketing contract adoption would also significantly increase the proportion of production which the producer would contract.

Cragg (1971) relaxed the assumption that the same variables and the same vector of parameters affect both decisions in a Tobit model. Katchova and Miranda (2004) applied Cragg's approach to a producer's marketing decision by estimating a double-hurdle model in which, initially, a producer decides whether to adopt marketing contracts, estimated through an independent probit model. Once the "hurdle" is crossed and the producer has adopted marketing contracts (that is, $c_i = 1$), then a truncated regression of the proportion of production to be contracted is estimated. The double-hurdle model serves as an alternative to the Tobit model[22].

In order to test the more restrictive Tobit model against the more general two-step model, Cragg proposed a likelihood ratio statistic to test for which approach is more appropriate (Greene 2000). The null hypothesis is that the Tobit model is the appropriate modeling technique and the alternative hypothesis is that Cragg's model (a separate probit and truncated regression) is the appropriate model. The test statistic is computed by fitting a Tobit model using a given set of explanatory variables and then separately fitting a probit model and a truncated model using the same set of explanatory variables. Utilizing the logs of the likelihood values for the three models, Cragg's double-hurdle likelihood ratio statistic, λ, is as follows:

(5.3) $$\lambda = -2\left[\log L_T - (\log L_P + \log L_{TR})\right]$$

In equation (5.3), L_T is the likelihood value for the Tobit model, L_P is the likelihood value for the probit model, and L_{TR} is the likelihood value for the truncated regression model. The likelihood ratio test statistic, λ, is distributed as chi-square (χ^2) with R degrees of freedom, where R is the number of independent variables including a constant. Cragg's test statistic (equation (5.3)) is estimated for several alternative modeling specifications of the contracting decisions. As discussed further below, in all cases, the estimated values of the test statistic, λ, are significantly larger than the critical χ^2 values at the

[22] Katchova and Miranda (2004) note that the truncation problem considered here is different from a "sample selection" problem which is commonly estimated by Heckman's two-step procedure. Heckman's model is not appropriate for problems like these because the quantity contracted for farmers who have not adopted marketing contracts are observed as being equal to zero rather than being literally unobserved. Please see Katchova and Miranda (2004), Greene (2000), and Lin and Schmidt (1984) for a more thorough discussion of this sampling problem.

ninety-nine percent confidence level. Thus, this study estimates Cragg's double-hurdle models to explain the contracting adoption and contract use decisions.

Heteroscedasticity is often present in cross-section data of the type used in this study. The sample of survey respondents is drawn from a tight geographic distribution and multiple observations come from single producers as each producer may produce more than one specialty crop. Therefore, there are systematic relationships among the error terms associated with individual observations. Greene (2000) notes that maximum likelihood estimators are not consistent in the presence of any form of heteroscedasticity, unmeasured heterogeneity, omitted variables which are orthogonal to the included variables, nonlinearity of the functional form of the index, or errors in distributional assumptions. In the case of heteroscedasticity, the concern here, Greene recommends using White's robust "sandwich" estimator for the asymptotic covariance matrix in order to control for heteroscedasticity. Thus, all of the standard errors in every reported model are computed using the Huber/White sandwich estimator of variances within Stata to account for the potential presence of heteroscedasticity in the error structure.

Empirical Variable Definitions and Expectations

The empirical models used to examine the adoption decision in equation (5.1) are probit models and the empirical models used to estimate the proportion of production to contract decision in equation (5.2) are truncated regression models. The variables incorporated in the matrix $\mathbf{z}_i$ for the adoption decision and the matrix $\mathbf{x}_i$ for the proportion of production to contract decision are personal, farm-specific, and crop-specific characteristics that affect both marketing decisions independently for individual specialty crop producers.

Variables for Personal Characteristics

The personal characteristic variables in matrices $\mathbf{z}_i$ and $\mathbf{x}_i$ are as follows. The producer's age, *Age*, is measured in years and serves as a proxy for experience. Experience may have a positive or negative effect on both the marketing contract adoption decision and the proportion of production to contract decision. As discussed in Chapter 3, farmers may become more or less risk-averse as experience increases, and therefore the effects of experience on both the adoption of a marketing contract as a risk-reducing mechanism and the proportion of production contracted is uncertain. Thus, the expected effect of *Age* is uncertain.

A producer's level of education, as measured through the dummy variables *Some College*, *College Degree*, and *Any College*, serves as a proxy for human capital. *Some College* controls for those producers who attended college but did not graduate, *College Degree* controls for those who graduated college with an undergraduate or graduate degree, and *Any College* controls for both those producers who attended college, whether or not they graduated. The effects of human capital on marketing decisions are unclear. Producers with a higher level of education have lower costs of understanding and interpreting the terms of marketing contracts (Musser et al. 1996), increasing the likelihood of adoption as well as the proportion of production contracted. However, producers with higher levels of education and human capital may be less risk-averse and, therefore, less likely to use marketing contracts as a risk reducing mechanism (Shapiro and Brorsen 1988).

Willingness to adopt new technology is proxied by the dummy variables *Internet* and *Bookkeeping on Computer*, which measure a producer's use of the internet in managing the farm operation and computer-based programs to manage bookkeeping. Producers who use the internet and bookkeeping programs on the computer are assumed to be more likely to adopt marketing contracts and to market a larger proportion of their production with marketing contracts (Goodwin and Schroeder 1994).

Variables for Farm-Specific Characteristics

Geographic-specific information such as the number of specialty crop buyers in a county or region, climate, and soil type varies by county and region, but data on these variables were not available. *A priori*, the effects of each county or regional dummy variable on a farm's marketing decisions are difficult to predict, but these effects should still be taken into account. Geographic effects upon marketing decisions were initially proxied by eight county dummy variables: *Chouteau*, *Daniels*, *McCone*, *Richland*, *Roosevelt*, *Sheridan*, *Valley*, and *Yellowstone*. These variables were intended to capture county-specific effects. However, multicollinearity appeared to be a problem within the set of county dummy variables. Thus, regional dummy variables are utilized. *Northeast* consists *Daniels*, *McCone*, *Richland*, *Roosevelt*, *Sheridan*, and *Valley*, *Northcentral* consists of *Chouteau*, and *Southcentral* consists of *Yellowstone*[23]. The county and regional dummy variables also proxy unknown, random conditions and characteristics of the producer's geographic location which are assumed to be factored into a producer's expectation of crop yield. The contracted proportion of production depends upon these unknown, random characteristics that directly affect crop yield, and therefore the geographic variables help account for yield-affecting random characteristics.

The total area of a farming operation, *Crop Acreage*, serves as proxy for the size of the entire farming operation. Crop-specific revenues would also control for the size and scope for the production of a specific crop, but yield and price data were unavailable for the purposes of this study. Therefore, *Crop Acreage* serves as the main proxy for farm size and the size and scope of the production of individual crops. Farm size is expected to have a positive effect on both contracting decisions as producers operating large farms may have economies of size with respect to their ability to spread costs incurred in learning about and entering into contracts over a large number of acres (Shapiro and Brorsen 1988; Sartwelle et al. 2000). *A priori*, the contract adoption and proportion of production contracted decisions are both expected to be positively related to *Crop Acreage*.

Total gross farm income (GFI) is an indicator of both farm size and farm wealth. Data were available only on the range of GFI within which each farm's income falls. The ranges of GFI included \$0-99,000, \$100-249,000, \$250-499,000, and \$500,000 and

[23] The regional dummy variables , *Northeast*, *Northcentral*, and *Southcentral* were constructed following the regional classification from the Montana Agricultural Statistics Service by which each of the individual county variables was classified into one of the three regional dummy variables.

greater. Three dummy variables, *$100-249K GFI*, *$250-499K GFI*, and *>$500K GFI* are utilized to account for the various levels of GFI, assuming that the base dummy variable is *$0-99K GFI*. Economies of size from higher levels of GFI would imply a predicted positive effect on both marketing decisions (Asplund et al. 1989; Edelman et al. 1990; Katchova and Miranda 2004). However, a potential wealth effect is associated with higher levels of gross income. Thus, from the wealth effect, producers may become less risk-averse[24] and thus both marketing contract decisions may be negatively related to increasing gross farm income (Musser et al. 1996). Therefore, *a priori* the effects on contracting decisions of each gross farm income variable are uncertain.

Sources of additional non-crop farm income are measured through the dummy variables *Off-Farm Income* and *Livestock*, which take on a value of one if the farm receives off-farm income or income from the sale of livestock. These variables proxy for enterprise diversification, as farms with multiple sources of income are considered to be diversified. For a diversified farm, the income from the sale of general and specialty crops is not as vital as it is to a farm whose sole source of income is crop-related income as diversified farms have alternative sources of risk management available. Therefore, contract adoption and the proportion of production contracted are likely to be inversely related to both *Off-Farm Income* and *Livestock*.

[24] Although increasing wealth is hypothesized to decrease the level of absolute risk-aversion, the effect of increasing wealth on relative risk-aversion is uncertain. Therefore, when hypothesizing the effects of wealth on the proportion of production contracted decision, the effect is typically more related to relative risk-aversion. However, in this study, controlling for total crop acreage allows the wealth effect to be analyzed from an absolute risk-aversion perspective for both the adoption and the contracted proportion of production decisions.

Variables for Crop-Specific Characteristics

Marketing channels differ among crops. For some crops, the spot cash market is well-established and locally available, but for others the spot cash market is thin and available only in few locations. For example, some crops that can be utilized for multiple end-products have several markets in which the production can be delivered. In addition, crop-specific characteristics also influence a producer's expectations about crop yield and crop yield variability, which affects the proportion of production contracted by individual producers. Therefore, crop-specific variables may serve as instrument variables for unknown and random characteristics of individual crops and the response of individual crops to random factors, all of which influence crop yields. Crop-specific effects upon marketing decisions were initially proxied by eight crop dummy variables *Canola*, *Chickpeas*, *Dry Edible Peas*, *Flax*, *Lentils*, *Malting Barley*, *Mustard*, and *Safflower*. These variables were intended to capture crop-specific effects. However, multicollinearity appeared to be a problem within this set of crop dummy variables. Thus, instead, two dummy variables for categories of crops. *Oilseeds* consist of *Canola*, *Flax*, *Mustard*, and *Safflower*, *Pulses* consist of *Chickpeas*, *Dry Edible Peas*, and *Lentils*, and *Malting Barley* is its own category due to its unique crop-specific qualities and lack of substitutes. Although some crops in the *Pulses* category may be used as livestock feed and are therefore less likely to be contracted, not all pulse crops are appropriate for use as feed for livestock. There are unknown characteristics accounted for in crop-specific variables and the categorical dummy variables. Thus, it is not possible to make distinct predictions about the relation of specific crop categorical variables to either contracting decision. Given that *Pulses* serve as the base dummy variable category, *a priori* it is not clear how both of the contracting decisions are related to the *Oilseeds* and *Malting Barley* variables.

Distance to market for the delivery of a specialty crop, *Distance*, is measured in miles and serves as a proxy for the transportation costs incurred in delivering contracted production to the market. Data on the difference between the distance to the contractor and the spot cash market were not available. Thus, the proxy variable *Distance* is not an ideal explanatory variable and, *a priori*, its effect on marketing decisions is uncertain.

One indicator of production costs, yield variability, and crop quality of a specific crop is whether or not the crop is irrigated. Thus, the dummy variable *Irrigated* is included in the model. As production costs increase, *ceteris paribus*, a producer may be more likely to ensure a guaranteed price for the crop. Irrigated crops are expected to have higher production costs per acre, and therefore marketing contract adoption is expected to be positively related to the variable *Irrigated*. In addition, yields for irrigated crops are typically less variable than dryland crops. Thus, the likelihood that a producer will have to default on delivery of production to the contractor is lower. Buyers of specialty crop production may also want to secure a higher proportion of irrigated crop production because of the predictable and more consistent production from irrigated crops. Therefore, a producer may be willing to contract a larger proportion of output, and the proportion contracted decision is thus expected to be positively related to the variable *Irrigated*.

Empirical Estimation Models and Estimation Methods

Several alternative empirical models are estimated to investigate how personal, farm-specific, and crop-specific characteristics independently influence both the decision to use marketing contracts and the proportion of production to be contracted. Model parameter estimates for the marketing contract adoption decision and the contracted proportion of production decision are presented in Tables 6 and 7 respectively. Table 8 presents Cragg's double-hurdle likelihood ratio test statistics and the results of likelihood ratio tests for joint significance of subsets of various variables. The contract adoption models are estimated as probit models in Stata in which the dependent variable is *Marketing Contract*, a zero-one dummy variable for the adoption of marketing contracts[25]. The contracted proportion of production models are estimated as truncated regressions in Stata in which the dependent variable is *Contracted Proportion*, a continuous variable measuring the proportion of production marketed under contract to buyers[26]. To correct for the potential problem of heteroscedasticity, all of the models were estimated in Stata using the robust standard error procedure.

The initial models, Adoption Model (1) and Proportion Contracted Model (1), incorporate all of the personal, farm-specific, and crop-specific characteristics described

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[25] Each adoption model is estimated using the "dprobit" option which, rather than reporting coefficients, reports the change in the probability for an infinitesimal change in each independent continuous variable. Also, "dprobit" by default yields the discrete change in the probability for dummy variables. Therefore, instead of coefficients, "Df/Dx" is reported in table 5.1.

[26] The truncated regressions estimated in Stata truncate the sample to include observations whose response for "Proportion of Production Contracted" is greater than zero. Of the 109 observations in the sample, 35 observations were truncated at zero because their proportion of production contracted was equal to zero.

above, including county-specific and crop-specific dummy variables. They are defined as follows:

Adoption Model (1):

$P(c_i = 1) = \varphi(\gamma_0 + \gamma_1 Age_i + \gamma_2 Some\ College_i + \gamma_3 College\ Degree_i + \gamma_4 Internet_i + \gamma_5 Bookkeeping\ on\ Computer_i + \gamma_6 Chouteau_i + \gamma_7 Daniels_i + \gamma_8 McCone_i + \gamma_9 Richland_i + \gamma_{10} Roosevelt_i + \gamma_{11} Valley_i + \gamma_{12} Crop\ Acreage_i + \gamma_{13} \$100\text{-}249K\ GFI_i + \gamma_{14} \$250\text{-}499K\ GFI_i + \gamma_{15} {>}\$500K\ GFI_i + \gamma_{16} Off\text{-}Farm\ Income_i + \gamma_{17} Livestock_i + \gamma_{18} Canola_i + \gamma_{19} Chickpeas_i + \gamma_{20} Dry\ Edible\ Peas_i + \gamma_{20} Flax_i + \gamma_{21} Lentils_i + \gamma_{22} Malting\ Barley_i + \gamma_{23} Mustard_i + \gamma_{24} Safflower_i + \gamma_{25} Distance_i + \gamma_{26} Irrigated_i + \varepsilon_{ci})$

Proportion Contracted Model (1):

$\alpha_i|_{ci=1} = \beta_0 + \beta_1 Age_i + \beta_2 Some\ College_i + \beta_3 College\ Degree_i + \beta_4 Internet_i + \beta_5 Bookkeeping\ on\ Computer_i + \beta_6 Chouteau_i + \beta_7 Daniels_i + \beta_8 McCone_i + \beta_9 Richland_i + \beta_{10} Roosevelt_i + \beta_{11} Valley_i + \beta_{12} Crop\ Acreage_i + \beta_{13} \$100\text{-}249K\ GFI_i + \beta_{14} \$250\text{-}499K\ GFI_i + \beta_{15} {>}\$500K\ GFI_i + \beta_{16} Off\text{-}Farm\ Income_i + \beta_{17} Livestock_i + \beta_{18} Canola_i + \beta_{19} Chickpeas_i + \beta_{20} Dry\ Edible\ Peas_i + \beta_{20} Flax_i + \beta_{21} Lentils_i + \beta_{22} Malting\ Barley_i + \beta_{23} Mustard_i + \beta_{24} Safflower_i + \beta_{25} Distance_i + \beta_{26} Irrigated_i + \varepsilon_{\alpha i}$

Parameter estimates for these initial models are presented in Tables 6 and 7. Inspection of the variance/covariance correlation matrix indicated that, as noted above, individual crop and county variables were highly correlated[27]. For each model, a likelihood ratio test was performed on the joint significance of both individual crop variables and individual county variables, and the test statistics are presented in Table 8. The individual crop variables were jointly significant in both of the models, and the individual county variables were significant in the Adoption Model, but not in the Proportion Contracted Model. Therefore, categorical variables for crop type replaced individual

[27] Appendix D presents results of variance/covariance correlation matrices for each empirical model. In addition, because the sample only consisted of 109 observations, the power of the model decreases with inclusion of additional variables.

crop dummy variables in each initial model, and individual county variables were replaced by regional dummy variables in the adoption model. In addition, *Some College* was highly correlated with *College Degree* and therefore *Some College* was also omitted.

Substituting categorical variables for individual crop dummy variables in each initial model and categorical geographic variables for individual county variables in Adoption Decision (1), and removing *Some College* to obtain the effects of controlling for a college degree results in a second set of estimated models, defined as:

Adoption Model (2):

$$P(c_i = 1) = \varphi(\gamma_0 + \gamma_1 Age_i + \gamma_2 College\ Degree_i + \gamma_3 Internet_i + \gamma_4 Bookkeeping\ on\ Computer_i + \gamma_5 Northcentral_i + \gamma_6 Southcentral_i + \gamma_7 Crop\ Acreage_i + \gamma_8 \$100\text{-}249K\ GFI_i + \gamma_9 \$250\text{-}499K\ GFI_i + \gamma_{10} {>}\$500K\ GFI_i + \gamma_{11} Off\text{-}Farm\ Income_i + \gamma_{12} Livestock_i + \gamma_{13} Oilseed_i + \gamma_{14} Malting\ Barley_i + \gamma_{15} Distance_i + \gamma_{16} Irrigated_i + \varepsilon_{ci})$$

Proportion Contracted Model (2):

$$\alpha_i|_{ci=1} = \beta_0 + \beta_1 Age_i + \beta_2 College\ Degree_i + \beta_3 Internet_i + \beta_4 Bookkeeping\ on\ Computer_i + \beta_5 Crop\ Acreage_i + \beta_6 \$100\text{-}249K\ GFI_i + \beta_7 \$250\text{-}499K\ GFI_i + \beta_8 {>}\$500K\ GFI_i + \beta_9 Off\text{-}Farm\ Income_i + \beta_{10} Livestock_i + \beta_{11} Oilseed_i + \beta_{12} Malting\ Barley_i + \beta_{13} Distance_i + \beta_{14} Irrigated_i + \varepsilon_{\alpha i}$$

Parameter estimates for Adoption Model (2) and Proportion Contracted Model (2) are presented in Tables 6 and 7 respectively. Inspection of the variance/covariance correlation matrix for both models indicates that there was no significant multicollinearity among the explanatory variables in Adoption Model (2). However, some degree of collinearity appeared to exist between *Crop Acreage*, the Gross Farm Income (*GFI*) variables, and *Livestock* and *Off-Farm Income* in Proportion Contracted Model (2). Thus, *Crop Acreage* was omitted from subsequent proportion contracted models. In addition, in both of the above models the effects of human capital accumulation are accounted for by the variable *College Degree*. To estimate human capital accumulation for those with no college education at all against those that attended or graduate from college, the variable *Any College* was substituted for *College Degree*. Thus, a third set of models is estimated in which the base educational category is changed to those not having attended any college in both the adoption and contracted proportion of production decisions, and *Crop Acreage* was omitted from Proportion Contracted Model (2). The third set of models is therefore:

Adoption Model (3):

$$P(c_i = 1) = \varphi(\gamma_0 + \gamma_1 Age_i + \gamma_2 Any\ College_i + \gamma_3 Internet_i + \gamma_4 Bookkeeping\ on\ Computer_i + \gamma_5 Northcentral_i + \gamma_6 Southcentral_i + \gamma_7 Crop\ Acreage_i + \gamma_8 \$100\text{-}249K\ GFI_i + \gamma_9 \$250\text{-}499K\ GFI_i + \gamma_{10} {>}\$500K\ GFI_i + \gamma_{11} Off\text{-}Farm\ Income_i + \gamma_{12} Livestock_i + \gamma_{13} Oilseed_i + \gamma_{14} Malting\ Barley_i + \gamma_{15} Distance_i + \gamma_{16} Irrigated_i + \varepsilon_{ci})$$

Proportion Contracted Model (3):

$$\alpha_i|_{ci=1} = \beta_0 + \beta_1 Age_i + \beta_2 Any\ College_i + \beta_3 Internet_i + \beta_4 Bookkeeping\ on\ Computer_i + \beta_5 \$100\text{-}249K\ GFI_i + \beta_6 \$250\text{-}499K\ GFI_i + \beta_7 {>}\$500K\ GFI_i + \beta_8 Off\text{-}Farm\ Income_i + \beta_9 Livestock_i + \beta_{10} Oilseed_i + \beta_{11} Malting\ Barley_i + \beta_{12} Distance_i + \beta_{13} Irrigated_i + \varepsilon_{\alpha i}$$

Parameter estimates from Adoption Model (3) and Proportion Contracted Model (3) are also reported in Tables 6 and 7. Inspection of the variance/covariance correlation matrix for these models did not indicate the presence of multicollinearity. Thus, the focus of the following discussion is on the parameter estimates for Adoption Model (3) and Proportion Contracted Model (3)[28].

Table 6: Probit Adoption Models (1-3)

VARIABLE	ADOPTION MODEL (1)	ADOPTION MODEL (2)	ADOPTION MODEL (3)
Age	0.000177 (0.0003844)**	-0.0037216 (.00555)	0.0016343 (.00505)
Some College	0.151898 (0.0899715)****	- -	- -
College Degree	0.227242 (0.0998919)****	0.1648784 (0.1038058)*	- -
Any College	- -	- -	0.6047331 (0.2121644)****
Internet	-0.001758 (0.0039763)****	-0.0761124 (.13445)	-0.1552610 (.06522)
Bookkeeping on Computer	-0.000969 (0.0022802)*	-0.1178742 (.09535)	-0.1667474 (0.0785146)**
Chouteau	-0.999978 (0.0000887)****	- -	- -
Daniels	-0.999997 (0.0000147)****	- -	- -
McCone	-0.999973 (0.0001055)****	- -	- -
Richland	-0.999998 (0.00000875)****	- -	- -
Roosevelt	-0.999983 (0.0001589)****	- -	- -
Sheridan	-0.950949 (0.15343)****	- -	- -
Valley	-0.999999 (0.0000133)****	- -	- -
Northcentral	- -	-0.0863746 (.24765)	-0.2318601 (.25342)
Southcentral	- -	0.1631246 (.06525)	0.1533353 (0.0564681)*
Crop Acreage	0.000002 (0.00000519)****	0.0000940 (0.0000242)****	0.0001234 (0.0000276)****
$100-249K GFI	-0.023557 (0.0353911)****	-0.2238650 (.20864)	-0.1444715 (.18452)

[28] Regressions for models in which all insignificant variables were dropped were also investigated. Parameter estimates were similar to those presented in Adoption Model (3) and Proportion Contracted Model (3).

Table 6: Probit Adoption Models (1-3) (Continued)

VARIABLE	ADOPTION MODEL (1)	ADOPTION MODEL (2)	ADOPTION MODEL (3)
$250-499K GFI	-0.233759 (0.2417441)***	-0.1430919 (.18229)	-0.2882781 (0.1843123)*
>$500K GFI	-0.810577 (0.3986393)***	-0.2067338 (.31275)	-0.5532523 (0.3456998)*
Off-Farm Income	0.205800 (0.1220879)****	0.4110674 (0.1082814)****	0.4521169 (0.1208007)****
Livestock	-0.000735 (.0024)	-0.1501411 (.11909)	-0.1857880 (0.1208466)**
Canola	-0.001532 (.00391)	- -	- -
Chickpeas	-0.004571 (.01629)	- -	- -
Dry Ed. Peas	-0.079304 (0.1344164)****	- -	- -
Flax	-0.333739 (0.3532684)****	- -	- -
Lentils	-0.019863 (0.0485194)**	- -	- -
Malting Barley	0.001209 (0.0026739)****	0.2261473 (0.0694779)***	0.1982173 (0.0739834)****
Mustard	0.000638 (.00147)	- -	- -
Safflower	-0.000042 (.00138)	- -	- -
Oilseed	- -	0.1552534 (0.1069624)**	0.1700768 (0.085521)***
Distance	0.000011 (0.0000238)**	0.0002858 (.00031)	0.0002595 (.00027)
Irrigated	-0.962543 (0.0791769)****	-0.4760643 (0.2164405)***	-0.4992280 (0.2621123)***
Observations	109	109	109
Pseudo-R-Squared	0.6468	0.4082	0.4385

The estimated coefficients are presented above with robust standard errors correcting for heteroscedasticity below it. ****, ***, ***, * show significance at 1%, 5%, 10%, and 15% respectively. Pseudo-R-Squared values provide a general guide for a goodness of fit between the respective models.

Table 7: Truncated Regression Proportion Contracted Models (1-3)

VARIABLE	PROPORTION MODEL (1)	PROPORTION MODEL (2)	PROPORTION MODEL (3)
Age	0.1324727 (.35128)	0.0685 (.3576)	0.1531 (.3515)

Table 7: Truncated Regression Proportion Contracted Models (1-3) (Continued)

VARIABLE	PROPORTION MODEL (1)	PROPORTION MODEL (2)	PROPORTION MODEL (3)
Some College	-11.29859	-	-
	(10.46515)	-	-
College Degree	-8.025162	-1.0724	-
	(10.97946)	(6.01483)	-
Any College	-	-	-0.7458
	-	-	(11.58447)
Internet	10.26009	5.5080	4.4407
	(10.56956)	(8.49166)	(9.64739)
Bookkeeping on Computer	1.902872	-3.0296	-4.7950
	(9.29974)	(7.514)	(8.79977)
Chouteau	-24.1004	-	-
	(16.97816)	-	-
Daniels	-4.384275	-	-
	(11.63078)	-	-
McCone	-24.37379	-	-
	(14.06209)**	-	-
Richland	-24.49322	-	-
	(12.9724)**	-	-
Roosevelt	-18.8996	-	-
	(10.9921)**	-	-
Sheridan	-15.05328	-	-
	(9.929591)*	-	-
Valley	-0.1397287	-	-
	(11.81888)	-	-
Crop Acreage	-0.0022428	-0.0014	-
	(0.0011476)***	(.00113)	-
$100-249K GFI	-4.308379	-4.6968	-8.9901
	(10.36902)	(6.7633)	(7.55977)
$250-499K GFI	-4.172365	-12.2087	-18.3886
	(12.41568)	(9.89319)	(7.183357)****
>$500K GFI	16.04681	7.2018	-4.9049
	(15.23343)	(12.75147)	(7.37975)
Off-Farm Income	6.031838	6.9179	6.4152
	(6.05241)	(6.04281)	(6.24959)
Livestock	13.08529	2.8590	-1.6864
	(7.795897)**	(6.99939)	(5.82666)
Canola	-11.16448	-	-
	(11.81595)	-	-
Chickpeas	-16.93234	-	-
	(16.44379)	-	-
Dry Ed. Peas	-11.02637	-	-
	(14.64821)	-	-

Table 7: Truncated Regression Proportion Contracted Models (1-3) (Continued)

VARIABLE	PROPORTION MODEL (1)	PROPORTION MODEL (2)	PROPORTION MODEL (3)
Flax	-46.9113	-	-
	(13.73909)****	-	-
Lentils	-8.385141	-	-
	(13.48169)	-	-
Malting Barley	2.212897	7.2083	8.6176
	(9.62588)	(8.55407)	(8.58314)
Mustard	9.075949	-	-
	(9.25651)	-	-
Safflower	18.67759	-	-
	(11.76706)*	-	-
Oilseed	-	10.3937	12.4643
	-	(6.807714)*	(7.090933)**
Distance	-0.0737431	-0.0769	-0.0740
	(0.0147803)****	(0.0146932)****	(0.0153329)****
Irrigated	-0.5866572	11.1220	13.3636
	(10.14421)	(7.273648)*	(7.831398)**
Constant	95.56157	83.0109	81.0767
	(26.055)****	(19.18268)****	(21.04124)****
Observations	74	74	74
Wald Chi-Square Value	136.12	85.03	81
P-Value (Chi-Square Critical)	0	0	0

The estimated coefficients are presented above with robust standard errors correcting for heteroscedasticity below it. ****, ***, ***, * show significance at 1%, 5%, 10%, and 15% respectively. The Wald Chi-Square test values and p-values are reported for each model, testing the joint significance of all variables within the model.

Table 8: Cragg's Double-Hurdle and Miscellaneous Likelihood Ratio Tests

Cragg's Double-Hurdle Tests: All Models

Formula: $$\lambda = -2\left[\log L_T - (\log L_P + \log L_{TR})\right]$$

Test Statistics	Adoption Model (1) & Proportion Model (1)	Adoption Model (2)	Adoption Model (3)	Proportion Model (2)	Proportion Model (3)
Log L_T	-402.377	-417.557	-417.563	-420.387	-420.993
Log L_P	-23.607	-37.182	-37.530	-39.910	-45.293
Log L_{TR}	-313.941	-323.866	-323.866	-325.410	-326.124
λ	129.658	113.018	112.334	110.134	99.152
R Degrees of Freedom	28.00	17.00	16.000	14.000	13.000
χ^2 Critical (99%)	50.89	33.41	32.00	29.14	27.69

Table 8: Cragg's Double-Hurdle and Miscellaneous Likelihood Ratio Tests (Continued)

Likelihood Ratio Test Statistics: Variable Joint Significance		
Test Statistics	Adoption Model (1)	Proportion Model (1)
Individual Crop Test		
LR Value	18.44	22.05
P-Value	0.0182	0.0048
Individual County Test		
LR Value	21.64	6.73
P-Value	0.0029	0.4572

Personal Characteristic Empirical Results

Characteristics of individual producers affect both the adoption and proportion of production contracted decisions for marketing specialty crop production. The effect of a producer's farming experience is proxied by the variable *Age*, and its expected effect on both decisions is uncertain due to unknown factors and characteristics such as the producer's risk preference. Prior studies have varied with respect to their findings about the effects of experience, and positive, negative, and insignificant effects on marketing decisions have been reported in different studies. Results for both decisions in Tables 6 and 7 indicate that, for the models of interest (Adoption Model (3) and Proportion Model (3)), *Age* is not statistically significant in either decision. However, *Age* is not a perfect measure of producer experience as producers begin farming at different ages and therefore may not capture the true effect of producer experience.

Education variables are included to control for the accumulation of human capital for individual producers. As with experience, there are competing hypotheses about the effect of human capital accumulation on the use of marketing contracts and the effect of education is therefore hypothesized to be uncertain. The results in Tables 6 and 7 indicate that human capital accumulation, measured through levels of education achieved, is statistically significant and positively related to the adoption decision but not statistically significant in the contracted proportion of production decision. The results in Table 6 indicate that the effects of having a college degree, *College Degree*, in Adoption Model (2) is only statistically significant at the 15 percent level, but the variable *Any College*, in Adoption Model (3), is statistically significant at the one percent level and the marginal effect is larger. Holding other explanatory variables at their means, a producer who attended or graduated from college is just over 60 percent more likely (.6047) to adopt marketing contracts than producers that have not attended or graduated from college. These results are similar to findings reported in previous studies which hypothesized that producers with higher levels of human capital are more successful at using and understanding marketing contracts (Fletcher and Terza 1986; Goodwin and Schroeder 1994; Musser et al. 1996; Katchova and Miranda 2004). The results are inconsistent with the hypothesis that producers with higher levels of education are less risk-averse and less willing to adopt risk-reducing marketing strategies (Shapiro and Brorsen 1988). Producers with higher levels of education, having attended college, are significantly more likely to adopt marketing contracts, but the effect of human capital accumulation does not significantly affect how much production a producer is likely to contract.

The willingness of a producer to adopt a new technology is proxied by the dummy variables *Internet* and *Bookkeeping on Computer*. Previous studies have not attempted to control for technology adoption with these specific variables, but, in general, have hypothesized that technology adoption is likely to be positively related to the adoption of other new technologies (Goodwin and Schroeder 1994). Therefore, it was expected that producers willing to adopt the internet and bookkeeping methods to manage their farms would be willing to adopt marketing contracts and contract a higher proportion of their production. The results in Tables 6 and 7 do not support this hypothesis as the parameter estimates for these variables are negative and statistically significant. The marginal effect of *Bookkeeping on Computer* is also relatively large as producers adopting bookkeeping methods on the computer are approximately 17 percent (-.1667) less likely to adopt marketing contracts than those who do not adopt these methods. The variable *Internet* is not significantly related to the adoption decision, and neither variable is significantly related to the proportion of production to contract decision. Internet adoption may be capturing technology adoption for personal use rather than farm use and the use of bookkeeping on the computer may not be a good measure of technology adoption or may be capturing other unidentified effects of other personal characteristics.

Farm-Specific Characteristic Empirical Results

The geographic location of the farming operation may affect marketing decisions by capturing geographic-specific effects such as proximity to buyers and the number of buyers in a particular geographic area. Multicollinearity problems precluded the use of individual county-specific dummy variables. Likelihood ratio tests of the joint significance of the county variables, reported in Table 8, indicate that while the null hypothesis that the variables are not jointly significant is rejected for the adoption decision, it is not rejected for the proportion of production contracted decision.

Therefore, geographical categorical variables were included in the subsequent adoption models with producers in the northeast region, *Northeast*, serving as the base dummy variable category[29]. Results in Table 6 indicate that producers in the northcentral region, *Northcentral*, are not significantly more likely to adopt contracts than producers in the northeast region. Producers in the southcentral region, *Southcentral*, are approximately 15 percent (.1533) more likely to adopt marketing contracts than producers in the northeast region, but this result is only statistically significant at the 15 percent level[30]. These results may be capturing a measure of the relative thinness of the spot cash market in various regions in Montana, as regions with fewer locations or buyers of specialty crop production in the spot cash market are considered thin markets. Thin markets are hypothesized to have a higher use of marketing contracts, and therefore the results indicate that the southcentral region may be a relatively thinner market than the northeast region.

The size of an individual farm, in acres, is accounted for by the variable *Crop Acreage* which is included to capture economies of size effects on the use of marketing contracts. Previous studies have found farm size to be positively related to the use of marketing contracts (Fletcher and Terza 1986; Shapiro and Brorsen 1988; Goodwin and

[29] A likelihood ratio test indicated that the individual county variables contained more information than the regional variables in the contract adoption model. However, as noted above, problems with multicollinearity ultimately precluded the use of the individual county variables.

[30] An additional survey of specialty crop buyers in Montana, North Dakota, Alberta, and Sasketchewan conducted in collaboration with Dr. Vincent H. Smith and Dr. James B. Johnson, of Montana State University's Department of Agricultural Economics & Economics. The survey provided thirteen specific contracts used to purchase specialty crop production. The contracts all contained similar provisions, and some buyers utilized only one contract to purchase more than one specific specialty crop. Therefore, county, regional, and crop-specific variables may not be capturing inherent differences in the structure of the contracts themselves, and are more likely to be picking up actual characteristics of the crop or geographic area.

Schroeder 1994; Sartwelle et al. 2000), but one study found farm size not to be statistically significant (Katchova and Miranda 2004). Results in Tables 6 and 7 are similar to those reported in previous studies which found economies of size in marketing contract adoption, but farm size does not have a significant effect on the contracted proportion of production. Increasing *Crop Acreage* by 1,000 acres increases the probability of marketing contract adoption by approximately 12 percent (.1234), holding other explanatory variables at their means.

Gross farm income (GFI), a second measure of farm size, is accounted for by the dummy variables *$100-249K GFI*, *$250-499K GFI*, and *>$500K GFI*. As with farm size, GFI may serve as a proxy for farm size, but income variables may also control for increasing producer wealth. Producers may become less risk-averse as their wealth increases, and therefore, *a priori*, the effects of gross farm income on contracting decisions are unclear. Previous studies have reported that farms with higher gross farm incomes are more likely to adopt marketing contracts (Asplund et al. 1989; Edelman et al. 1990; Katchova and Miranda 2004), but some found that the contracted proportion of production was negatively related to gross farm income (Musser et al. 1996). In Tables 6 and 7, only two of the gross farm income variables, *$250-499K GFI* and *>$500K GFI*, are statistically significant (at the 15 percent level) and negatively related to the adoption decision. A producer with *$250-499K GFI* is approximately 29 percent (-.2883) less likely to adopt marketing contracts than producers with *$0-99K GFI*, while a producer with *>$500K GFI* is approximately 55 percent (-.5532) less likely to adopt marketing contracts than producers with *$0-99K GFI*. In addition, *$250-499K GFI* is the only statistically significant GFI variable negatively related to the proportion of production contracted decision. A producer with *$250-499K GFI* contracts approximately 18 percent (-18.3886) less production than a producer with *$0-99K GFI*. These results are inconsistent with the hypotheses that gross farm income serves as an indicator of economies of size in the use of marketing contracts, but the results are similar to those reported with previous studies that have reported that producers with higher income are less risk-averse (Musser et al. 1996).

Two additional income variables control for farm diversification by indicating whether or not a farm receives income from off-farm sources, *Off-Farm Income*, or from the sale of livestock, *Livestock*. Previous studies have reported that farms with additional sources of income, or those that are not specialized in grain production, are less likely to adopt or use marketing contracts (Edelman et al. 1990; Musser et al. 1996; McLeay and Zwart 1998; Sartwelle et al. 2000; Katchova and Miranda 2004). Similar results are reported here. The variable *Livestock* is statistically significant and the results indicate that producers with income from the sale of livestock are approximately 19 percent (-.1858) less likely to adopt marketing contracts than producers without income from livestock. However, the adoption of marketing contracts is positively related to *Off-Farm Income*, a finding that is inconsistent with results from previous studies. The contracted proportion of production decision is not significantly related to either *Livestock* or *Off-Farm Income*. *Off-Farm Income* and *Livestock* are not perfect proxies for farm diversification, and therefore the results of each variable may be capturing other information.

Crop-Specific Characteristic Empirical Results

One important aspect of this study relative to previous studies is the attempt to explain the use of contracts in terms of characteristics specific to individual specialty crops. Characteristics of an individual crop may also significantly affect marketing decisions through capturing various crop-specific effects such as quality requirements or other specific needs of the buyers of individual crops. As with county-specific variables, correlation problems precluded the use of individual crop-specific dummy variables. Likelihood ratio tests for the joint significance of the crop-specific variables, reported in Table 8, indicate that the null hypothesis that the variables are not jointly significant is rejected for both the adoption and proportion contracted decisions. Therefore, crop-related categorical variables were included in the subsequent adoption models.

The results indicate that relative to the base category *Pulses*, both *Oilseeds* and *Malting Barley* are statistically significantly and positively related to the adoption decision. Only *Oilseeds* are statistically significantly and positively related to the proportion of production to contract decision. *Oilseeds* are approximately 17 percent (.1701) more likely to be contracted than *Pulses*; *Malting Barley* is approximately 20 percent (.1982) more likely to be contracted than *Pulses*. In addition, the contracted proportion of *Oilseeds* production is approximately 12 percent (12.4643) higher than the proportion of *Pulses* production. These results suggest that crops such as *Pulses* are less likely to be contracted than other crops and, if contracted, are contracted in lower proportions than other crops. In addition to the geographic location variables, crop-specific variables may be capturing the relative thinness of the spot cash market for individual crops or categories of crops. Crops with fewer buyers or locations for delivery of production in the spot cash market are considered thin markets, and thin markets are hypothesized to have a higher use of marketing contracts due to fewer opportunities to deliver production in the spot cash market. Thus, the results indicate that there may be more buyers in the spot cash market of pulse crops than oilseed crops and malting barley and the pulse crop market is not as thin as the market for oilseeds and malting barley[31].

The distance to the market for a specific specialty crop is proxied by the variable *Distance*. No distinctions can be made between the difference in distances between production marketed with contracts and production sold in the spot cash market, thus the effects of distance were uncertain. Previous results indicated that distance is not a significant predictor of contract use (Sartwelle et al. 2000). However, the results in Tables 6 and 7 indicate that the adoption decision is not significantly related to *Distance*, but the contracted proportion of production is significantly and negatively related to *Distance*. As the distance to the market for contracted production increases by one hundred miles, the overall proportion of production contracted decreases by approximately seven percent (-.074). Therefore, for producers who contract, being further away from the market decreases the proportion of production that will be contracted. This result is consistent with the rationale that transportation costs increase as

[31] The North Dakota Dry Pea and Lentil Association listed 53 pulse crop buyers in a region encompassing North Dakota, Minnesota, Saskatchewan, California, and Manitoba. The Agriculture and Agri-Food Department of Canada listed five oilseed crushing facilities in a region encompassing North Dakota, Manitoba, and Montana. Thus, it appears that the market for oilseeds is thinner than the market for pulse crops for producers in Montana.

the distance to the market increases, and therefore a lower proportion of production will be marketed under contract.

The level of production costs, yield variability, and buyer preferences for a specific quality of a specialty crop are proxied by measuring whether a crop is irrigated or not through the dummy variable, *Irrigated*. Irrigated crops are hypothesized to be positively related to both contracting decisions as production costs are higher for irrigated crops, the probability of producers defaulting on contracts is lower due to less yield variability with irrigated crops. In addition, buyers may seek to purchase irrigated specialty crop production through contracts due to increased yield consistency and quality. The results in Tables 6 and 7 indicate that the variable *Irrigated* is statistically significant in both the adoption decision and the contracted proportion of production decision. However, the sign on the coefficient for *Irrigated* in the adoption decision is negative while the sign on the coefficient for *Irrigated* in the proportion contracted is positive. *Irrigated* crops are approximately 50 percent (-.4992) less likely to be contracted than dryland crops, but among contracted crops, approximately 13 percent (13.364) more of production is contracted for irrigated crops than for dryland crops. Therefore, if a crop is irrigated, the probability of marketing contract adoption decreases, but for those that adopt marketing contracts, an irrigated crop increases the proportion of production contracted. This is consistent with the hypothesis that the risk of default on the contract matters for marketing decisions made by individual producers and the hypothesis that buyers of specialty crops may seek to purchase more irrigated production.

Summary

This chapter has described the empirical analysis of how personal, farm-specific, and crop-specific characteristics affect the adoption of marketing contracts and the decision of what proportion of production to contract. Cragg's double-hurdle likelihood ratio test provides empirical evidence that estimating each decision independently is appropriate. Therefore, probit models were estimated to explain the adoption decision while separate truncated regressions were estimated to explain the decision about what proportion of production to contract.

Adoption of marketing contracts is significantly affected by a wide variety of personal, farm-specific, and crop-specific characteristics. Producers with higher levels of human capital, *Any College*, are approximately 60 percent more likely to adopt contracts than producers with lower levels of human capital. Also, producers of *Oilseeds* and *Malting Barley* are approximately 17 and 20 percent more likely to adopt marketing contracts than producers of *Pulses* respectively, providing evidence that the spot cash markets for oilseeds and malting barley is thinner than the spot cash market for pulse crops. Economies of size are supported in the adoption decision as producers with more cropland acres, *Crop Acreage*, are more likely to adopt marketing contracts. Diversified farms receiving receipts of income from the sale of livestock, *Livestock*, are approximately 19 percent less likely to adopt marketing contracts, supporting the hypothesis that farms more specialized in crop production are more likely to adopt marketing contracts. Gross farm income variables, *$250-499K GFI* and *>$500K GFI*, are only statistically significant at the 15 percent level, and negatively related to the adoption decision. These findings are inconsistent with the hypothesis that income serves as a proxy for economies of size but provide support for the decreasing risk aversion hypothesis.

Producers operating in the southcentral geographic region, *Southcentral*, are more likely to adopt marketing contracts than producers in the northeast geographic region providing evidence that the spot cash market is thinner in the southcentral region, but this result is only significant at the fifteen percent level. The adoption of bookkeeping on the computer, *Bookkeeping on Computer*, and irrigated crops, *Irrigated*, both significantly decreased the probability of marketing contract adoption which was inconsistent with the hypothesized effects of each. In addition, receiving off-farm income, *Off-Farm Income*, significantly increased the probability of adoption which was contrary to expectations as well. *Bookkeeping on Computer*, *Irrigated*, and *Off-Farm Income* may be capturing other characteristics due to the fact that they are not perfect proxies for technology adoption, value of production, and income diversification respectively.

The decision of what proportion of specialty crop production to market with contracts is significantly affected by relatively few farm and crop-specific characteristics and personal characteristics are all insignificant. *Oilseeds* are contracted in higher proportions, approximately 12 percent, than *Pulses*. One measure of gross farm income, *$250-499K GFI*, supports the reduction in risk aversion hypothesis that higher levels of income reduce a producer's level of risk aversion and therefore they utilize risk-reducing mechanisms such as contracting less frequently. A crop that is irrigated, *Irrigated*, is contracted in significantly higher proportions than contracted non-irrigated crops, supporting the hypothesis that the probability of contract default by producers is lower with irrigated production due to decreased yield variability and also supporting the hypothesis that buyers may seek to purchase irrigated production with contracts. Thus, irrigated crops will be contracted in higher proportions. As the distance from the contracting market, *Distance*, increases, crops are contracted in lower proportions suggesting that the increased transportation costs per unit of production are important in how producers market their production.

Overall, a wider variety of personal, farm-specific, and crop-specific variables affect the marketing contract adoption decision, while only a small number of farm-specific and crop-specific variables affect the decision of what proportion of production to contract. This implies that once the decision to contract has been made, producers decide what proportion to contract based on only a few farm and crop-specific characteristics.

CHAPTER 7

CONCLUSION

The purpose of this study has been to examine why the use of contracts as marketing mechanisms varies across producers and crops. Contract use is affected by personal, farm-specific, and crop-specific characteristics. Contract use by specialty crop producers is examined using data obtained from a non-random sample of 89 farmers located in eight Montana counties. The survey gathered information on operator, farm-specific, and crop-specific characteristics. The effects of crop-specific characteristics on contracting decisions have not been examined in previous studies.

Two separate and independent marketing decisions concerning contract use are examined. The first is the decision about whether or not to contract at all. If the expected utility of profits obtained from marketing at least a portion of production with marketing contracts is greater than the expected utility of profits from utilizing only the spot cash market, then marketing contracts will be adopted. Producers who adopt marketing contracts must then decide what proportion of their output to market under contract and what proportion to market in the spot cash market. The double-hurdle framework allows each of these decisions to be affected in different ways by the same or a different set of characteristics. Cragg's double-hurdle likelihood ratio tests provide support for the two-stage approach to modeling the adoption and proportion of production contracted decisions.

The results from this study indicate that the marketing contract adoption decision is affected by the personal characteristics of the farmer, but the contracted proportion of production decision is not affected in a statistically significant way by those characteristics. Neither decision is significantly related to the proxy for years of producer experience, although the proxy variable *Age* may not perfectly capture the true effect of producer experience. However, producers with higher levels of human capital accumulation, as measured by a producer's highest level of education achieved, were found to be more likely to adopt marketing contracts. This may be because producers with higher levels of human capital have lower costs of understanding and interpreting terms of contracts, which increases contract adoption.

The adoption of marketing contracts and the contracted proportion of production decisions are both hypothesized to be positively related to a producer's willingness to adopt new technologies. Parameter estimates for the variables used to proxy for this characteristic, adoption of the internet and methods of bookkeeping on the computer, did not support this hypothesis, but these variables may be capturing other personal or farm-related characteristics because they are not perfect proxies for willingness to adopt new technology.

Both the contract adoption and the proportion of production to contract decisions were found to be significantly related to specific characteristics of a farm's operations. Economies of size, in terms of total crop acreage, are supported in the adoption decision as producers with more cropland acres are more likely to adopt marketing contracts. However, as gross farm income increases, the probability of marketing contract adoption and the proportion of production contracted both decline. These two results are not consistent with the economies of size hypothesis, but do provide support for the hypothesis that producers with higher levels of gross farm income are less risk-averse and thus less likely to adopt risk-reducing mechanisms such as marketing contracts.

Other variables that control for additional sources of farm income and the geographic location of the farming operation were examined. The results indicate that farms with livestock operations are less likely to adopt contracting for their specialty crop production. The decision to adopt contracts was significantly related to county or region-specific dummy variables, which indicate the geographic location of the farming operation. However, the decision about what proportion of specialty crop production to market under contract was not significantly related to these variables. Geographic variables were included to capture county or regional-specific information and other random factors such as soil types, weather, and other characteristics that may be significantly related to the adoption and use of marketing contracts. Including all county-specific variables provided results which suggested that multicollinearity may be a problem between county variables and other explanatory variables such as the income-related variables. Therefore, regional categorical variables were utilized and the results indicate that producers operating in the southcentral region of Montana are more likely to adopt marketing contracts than producers in the northeast region. This result suggests that the spot cash market in the southcentral region may be relatively thinner than the northeast region.

One important contribution of this study is the inclusion of crop-specific variables to control for crop-related characteristics that influence the adoption and use of marketing contracts. The inclusion of dummy variables for each crop suggested that multicollinearity may be a problem between the crop dummy variables and other explanatory variables. Thus, each crop was allocated to one of three categories: pulses, oilseeds, and malting barley. The results of this study indicate that oilseed crops and malting barley are significantly more likely to be contracted than pulse crops, and producers are significantly more likely to contract higher proportions of their production of oilseeds than pulse crops. These results indicate that the spot cash market may be relatively thinner for oilseeds and malting barley compared with pulse crops, as there may be more buyers of pulse crops in the spot cash market.

A crop that is irrigated is significantly less likely to be contracted than dryland crops. However, for crops that are contracted, irrigating the crop significantly increased the proportion of production that is contracted. This provides support to the hypothesis that irrigated crops have less variability in production and therefore less probability for default on the contract by the producer, and also that buyers of specialty crops are more likely to seek to contract for a higher proportion of irrigated production to contract.

The adoption of marketing contracts is not significantly related to the distance from the market, but the contracted proportion of production is significantly reduced as the distance to the market increases. This result supports the hypothesis that transportation costs increase as the distance to the contract market increases, and therefore a lower proportion of production is contracted.

In summary, a variety of personal, farm-specific, and crop-specific characteristics affect the adoption of marketing contracts. However, a smaller number of farm and crop-specific characteristics affect the decision about what proportion of production to contract. This study has examined the role of crop-specific variables in explaining differences in contracting by crop and has utilized new measures of crop characteristics such as an indicator variable for irrigation. A new, primary dataset was collected and utilized to examine contracting among specialty crops. The variables used in this study to proxy particular characteristics may not have been perfect representations of the characteristics themselves, and this study was limited to the 109 survey observations in the dataset of Montana Grain Growers Association Members. Future research would benefit by extending this study beyond the limited geographic area accounted for in this study. In addition, variables that more closely proxy the characteristics hypothesized to affect each marketing decision may increase significance and robustness of the results.

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APPENDICES

APPENDIX A

EMPIRICAL LITERATURE REVIEW TABLE

Table 9: Empirical Literature Review Table

Authors	Data Utilized	Estimation Technique	Key Findings
Fletcher and Terza (1986)	Survey (1982 Georgia wheat producers)	Multivariate Probit	Educated farmers of large operations with storage facilities and who use associations for price information are more likely to use contracts. Age, diversification, and full versus part-time farming had no statistically significant impact on contract use.
Shapiro and Brorsen (1988)	Survey (1985 Top Farmer Crop Workshop)	Tobit	Differences in the beliefs of the futures markets' ability to provide income stability were the most important in determining the level of hedging. Highly leveraged farmers forward contracted much more than they hedged. Education levels and class participation didn't affect hedging differences among producers.
Asplund, Forster, and Stout (1989)	Survey Panel (1989 Ohio farm households)	Logit	Economies of size exist in the use of marketing tools indicating a minimum level of gross sales which must exist to justify the costs of contracting (or hedging). Using computers and consulting services as well as participation in farm organizations are actions of searching that increase contract use. Full-time operators of large farms tend to be risk-averse and seek to use risk-reduction strategies like forward pricing. Operators of smaller farms with financial leverage tend not to use forward pricing tools.
Edelman, Schmiesing, and Olsen (1990)	Survey (1988 Iowa Farm Finance Survey)	Logit	Larger, specialized farm operations are more likely to use forward pricing mechanisms and there are complementarities in the use of other various forward pricing alternatives suggesting that education efforts may increase the use of multiple forward pricing mechanisms.
Goodwin and Schroeder (1994)	Survey (1992 Kansas farms)	Probit and Tobit	Adoption of forward pricing decreases with increased experience, but increases with farm size, crop intensity, input intensity, leverage, and education. The most important result, in the authors' opinions, is that participation in marketing and risk management educational programs increases adoption.
Musser, Patrick, and Eckman (1996)	Survey (1993 Top Farmer Crop Workshop)	Tobit	Age and education had short-run effects on using contracts but no long-run effects. Size of the farm had a significant negative impact suggesting as the farm size increased, contracting was used less often for the sample of large farmers. Leveraged farmers were more likely to contract and attitude toward losses was significant in the long-run.
McLeay and Zwart (1998)	Survey (New Zealand crop farmers)	Logit	The percent of farm area devoted to a crop was positively associated with forward contract use and products that require high levels of physical capital to grow or harvest are more likely to be sold using contracts. No evidence found for contracts prevailing in perishable crops or those that have high levels of price variability.
Sartwelle et al. (2000)	Survey (Kansas, Iowa, and Texas producers)	Tobit and Multinomial Logit	Use of contracts is positively affected by geographic location, average crop acreage, specialization in grain enterprises, and the use of on-farm storage. There is no impact of grain marketers' attitudes toward managing price risk upon their marketing practice decisions. The use of crop insurance has a positive relationship with the use of forward contracts.
Katchova and Miranda (2004)	Survey (1999 USDA's NASS ARMS Study)	Probit, Tobit, Poisson, and Logit	Personal and farm characteristics affect the adoption decision and the quantity, frequency, and contract type decisions in very different ways. Specialized farmers contract more frequently, and education programs and advisory services increase adoption of contracts. Well-educated farmers on large farms that use written marketing plans, advisory services, and futures are more likely to adopt contracts. Personal and farm characteristics mostly affect the adoption decision over the other decisions. Personal and farm characteristics that increase probability of adoption do not necessarily increase quantity, frequency, or contract types.

APPENDIX B

SAMPLE LETTERS AND SURVEY FORMS

INITIAL SURVEY LETTER
(Montana Grain Growers Association Letterhead)

Date

Dear Producer,

Enclosed you will find a one-page survey concerning the production of specialty agricultural crops. The Montana Grain Growers Association and the Department of Agricultural Economics and Economics at Montana State University are collaborating to implement a survey project on the production and marketing of specialty grains and oilseeds in Montana.

We would like to ask you to respond to the following questionnaire. The information in this survey simply addresses whether or not you produce specialty crops. We would like to ask you how many acres of your operation have been planted to each of several specialty crops over the past three years and whether or not you were able to harvest those acres. All responses will be held as strictly confidential and information will be presented in summary with similar responses from other producers. Any information you could provide will greatly facilitate our understanding of the role of alternative crops in Montana farm operations. Please take just a few moments to answer the survey questions as completely as possible and return your answers in the enclosed postage-paid envelope.

If you have produced any of the crops listed in the following survey, it would be especially helpful to this project if you would be willing to participate in a more detailed follow-up survey concerning the marketing and contracting of these crops. If you are willing to participate in the follow-up marketing survey, please respond to questions 2 and 3 of the survey. Please note that we are utilizing this two-stage approach to minimize any inconvenience you may incur in participating in this project.

We at Montana Grain Growers and Montana State University appreciate your time and efforts to make this project a success, and we look forward to receiving your completed survey. This survey is being administered by the Montana Grain Growers Association to ensure that no other entity will have access to your mailing address.

With Best Wishes and Many Thanks,

Richard Owen
Executive Vice-President
Montana Grain Growers Association

Vince Smith
Professor
Montana State University

INITIAL SURVEY FORM

1. For each of the following crops, please indicate the acres planted to each crop in each of the three years (200-2002) and indicate whether or not any of the crop was harvested.

	Malting Barley			Canola			Sunflower			Safflower			Mustard	
	ACREAGE			ACREAGE			ACREAGE			ACREAGE			ACREAGE	
	Planted	Harvested		Planted	Harvested		Planted	Harvested		Planted	Harvested		Planted	Harvested
2000			2000			2000			2000			2000		
2001			2001			2001			2001			2001		
2002			2002			2002			2002			2002		
	Crambe			Chickpeas			Pinto Beans			Flax			Lentils	
	ACREAGE			ACREAGE			ACREAGE			ACREAGE			ACREAGE	
	Planted	Harvested		Planted	Harvested		Planted	Harvested		Planted	Harvested		Planted	Harvested
2000			2000			2000			2000			2000		
2001			2001			2001			2001			2001		
2002			2002			2002			2002			2002		
	Austrian Winter Peas			Dry Edible Peas			Alfalfa Seed							
	ACREAGE			ACREAGE			ACREAGE							
	Planted	Harvested		Planted	Harvested		Planted	Harvested						
2000			2000			2000								
2001			2001			2001								
2002			2002			2002								

2. Would you be willing to participate in a follow-up survey with Montana Grain Growers Association/Montana State University in regard to contracting/marketing of your specialty crops? (Please circle: YES or NO)

3. If you are willing and able to participate in the follow-up survey, which month would be the best to contact you:

____

FOLLOW-UP SURVEY LETTER
(Montana Grain Growers Association Letterhead)

September 29, 2003

Dear _________________(Producer),

Thank you for volunteering to participate in this follow-up survey concerning the marketing and contracting of specialty crops.

Enclosed you will find two forms. First, please complete the yellow form. The yellow form pertains to your overall farm/ranch operation.

Next, you will see that there are several green forms. Please complete a green form for **each** OTHER (SPECIALTY) crop that you listed as planted in 2003 on question two (2) of the yellow form. Please complete a green form for OTHER (SPECIALTY) crops grown in any or all of the years from 2000-2003 (please indicate year grown).

Please return the completed yellow and green forms in the enclosed pre-paid envelope.

The Montana Grain Growers Association and Montana State University would like to emphasize that all responses are strictly confidential. The information you provide will be presented in summary form with responses from other producers and will greatly facilitate the understanding of the importance of marketing contracts to Montana alternative crop producers.

We sincerely appreciate your time and effort to make this project a success. We look forward to receiving your completed forms. This survey is being administered by the Montana Grain Growers Association to ensure that no other entity has access to your mailing address. Please place the survey in the mail no later than October 10, 2003.

Thanks,

Richard Owen
Executive Vice-President
Montana Grain Growers Association

FOLLOW-UP SURVEY GENERAL FORM

Please, as the farm manager, respond to the following questions regarding your OVERALL farm/ranch operation:

1) How many cropland acres are in your 2003 farming operation? ____________________ TOTAL CROPLAND ACRES

2) Please specify the appropriate planted cropland acres for the following crops:

Note: OTHER (GENERAL) crops include but are not limited to:

Alfalfa for Hay	*Oats*
Grain for Hay	*Rye*
Other Hay	*Sorghum*
Corn	*Sugarbeets*

OTHER (SPECIALTY) crops include:

Alfalfa Seed	*Austrian Winter Peas*
Canola	*Crambe*
Small Chickpeas	*Dry Edible Peas*
Flax	*Large Chickpeas*
Lentils	*Malting Barley*
Mustard	*Pinto Beans*
Potatoes	*Safflower*
Sunflower	

CROP	ACRES Recropped	ACRES Planted on Fallow
Winter Wheat		
Spring Wheat		
Feed Barley		
Durum		
Example of OTHER (GENERAL) crop: CORN	*250*	
OTHER (GENERAL) (specify crop):		
OTHER (GENERAL) (specify crop):		
OTHER (GENERAL) (specify crop):		
OTHER (GENERAL) (specify crop):		
OTHER (GENERAL) (specify crop):		
OTHER (GENERAL) (specify crop):		
Example of OTHER (SPECIALTY) crop: CANOLA		*300*
OTHER (SPECIALTY) (specify crop):		
OTHER (SPECIALTY) (specify crop):		
OTHER (SPECIALTY) (specify crop):		
OTHER (SPECIALTY) (specify crop):		
OTHER (SPECIALTY) (specify crop):		
OTHER (SPECIALTY) (specify crop):		
Acres enrolled in CRP in 2003		
Acres Fallowed in 2003		
TOTAL ACRES (EQUAL TO TOTAL ACRES FROM NUMBER ONE)		

3) In what county was the largest acreage of cropland planted in 2003? ________________________ COUNTY

4) How many years have you been farming/ranching? ________________________ YEARS

5) What is your age? ________________________ AGE (IN YEARS)

6) What is your highest level of education?

	(X ONE BOX)
Some High School	
High School Diploma or Equivalent	
Some College	
College Degree	
Advanced Degree	

For Questions 7-11, Please Check YES or NO

7) Do you have a computer? YES ☐ NO ☐

8) Do you perform bookkeeping on the computer? YES ☐ NO ☐

9) Do you have internet access for your farm/ranch? YES ☐ NO ☐

10) Do you receive any farm/family income from off-farm employment or non-farm investments? YES ☐ NO ☐

11) Do you receive any farm/family income from the sale of livestock/livestock products? YES ☐ NO ☐

12) What was your gross farm revenue in 2002 from sales of crops, CRP & commodity-related government payments, and crop insurance indemnifications?

GROSS REVENUE	(X ONE BOX)
<$10,000	
$10-49,999	
$50-99,999	
$100-249,999	
$250-499,999	
>$500,000	

13) Do you use marketing contracts for any crop on your operation?

CLASS OF PRODUCTION	(X IF YES)
GENERAL crop production	
SPECIALTY crop production	

FOLLOW-UP SURVEY DETAILED FORM

Please respond to the following questions regarding ONE specific OTHER (SPECIALTY) crop from your farm/ranch operation:

1) Please list the OTHER (SPECIALTY) crop used for this form: *(Reminder: OTHER (SPECIALTY) crops consist of alfalfa seed, Austrian winter peas, canola, crambe, small chickpeas, dry edible peas, flax, large chickpeas, lentils, malting barley, mustard, pinto beans, safflower,& sunflower)*

EXAMPLE: MUSTARD/RECROP

____

2) Is this crop irrigated? YES ☐ NO ☐

3) What year(s) from 2000-2003 did you plant this crop?

2000 ☐ 2001 ☐ 2002 ☐ 2003 ☐

4) How many acres of this crop were harvested in 2003? ________________________ACRES

5) What was your average yield/acre for this harvested crop in the most recent year of production?

YEAR:________________ YIELD/ACRE:__________________

6) On a scale of 1-4, please rate the following sources for information regarding the pricing of this specialty crop. 1=Never Used 2=Use Occasionally 3=Use Frequently 4=Primary Source of Information

		Rate each item from 1-4
A	Internet Websites (Montana MarketManager Online)	
B	Data Transmission Network (DTN)	
C	Newspapers (daily and/or weekly)	
D	Agricultural Press (ex. AGWEEK, Prairie Star)	
E	Subscription newsletter (ex. Pro Farmer)	
F	Other Media (ex. Radio/TV; specify):_______________	
G	Other (specify):________________________________	

7) What percentage of this specialty crop production is priced in the following manner?

		(if none, write zero)
A	Marketing cooperative with a predetermined price	%
B	Marketing cooperative without a predetermine price	%
C	Sold to a buyer under contract with a predetermined price	%
D	Sold to a buyer under contract without a predetermined price	%
E	Spot cash market	%
F	Other (specify):____________________________________	%
		100%

8) What specific types of contracts have you used for the production of this particular specialty crop?

(Please X all that apply)

A Production Contract (buyer shares risk, purchases inputs, etc.)
B Marketing Contract (simply specifying price/delivery, etc.)
C Other types of contracts (specify):______________________
D None (if none, skip to question 15)

9) What provisions were present in contracts used in marketing this specialty crop?

(Please X all that apply)

A Act of God for Producer
B Act of God for Buyer
C Quality Requirements
D Specific Quality Discounts
E Specific Quality Premiums
F Chemical Use Restrictions
G First Right of Refusal for Buyer
H Last Right of Refusal for Buyer
I Sell a specific % of Crop to Buyer
J Sell ALL of Crop to Buyer
K Storage and Freight Clauses
L Price Pre-Determined
M Price Determined Upon Delivery
N Specific Breach of Contract Penalty
O Refusal Limits of Foreign Material, Etc.

10) On the following scale of 1-4, where 1=Not Considered 2=Slight Importance 3=Very Important 4=Primary Reason to Use a Contract, please indicate how important each of the following factors were in your decision to contract.

Rate each item from 1-4

A Required for quality of crop
B Required for amount of crop to be purchased
C Reduces price risk for you, the producer
D Reduces risk for the buyer
E Ensures a market for your harvested crop
F Other (specify):_____________________

11) For this specialty crop, when in the production marketing cycle do you sign a contract for the delivery of the crop to a buying firm? Rate each of the following time periods on the following scale of 1-4, where 1=Never sign contract during the period 2=Contract sometimes during the period 3=Contract often during the period 4=Primary time to sign the contract.

Rate each item from 1-4

A Before the crop is planted
B After the crop is planted, but before crop quality can be determined
C After crop quality is established, but before harvest
D During harvesting of the crop
E Post-Harvest

12) What type of firm do you contract with?

(Please X all that apply)

A Processor
B Local Elevator
C Broker
D Other (specify):____________

13) Where is the firm you contract with located?

(Please X all that apply)

A Montana
B North Dakota
C Other (USA: specify state):_________
D Canada (Specify Province):_________
E Other (Foreign: specify):_________

14) What is the distance from your farm to the nearest point of delivery for this specialty crop?

__________________(MILES)

<u>Questions 15-18 are for producers who do NOT contract or contract only a portion of their crop.</u>

15) On a scale of 1-4, please rate the following influences that impede the use of contracts for this crop if a contract is NOT used for all or a portion of the production of this crop. 1=Not Considered 2=Slight Factor 3=Major Impediment 4=Primary Reason to NOT Use a Contract

Rate each item from 1-4

A No specific contract for this crop
B Not a defined market for the crop
C Lack of access to the market for the crop
D Buyer prefers no contracting
E Too much uncertainty in your production of this crop
F You used other marketing methods (specify):_________________
G Other (specify):___________________________

16) Where do you market this specialty crop upon harvest?

(Please X all that apply)

A Directly to the Final Consumer
B Directly to the Processor
C To a Local Elevator
D To a Broker
E Other (specify):______________

17) In what geographic area is the buyer of this specialty crop located?

(Please X all that apply)

A Montana
B North Dakota
C Other (USA: specify state):____________
D Canada (Specify Province):____________
E Other (Foreign: specify):_______________

18) What is the distance from your farm to the nearest point of delivery for this specialty crop?

___________________(MILES)

THANK YOU FOR YOUR PARTICIPATION!!!
FROM MONTANA GRAIN GROWERS ASSOCIATION AND MONTANA STATE UNIVERSITY

FOLLOW-UP SURVEY LETTER FOR RE-SEND
(Montana Grain Growers Association Letterhead)

February 23rd, 2004

Dear Montana Producer,

The Montana Grain Growers Association and the Department of Agricultural Economics and Economics at Montana State University are collaborating on a survey on the production and marketing of specialty grains and oilseeds in Montana.

Earlier this fall, you were sent surveys as a part of our effort to obtain this vital information. Some of you did not complete the initial set of surveys that we sent. If you did not complete the survey forms earlier, we would tremendously appreciate it if you would respond to the enclosed questionnaires. This follow-up survey examines your specialty crop production and marketing in more detail, and once again, all responses will be held as strictly confidential and information will be presented in summary with similar responses from other producers. Please take just a few moments to answer the survey questions as completely as possible and return your answers in the enclosed postage-paid envelope by March 12th.

Please complete one general survey pertaining to your overall farm/ranch operation. Also, please complete one detailed survey for EACH of the individual specialty crops that you have produced. The surveys are color coded, so please begin with the gray general survey and then complete the blue detailed surveys. If you did in fact respond earlier, we apologize for any inconvenience, but would appreciate a second response.

We appreciate your time and efforts to make this project a success, and we look forward to receiving your completed surveys. Be assured that no other entity will have access to your contact information.

Many Thanks,

Richard Owen
Executive Vice President
Montana Grain Growers Association

APPENDIX C

SURVEY VARIABLE TABLES

Table 10: Producer-Specific Survey Crops Grown Variable Definitions

VARIABLE	VARIABLE DEFINITION
WintWhtRecrop	Acres of Winter Wheat planted on re-cropped land
WintWhtFall	Acres of Winter Wheat planted on fallowed land
SprWhtRecrop	Acres of Spring Wheat planted on re-cropped land
SprWhtFall	Acres of Spring Wheat planted on fallowed land
FdBarleyRecrop	Acres of Feed Barley planted on re-cropped land
FdBarleyFall	Acres of Feed Barley planted on fallowed land
DurumRecrop	Acres of Durum Wheat planted on re-cropped land
DurumFall	Acres of Durum Wheat planted on fallowed land
AlfalfaHayRecrop	Acres of Alfalfa for hay planted on re-cropped land
AlfalfaHayFall	Acres of Alfalfa for hay planted on fallowed land
GrainHayRecrop	Acres of Grain for hay planted on re-cropped land
GrainHayFall	Acres of Grain for hay planted on fallowed land
OtherHayRecrop	Acres of Other hay planted on re-cropped land
OtherHayFall	Acres of Other hay planted on fallowed land
CornRecrop	Acres of Corn planted on re-cropped land
CornFall	Acres of Corn planted on fallowed land
OatsRecrop	Acres of Oats planted on re-cropped land
OatsFall	Acres of Oats planted on fallowed land
SugarBeetsRecrop	Acres of Sugar Beets planted on re-cropped land
SugarBeetsFall	Acres of Sugar Beets planted on fallowed land
MilletRecrop	Acres of Millet planted on re-cropped land
MilletFall	Acres of Millet planted on fallowed land
FieldPeaSeedRecrop	Acres of Field Peas for seed planted on re-cropped land
FieldPeaSeedFall	Acres of Field Peas for seed planted on fallowed land
AlfalfaSeedRecrop	Acres of Alfalfa for seed planted on re-cropped land
AlfalfaSeedFall	Acres of Alfalfa for seed planted on fallowed land
CanolaRecrop	Acres of Canola planted on re-cropped land
CanolaFall	Acres of Canola planted on fallowed land
SmChickRecrop	Acres of Small Chickpeas planted on re-cropped land
SmChickFall	Acres of Small Chickpeas planted on fallowed land
FlaxRecrop	Acres of Flaxseed planted on re-cropped land
FlaxFall	Acres of Flaxseed planted on fallowed land
LentilsRecrop	Acres of Lentils planted on re-cropped land
LentilsFall	Acres of Lentils planted on fallowed land
MustardRecrop	Acres of Mustard Seed planted on re-cropped land
MustardFall	Acres of Mustard Seed planted on fallowed land
SunflRecrop	Acres of Sunflower planted on re-cropped land
SunflFall	Acres of Sunflower planted on fallowed land
AustWintPeaRecrop	Acres of Austrian Winter Peas planted on re-cropped land
AustWintPeaFall	Acres of Austrian Winter Peas planted on fallowed land
CrambeRecrop	Acres of Crambe planted on re-cropped land
CrambeFall	Acres of Crambe planted on fallowed land
DrEdPeaRecrop	Acres of Dry Edible Peas planted on re-cropped land
DrEdPeaFall	Acres of Dry Edible Peas planted on fallowed land

Table 10: Producer-Specific Survey Crops Grown Variable Definitions (Continued)

VARIABLE	VARIABLE DEFINITION
LgChickRecrop	Acres of Large Chickpeas planted on re-cropped land
LgChickFall	Acres of Large Chickpeas planted on fallowed land
MaltBarlRecrop	Acres of Malting Barley planted on re-cropped land
MaltBarlFall	Acres of Malting Barley planted on fallowed land
PintoBeanRecrop	Acres of Pinto Beans planted on re-cropped land
PintoBeanFall	Acres of Pinto Beans planted on fallowed land
SafflowerRecrop	Acres of Safflower planted on re-cropped land
SafflowerFall	Acres of Safflower planted on fallowed land
GrassSdRecrop	Acres of Grass Seed planted on re-cropped land
GrassSdFall	Acres of Grass Seed planted on fallowed land
CRP	Acres of farming operation in the Conservation Reserve Program (CRP)
Fallowed	Acres of farming operation fallowed
Crop Acreage	Total acreage of farming operation

Table 11: Producer-Specific Survey General Information Variable Definitions

VARIABLE	VARIABLE DEFINITION
Chouteau	(0,1) Dummy for Chouteau as the county where farming operation is located
Daniels	(0,1) Dummy for Daniels as the county where farming operation is located
McCone	(0,1) Dummy for McCone as the county where farming operation is located
Richland	(0,1) Dummy for Richland as the county where farming operation is located
Roosevelt	(0,1) Dummy for Roosevelt as the county where farming operation is located
Sheridan	(0,1) Dummy for Sheridan as the county where farming operation is located
Valley	(0,1) Dummy for Valley as the county where farming operation is located
Yellowstone	(0,1) Dummy for Yellowstone as the county where farming operation is located
Northcentral	(0,1) Dummy for Northcentral as the geographic region where farming operation is located
Northeast	(0,1) Dummy for Northeast as the geographic region where farming operation is located
Southcentral	(0,1) Dummy for Southcentral as the geographic region where farming operation is located
Years Farming	Years of farming experience for farm operator
Age	Age of farm operator
Some High School	(0,1) Dummy for Some High School as highest educational level attained
High School Diploma	(0,1) Dummy for High School Diplomaas highest educational level attained
Trade School	(0,1) Dummy for Trade School as highest educational level attained
Associate Degree	(0,1) Dummy for Associates Degree as highest educational level attained
Some College	(0,1) Dummy for Some College as highest educational level attained
College Degree	(0,1) Dummy for College Degree as highest educational level attained
Graduate Degree	(0,1) Dummy for Graduate Degree as highest educational level attained
College Graduate	(0,1) Dummy combining College Degree and Graduate Degree
Any College	(0,1) Dummy combining Some College, College Degree, and Graduate Degree
Computer	(0,1) Dummy for ownership of a computer
Bookkeeping on Computer	(0,1) Dummy for performing of bookkeeping on a computer

Table 11: Producer-Specific Survey General Information Variable Definitions (Continued)

VARIABLE	VARIABLE DEFINITION
Internet	(0,1) Dummy for internet access on the farm/ranch
Off-Farm Income	(0,1) Dummy for receipt of income from off-farm employment
Livestock	(0,1) Dummy for receipt of income from sale of livestock
<$10K GFI	(0,1) Dummy for Gross Farm Revenues less than $10,000
$10-49K GFI	(0,1) Dummy for Gross Farm Revenues between $10-49,999
$50-99K GFI	(0,1) Dummy for Gross Farm Revenues between $50-99,999
$100-249K GFI	(0,1) Dummy for Gross Farm Revenues between $100-249,999
$250-499K GFI	(0,1) Dummy for Gross Farm Revenues between $250-499,999
>$500K GFI	(0,1) Dummy for Gross Farm Revenues over $500,000
Contracts General Crops	(0,1) Dummy for use of marketing contracts for General Crop production (wheat, barley, etc.)
Contracts Specialty Crops	(0,1) Dummy for use of marketing contracts for Specialty Crop production (canola, etc.)
Crop Acreage	Total acreage of farming operation

Table 12: Producer-Specific Survey Crops Grown Variable Summary Statistics

VARIABLE	TOTAL ACREAGE	NUMBER OF OBS.	AVG. ACREAGE	MINIMUM	MAXIMUM	STANDARD DEV.
WintWhtRecrop	8967.80	10.00	896.78	38.00	5500.00	1646.92
WintWhtFall	13541.00	12.00	1128.42	100.00	4500.00	1149.23
SprWhtRecrop	63541.20	54.00	1176.69	100.00	3500.00	1012.76
SprWhtFall	38720.40	40.00	968.01	15.00	3500.00	862.06
FdBarleyRecrop	2382.00	8.00	297.75	20.00	660.00	232.57
FdBarleyFall	100.00	1.00	100.00	100.00	100.00	#DIV/0!
DurumRecrop	31080.00	31.00	1002.58	10.00	4500.00	951.61
DurumFall	12944.70	25.00	517.79	30.00	2700.00	529.39
AlfalfaHayRecrop	2813.90	19.00	148.10	8.00	400.00	117.11
AlfalfaHayFall	80.00	1.00	80.00	80.00	80.00	#DIV/0!
GrainHayRecrop	455.40	7.00	65.06	20.00	114.40	39.79
GrainHayFall	403.00	2.00	201.50	3.00	400.00	280.72
OtherHayRecrop	1350.00	8.00	168.75	10.00	500.00	197.06
OtherHayFall	200.00	1.00	200.00	200.00	200.00	#DIV/0!
CornRecrop	28.00	1.00	28.00	28.00	28.00	#DIV/0!
CornFall	0.00	0.00	0.00	0.00	0.00	0.00
OatsRecrop	250.30	4.00	62.58	20.00	90.00	31.01
OatsFall	0.00	0.00	0.00	0.00	0.00	0.00
SugarBeetsRecrop	300.00	2.00	150.00	150.00	150.00	0.00
SugarBeetsFall	0.00	0.00	0.00	0.00	0.00	0.00
MilletRecrop	114.00	2.00	57.00	54.00	60.00	4.24
MilletFall	0.00	0.00	0.00	0.00	0.00	0.00
FieldPeaSeedRecrop	102.00	1.00	102.00	102.00	102.00	#DIV/0!
FieldPeaSeedFall	0.00	0.00	0.00	0.00	0.00	0.00
AlfalfaSeedRecrop	670.00	2.00	335.00	260.00	410.00	106.07
AlfalfaSeedFall	0.00	0.00	0.00	0.00	0.00	0.00

Table 12: Producer-Specific Survey Crops Grown Variable Summary Statistics (Continued)

VARIABLE	TOTAL ACREAGE	NUMBER OF OBS.	AVG. ACREAGE	MINIMUM	MAXIMUM	STANDARD DEV.
CanolaRecrop	4915.50	16.00	307.22	125.00	800.70	204.89
CanolaFall	128.00	1.00	128.00	128.00	128.00	#DIV/0!
SmChickRecrop	800.00	2.00	400.00	100.00	700.00	424.26
SmChickFall	0.00	0.00	0.00	0.00	0.00	0.00
FlaxRecrop	1857.00	5.00	371.40	147.00	650.00	222.46
FlaxFall	0.00	0.00	0.00	0.00	0.00	0.00
LentilsRecrop	2333.60	6.00	388.93	79.00	960.00	333.48
LentilsFall	400.00	2.00	200.00	200.00	200.00	0.00
MustardRecrop	5775.00	14.00	412.50	120.00	2200.00	532.59
MustardFall	25.00	1.00	25.00	25.00	25.00	#DIV/0!
SunflRecrop	50.00	1.00	50.00	50.00	50.00	#DIV/0!
SunflFall	60.00	1.00	60.00	60.00	60.00	#DIV/0!
AustWintPeaRecrop	0.00	0.00	0.00	0.00	0.00	0.00
AustWintPeaFall	0.00	0.00	0.00	0.00	0.00	0.00
CrambeRecrop	1745.00	5.00	349.00	225.00	700.00	198.00
CrambeFall	0.00	0.00	0.00	0.00	0.00	0.00
DrEdPeaRecrop	8142.70	16.00	508.92	54.00	3175.00	746.85
DrEdPeaFall	238.00	2.00	119.00	38.00	200.00	114.55
LgChickRecrop	120.00	1.00	120.00	120.00	120.00	#DIV/0!
LgChickFall	0.00	0.00	0.00	0.00	0.00	0.00
MaltBarlRecrop	3672.60	14.00	262.33	40.00	700.00	157.72
MaltBarlFall	2267.00	6.00	377.83	100.00	900.00	310.34
PintoBeanRecrop	435.00	2.00	217.50	100.00	335.00	166.17
PintoBeanFall	0.00	0.00	0.00	0.00	0.00	0.00
SafflowerRecrop	5854.40	13.00	450.34	116.00	1000.00	265.49
SafflowerFall	509.00	4.00	127.25	30.00	200.00	70.89
GrassSdRecrop	143.00	1.00	143.00	143.00	143.00	#DIV/0!
GrassSdFall	149.00	2.00	74.50	6.00	143.00	96.87
CRP	13893.10	23.00	604.05	11.00	1570.00	502.81
Fallowed	41074.00	33.00	1244.67	95.00	5800.00	1150.37
Crop Acreage	287044.80		3225.22	146.00	13840.00	2776.40

Table 13: Producer-Specific Survey General Information Variable Summary Statistics

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Chouteau	89	12.36%	0.00%	100.00%	33.10%
Daniels	89	4.49%	0.00%	100.00%	20.84%
McCone	89	4.49%	0.00%	100.00%	20.84%
Richland	89	6.74%	0.00%	100.00%	25.22%
Roosevelt	89	30.34%	0.00%	100.00%	46.23%
Sheridan	89	16.85%	0.00%	100.00%	37.65%
Valley	89	20.22%	0.00%	100.00%	40.40%
Yellowstone	89	4.49%	0.00%	100.00%	20.84%

Table 13: Producer-Specific Survey General Information Variable Summary Statistics (Continued)

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Northcentral	89	12.36%	0.00%	100.00%	33.10%
Northeast	89	83.15%	0.00%	100.00%	37.65%
Southcentral	89	4.49%	0.00%	100.00%	20.84%
Years Farming	89	28.66	1.00	60.00	10.56
Age	88	51.72	29.00	85.00	9.82
Some High School	88	4.55%	0.00%	100.00%	20.95%
High School Diploma	88	11.36%	0.00%	100.00%	31.92%
Trade School	88	1.14%	0.00%	100.00%	10.66%
Associate Degree	88	1.14%	0.00%	100.00%	10.66%
Some College	88	38.64%	0.00%	100.00%	48.97%
College Degree	88	39.77%	0.00%	100.00%	49.22%
Graduate Degree	88	4.55%	0.00%	100.00%	20.95%
College Graduate	88	44.32%	0.00%	100.00%	49.96%
Any College	88	82.95%	0.00%	100.00%	37.82%
Computer	89	91.01%	0.00%	100.00%	28.76%
Bookkeeping on Computer	89	68.54%	0.00%	100.00%	46.70%
Internet	89	86.52%	0.00%	100.00%	34.35%
Off-Farm Income	89	65.17%	0.00%	100.00%	47.91%
Livestock	89	43.82%	0.00%	100.00%	49.90%
<$10K GFI	84	1.19%	0.00%	100.00%	10.91%
$10-49K GFI	84	3.57%	0.00%	100.00%	18.67%
$50-99K GFI	84	13.10%	0.00%	100.00%	33.94%
$100-249K GFI	84	38.10%	0.00%	100.00%	48.85%
$250-499K GFI	84	30.95%	0.00%	100.00%	46.51%
>$500K GFI	84	10.71%	0.00%	100.00%	31.12%
Contracts General Crops	89	35.96%	0.00%	100.00%	48.26%
Contracts Specialty Crops	89	52.81%	0.00%	100.00%	50.20%

Table 14: Crop-Specific Survey Contracted Variable Definitions

VARIABLE	VARIABLE DEFINITION
Canola	(0,1) Dummy for Canola as the specialty crop of interest
Chickpeas	(0,1) Dummy for Chickpeas as the specialty crop of interest
Dry Edible Peas	(0,1) Dummy for Dry Edible Peas as the specialty crop of interest
Flax	(0,1) Dummy for Flax as the specialty crop of interest
Lentils	(0,1) Dummy for Lentils as the specialty crop of interest
Malting Barley	(0,1) Dummy for Malting Barley as the specialty crop of interest
Mustard	(0,1) Dummy for Mustard as the specialty crop of interest
Safflower	(0,1) Dummy for Safflower as the specialty crop of interest
Pulses	(0,1) Dummy for Pulses as the specialty crop category of interest

Table 14: Crop-Specific Survey Contracted Variable Definitions (Continued)

VARIABLE	VARIABLE DEFINITION
Oilseeds	(0,1) Dummy for Oilseeds as the specialty crop category of interest
Irrigated	(0,1) Dummy for irrigating crop of interest
Grown2000	(0,1) Dummy for producing crop in 2000 crop year
Grown2001	(0,1) Dummy for producing crop in 2001 crop year
Grown2002	(0,1) Dummy for producing crop in 2002 crop year
Grown2003	(0,1) Dummy for producing crop in 2003 crop year
Acres2003	Acres of crop planted in 2003 crop year
%ofTotalAcres2003	Percent of entire farm operation planted to crop of interest
YearLastGrown	Most recent year producing crop of interest
Yield	Yield in most recent year producing crop of interest
InternetWebsites	(1-4) Rank variable for the use of Internet Websites for pricing information
DTN	(1-4) Rank variable for the use of the Data Transmission Network (DTN) for pricing information
Newspapers	(1-4) Rank variable for the use of Newspapers for pricing information
AgPress	(1-4) Rank variable for the use of Agricultural Press for pricing information
SubNewsLett	(1-4) Rank variable for the use of Subscription Newsletters for pricing information
TV/Radio	(1-4) Rank variable for the use of TV & Radio for pricing information
InfoFromBuyer	(1-4) Rank variable for the use of Information from the Buyer for pricing information
PersonalContacts	(1-4) Rank variable for the use of Personal Contracts for pricing information
StatPubCanada	(1-4) Rank variable for the use of Statpub Canada (Statpub.com) for pricing information
Broker	(1-4) Rank variable for the use of personal Brokers for pricing information
OtherWebsites	(1-4) Rank variable for use of other miscellaneous internet websites for pricing information
AgOrganizations	(1-4) Rank variable for the use of Agricultural Organizations for pricing information
Cooperative With Price	Percentage of specialty crop production priced to a marketing cooperative with a predetermined price
Cooperative No Price	Percentage of specialty crop production priced to a marketing cooperative without a predetermined price
Marketing Contract	Percentage of specialty crop production priced to a buyer under contract with a predetermined price
Contract No Price	Percentage of specialty crop production priced to a buyer under contract without a predetermined price
Spot Cash	Percentage of specialty crop production priced through the spot cash market
Basis Fixed Contract	Percentage of specialty crop production priced to a buyer with a basis-fixed contract
Production Contract Dummy	(0,1) Dummy for use of a production contract in producing crop of interest
Marketing Contract Dummy	(0,1) Dummy for use of a marketing contract in producing crop of interest
Other Contracts Dummy	(0,1) Dummy for use of other types of contract in producing crop of interest
No Contract Dummy	(0,1) Dummy for not using any type of contract in producing crop of interest
AOGProducer	(0,1) Dummy for Act of God for the Producer provision present in contracts used
AOGBuyer	(0,1) Dummy for Act of God for the Buyer provision present in contracts used
QualityReq	(0,1) Dummy for Specific Quality Discounts provision present in contracts used
SpecQualityDisc	(0,1) Dummy for Specific Quality Premiums provision present in contracts used
SpecQualityPrem	(0,1) Dummy for Chemical Use Restrictions provision present in contracts used
ChemUseRest	(0,1) Dummy for Chemical Use Restrictions provision present in contracts used

Table 14: Crop-Specific Survey Contracted Variable Definitions (Continued)

VARIABLE	VARIABLE DEFINITION
FRORBuyer	(0,1) Dummy for First Right of Refusal for Buyer provision present in contracts used
LRORBuyer	(0,1) Dummy for Last Right of Refusal for Buyer provision present in contracts used
Spec%toBuyer	(0,1) Dummy for Selling a Specifiic Percentage of Crop to the Buyer provision present in contracts used
ALLtoBuyer	(0,1) Dummy for Selling All of the Crop to the Buyer provision present in contracts used
StorageFrghtClause	(0,1) Dummy for Storage and Freight Clauses present in contracts used
PricePred	(0,1) Dummy for Price Predetermiend provision present in contracts used
PriceAtDelivery	(0,1) Dummy for Price Determined Upon Delivery provision present in contracts used
SpecBreachPenalty	(0,1) Dummy for Specific Breach of Contract Penalty present in contracts used
RefusalLimits	(0,1) Dummy for Refusal Limits of Foreign Materials present in contracts used
RequiredForCropQuality	(1-4) Rank variable for importance of contract being required for the quality of the crop
RequiredForAmtOfCrop	(1-4) Rank variable for importance of contract being required for amount of crop to be purchased
PriceRiskRedProducer	(1-4) Rank variable for importance of contract reducing risk for the producer
PriceRiskRedBuyer	(1-4) Rank variable for importance of contract reducing risk for the buyer
EnsuresMarket	(1-4) Rank variable for importance of contract ensuring a market for the harvested crop
MoveCropOutStorage	(1-4) Rank variable for importance of contract to move the crop out of storage
FormCropInsurance	(1-4) Rank variable for importance of contract to serve as a form of crop insurance
BeforePlanted	(1-4) Rank variable for frequency of signing contracts before the crop is planted
AfterPlantedBeforeQuality	(1-4) Rank variable for frequency of signing contracts after the crop is planted but before crop quality determined
AfterQualityBeforeHarvest	(1-4) Rank variable for frequency of signing contracts after the crop quality is established but before harvest
DuringHarvest	(1-4) Rank variable for frequency of signing contracts during harvesting of the crop
PostHarvest	(1-4) Rank variable for frequency of signing contracts after crop is harvested
Processor	(0,1) Dummy for contracting with the processor of the crop
LocalElevator	(0,1) Dummy for contracting with a local elevator
Broker	(0,1) Dummy for contracting with a broker
Other	(0,1) Dummy for contracting with a different type of firm
Montana	(0,1) Dummy for contracting with a firm in Montana
NorthDakota	(0,1) Dummy for contracting with a firm in North Dakota
Colorado	(0,1) Dummy for contracting with a firm in Colorado
Saskatchewan	(0,1) Dummy for contracting with a firm in Saskatchewan
OtherUSAUnknownState	(0,1) Dummy for contracting with a firm in an unknown US state
Idaho	(0,1) Dummy for contracting with a firm in Idaho
Minnesota	(0,1) Dummy for contracting with a firm in Minnesota
NorthCarolina	(0,1) Dummy for contracting with a firm in North Carolina
Alberta	(0,1) Dummy for contracting with a firm in Alberta
California	(0,1) Dummy for contracting with a firm in California
Wyoming	(0,1) Dummy for contracting with a firm in Wyoming
Distance	Distance in miles from the point of delivery for the crop of interest

Table 15: Crop-Specific Survey Non-Contracted Variable Definitions

VARIABLE	VARIABLE DEFINITION
NoContractForCrop	(1-4) Rank variable for importance of not contracting due to no specific contract for the crop
NotDefinedMarket	(1-4) Rank variable for importance of not contracting due to an undefined market for the crop
InaccessibleMarket	(1-4) Rank variable for importance of not contracting due to lack of access to market for the crop
BuyerPrefersNoContract	(1-4) Rank variable for importance of not contracting due to buyer preferring no contract
TooMuchUncertaintyInProd	(1-4) Rank variable for importance of not contracting due to too much production uncertainty
UsedOtherMethods	(1-4) Rank variable for importance of not contracting due to using other marketing methods
SpotMarket	(1-4) Rank variable for importance of not contracting due to use of the spot cash market
PriceLowerDuring/BeforeSeeding	(1-4) Rank variable for importance of not contracting due to the price being lower before and during seeding
DirectlyToConsumer	(0,1) Dummy for marketing the crop direclty to the final consumer
DirectlyToProcessor	(0,1) Dummy for marketing the crop directly to the process of the crop
LocalElevator	(0,1) Dummy for marketing the crop to a local elevator
ToBroker	(0,1) Dummy for marketing the crop to a broker
CanadianElevator	(0,1) Dummy for marketing the crop to a Canadian elevator
MontanaNON	(0,1) Dummy for non-contracting buyer located in Montana
NorthDakotaNON	(0,1) Dummy for non-contracting buyer located in North Dakota
MinnesotaNON	(0,1) Dummy for non-contracting buyer located in Minnesota
SaskatchewanNON	(0,1) Dummy for non-contracting buyer located in Saskatchewan
CaliforniaNON	(0,1) Dummy for non-contracting buyer located in California
ManitobaNON	(0,1) Dummy for non-contracting buyer located in Manitoba
WyomingNON	(0,1) Dummy for non-contracting buyer located in Wyoming
Distance	Distance in miles from the point of delivery for the crop of interest

Table 16: Crop-Specific Survey Contracted Variable Summary Statistics

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Canola	110	17.27%	0.00%	100.00%	37.97%
Chickpeas	110	5.45%	0.00%	100.00%	22.81%
Dry Edible Peas	110	14.55%	0.00%	100.00%	35.42%
Flax	110	4.55%	0.00%	100.00%	20.93%
Lentils	110	9.09%	0.00%	100.00%	28.88%
Malting Barley	110	13.64%	0.00%	100.00%	34.47%
Mustard	110	13.64%	0.00%	100.00%	34.47%
Safflower	110	14.55%	0.00%	100.00%	35.42%
Pulses	110	29.09%	0.00%	100.00%	45.63%
Oilseeds	110	50.00%	0.00%	100.00%	50.23%
Irrigated	110	8.18%	0.00%	100.00%	27.53%
Grown2000	110	47.27%	0.00%	100.00%	50.15%
Grown2001	110	63.64%	0.00%	100.00%	48.32%
Grown2002	110	82.73%	0.00%	100.00%	37.97%
Grown2003	110	90.91%	0.00%	100.00%	28.88%

Table 16: Crop-Specific Survey Contracted Variable Summary Statistics (Continued)

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
Acres2003	110	382.59	47.50	3213.00	399.56
%ofTotalAcres2003	99	12.36%	2.01%	57.75%	10.70%
YearLastGrown	110	0.00	0.00	0.00	0.00
Yield	99	0.00	0.00	0.00	0.00
InternetWebsites	108	1.72	1.00	4.00	1.08
DTN	108	1.36	1.00	4.00	0.83
Newspapers	108	1.49	1.00	4.00	0.75
AgPress	108	1.86	1.00	4.00	0.94
SubNewsLett	108	1.32	1.00	4.00	0.73
TV/Radio	108	1.39	1.00	4.00	0.76
InfoFromBuyer	108	2.03	1.00	4.00	1.37
PersonalContacts	108	1.40	1.00	4.00	0.99
StatPubCanada	108	1.05	1.00	4.00	0.35
Broker	108	1.03	1.00	4.00	0.29
OtherWebsites	108	1.19	1.00	4.00	0.67
AgOrganizations	108	1.06	1.00	3.00	0.30
Cooperative With Price	110	3.64%	0.00%	100.00%	18.80%
Cooperative No Price	110	4.55%	0.00%	100.00%	20.93%
Marketing Contract	110	57.00%	0.00%	100.00%	44.42%
Contract No Price	110	2.45%	0.00%	100.00%	14.28%
Spot Cash	110	30.73%	0.00%	100.00%	41.21%
Basis Fixed Contract	110	1.64%	0.00%	100.00%	10.97%
Production Contract Dummy	109	8.26%	0.00%	100.00%	27.65%
Marketing Contract Dummy	109	68.81%	0.00%	100.00%	46.54%
Other Contracts Dummy	109	3.67%	0.00%	100.00%	18.89%
No Contract Dummy	109	23.85%	0.00%	100.00%	42.82%
AOGProducer	82	80.49%	0.00%	100.00%	39.87%
AOGBuyer	82	10.98%	0.00%	100.00%	31.45%
QualityReq	82	89.02%	0.00%	100.00%	31.45%
SpecQualityDisc	82	69.51%	0.00%	100.00%	46.32%
SpecQualityPrem	82	28.05%	0.00%	100.00%	45.20%
ChemUseRest	82	26.83%	0.00%	100.00%	44.58%
FRORBuyer	82	41.46%	0.00%	100.00%	49.57%
LRORBuyer	82	3.66%	0.00%	100.00%	18.89%
Spec%toBuyer	82	24.39%	0.00%	100.00%	43.21%
ALLtoBuyer	82	46.34%	0.00%	100.00%	50.17%
StorageFrghtClause	82	42.68%	0.00%	100.00%	49.77%
PricePred	82	89.02%	0.00%	100.00%	31.45%
PriceAtDelivery	82	8.54%	0.00%	100.00%	28.11%
SpecBreachPenalty	82	20.73%	0.00%	100.00%	40.79%
RefusalLimits	82	42.68%	0.00%	100.00%	49.77%
RequiredForCropQuality	82	1.90	1.00	4.00	1.04

Table 16: Crop-Specific Survey Contracted Variable Summary Statistics (Continued)

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
RequiredForAmtOfCrop	82	2.52	1.00	4.00	1.22
PriceRiskRedProducer	82	3.33	1.00	4.00	0.93
PriceRiskRedBuyer	82	1.46	1.00	4.00	0.83
EnsuresMarket	82	3.30	1.00	4.00	0.90
MoveCropOutStorage	82	1.04	1.00	4.00	0.33
FormCropInsurance	82	1.04	1.00	4.00	0.33
BeforePlanted	80	3.39	1.00	4.00	1.08
AfterPlantedBeforeQuality	80	1.45	1.00	4.00	0.71
AfterQualityBeforeHarvest	80	1.40	1.00	4.00	0.69
DuringHarvest	80	1.38	1.00	4.00	0.66
PostHarvest	80	1.96	1.00	4.00	1.20
Processor	83	83.13%	0.00%	100.00%	37.67%
LocalElevator	83	28.92%	0.00%	100.00%	45.61%
Broker	83	34.94%	0.00%	100.00%	47.97%
Other	83	0.00%	0.00%	0.00%	0.00%
Montana	83	48.19%	0.00%	100.00%	50.27%
North Dakota	83	21.69%	0.00%	100.00%	41.46%
Colorado	83	3.61%	0.00%	100.00%	18.78%
Saskatchewan	83	33.73%	0.00%	100.00%	47.57%
Other USA Unknown State	83	2.41%	0.00%	100.00%	15.43%
Idaho	83	4.82%	0.00%	100.00%	21.55%
Minnesota	83	2.41%	0.00%	100.00%	15.43%
North Carolina	83	3.61%	0.00%	100.00%	18.78%
Alberta	83	6.02%	0.00%	100.00%	23.94%
California	83	8.43%	0.00%	100.00%	27.96%
Wyoming	83	1.20%	0.00%	100.00%	10.98%
Distance	81	78.80	0.00	500.00	94.10

Table 17: Crop-Specific Survey Non-Contracted Variable Summary Statistics

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
NoContractForCrop	42	1.98	1.00	4.00	1.26
NotDefinedMarket	42	1.36	1.00	4.00	0.82
InaccessibleMarket	42	1.38	1.00	4.00	0.73
BuyerPrefersNoContract	42	1.33	1.00	4.00	0.75
TooMuchUncertaintyInProd	42	2.43	1.00	4.00	1.33
UsedOtherMethods	42	1.29	1.00	4.00	0.81
SpotMarket	42	1.00	1.00	1.00	0.00
PriceLowerDuring/BeforeSeeding	42	1.10	1.00	3.00	0.43
DirectlyToConsumer	45	2.22%	0.00%	100.00%	14.91%
DirectlyToProcessor	45	53.33%	0.00%	100.00%	50.45%
LocalElevator	45	35.56%	0.00%	100.00%	48.41%
ToBroker	45	31.11%	0.00%	100.00%	46.82%
CanadianElevator	45	4.44%	0.00%	100.00%	20.84%

Table 17: Crop-Specific Survey Non-Contracted Variable Summary Statistics (Continued)

VARIABLE	NUMBER OF OBS.	AVERAGES	MINIMUM	MAXIMUM	STANDARD DEV.
MontanaNON	45	46.67%	0.00%	100.00%	50.45%
NorthDakotaNON	45	37.78%	0.00%	100.00%	49.03%
MinnesotaNON	45	2.22%	0.00%	100.00%	14.91%
SaskatchewanNON	45	44.44%	0.00%	100.00%	50.25%
CaliforniaNON	45	4.44%	0.00%	100.00%	20.84%
ManitobaNON	45	4.44%	0.00%	100.00%	20.84%
WyomingNON	45	2.22%	0.00%	100.00%	14.91%
Distance	45	129.42	0.00	750.00	146.91

APPENDIX D

VARIANCE/COVARIANCE CORRELATION MATRICES

Table 18: Adoption Model (1) Variance/Covariance Correlation Matrix

	Crop Acreage	*Distance*	*Irrigated*	*Canola*	*Chickpeas*	*Dry Ed. Peas*	*Flax*
Crop Acreage	1						
Distance	0.5985	1					
Irrigated	-0.6111	-0.6357	1				
Canola	-0.3118	-0.2054	0.2198	1			
Chickpeas	0.0352	0.0436	-0.092	0.365	1		
Dry Ed. Peas	-0.3252	-0.0629	0.3203	0.4271	0.4896	1	
Flax	-0.4018	-0.6269	0.4108	0.3918	0.4678	0.4643	1
Lentils	-0.0921	0.0111	0.1736	0.3887	0.5324	0.6576	0.382
Malting Barley	0.3836	0.608	-0.4097	0.1611	0.4064	0.2042	-0.163
Mustard	0.4175	0.5811	-0.3798	0.0414	0.4439	0.2703	-0.0768
Safflower	0.1024	0.4564	-0.2486	0.2219	0.5378	0.4667	0.1294
Chouteau	-0.8432	-0.6405	0.854	0.2211	-0.1419	0.2423	0.3398
Daniels	-0.85	-0.5718	0.8488	0.2327	-0.1854	0.2826	0.2896
McCone	-0.859	-0.6767	0.8366	0.2476	-0.1796	0.2166	0.3355
Richland	-0.8522	-0.5832	0.8273	0.1602	-0.2371	0.1942	0.2619
Roosevelt	-0.8447	-0.5878	0.8153	0.1836	-0.1982	0.149	0.244
Sheridan	-0.8229	-0.514	0.7285	0.2025	-0.085	0.2259	0.2758
Valley	-0.8667	-0.6212	0.8217	0.1548	-0.1856	0.2295	0.3062
Some College	0.8057	0.5665	-0.7355	-0.2965	0.0068	-0.3614	-0.3821
College Grad.	0.868	0.5875	-0.7176	-0.3758	0.0831	-0.2971	-0.3382
Internet	-0.3064	-0.0652	0.3698	0.113	0.2292	0.2856	0.3042
Age	0.6662	0.2409	-0.5806	-0.1148	0.3639	-0.118	0.1074
Bookkeep. Comp.	-0.297	-0.1179	0.4037	0.2479	-0.129	0.2072	-0.1148
Off-Farm Inc.	0.7543	0.56	-0.8115	-0.2544	0.1664	-0.3198	-0.3208
Livestock	0.0137	-0.0021	0.2925	0.2274	0.0768	0.2694	-0.0206
$200-249K GFI	-0.6489	-0.2789	0.4644	0.0468	-0.2669	0.143	0.0141
$250-499K GFI	-0.8436	-0.3945	0.5775	0.203	-0.0817	0.2609	0.164
> $500K GFI	-0.7944	-0.3401	0.4306	0.1091	-0.0181	0.2645	0.199
Constant	-0.4143	-0.2199	0.1949	0.0274	-0.4238	-0.1052	-0.1617

	Lentils	*Malting Barley*	*Mustard*	*Safflower*	*Chouteau*	*Daniels*	*McCone*
Lentils	1						
Malting Barley	0.3006	1					
Mustard	0.393	0.733	1				
Safflower	0.4504	0.6382	0.6582	1			
Chouteau	0.0569	-0.4693	-0.4545	-0.3187	1		
Daniels	0.0547	-0.4142	-0.4294	-0.1967	0.9587	1	
McCone	0.0271	-0.5452	-0.54	-0.3431	0.9631	0.9535	1
Richland	0.0007	-0.4776	-0.45	-0.2936	0.9585	0.9603	0.9585
Roosevelt	-0.0402	-0.426	-0.4527	-0.2705	0.9622	0.9623	0.9556
Sheridan	0.0313	-0.315	-0.3406	-0.1397	0.9121	0.9293	0.9085
Valley	0.0285	-0.4659	-0.4313	-0.2255	0.9565	0.9652	0.9567
Some College	-0.2196	0.4113	0.3795	0.1236	-0.8267	-0.8058	-0.8094

Table 18: Adoption Model (1) Variance/Covariance Correlation Matrix (Continued)

	Lentils	*Malting Barley*	*Mustard*	*Safflower*	*Chouteau*	*Daniels*	*McCone*
College Grad.	-0.1229	0.381	0.4006	0.1511	-0.8675	-0.8754	-0.8812
Internet	0.2337	0.0589	0.1539	0.3122	0.4109	0.4006	0.2855
Age	0.0353	0.3401	0.3766	0.2774	-0.6846	-0.7097	-0.7032
Bookkeep. Comp.	0.258	-0.0267	-0.143	-0.0419	0.4133	0.4894	0.4339
Off-Farm Inc.	-0.067	0.4001	0.4641	0.1947	-0.8643	-0.8988	-0.8277
Livestock	0.3938	0.1426	0.1234	0.0967	0.1798	0.2249	0.1199
$200-249K GFI	-0.0826	-0.3325	-0.3184	-0.1178	0.5852	0.5857	0.5755
$250-499K GFI	0.0626	-0.2667	-0.2959	-0.0954	0.7822	0.76	0.76
> $500K GFI	0.0629	-0.2437	-0.2682	-0.0332	0.6487	0.6231	0.61
Constant	-0.2131	-0.4046	-0.4755	-0.4331	0.28	0.2879	0.3577

	Richland	*Roosevelt*	*Sheridan*	*Valley*	*Some College*	*College Grad.*	*Internet*
Richland	1						
Roosevelt	0.9659	1					
Sheridan	0.91	0.9488	1				
Valley	0.9719	0.9616	0.9219	1			
Some College	-0.8077	-0.7738	-0.6717	-0.8151	1		
College Grad.	-0.8631	-0.8463	-0.7919	-0.877	0.9201	1	
Internet	0.3303	0.3546	0.3733	0.3831	-0.4541	-0.4137	1
Age	-0.7721	-0.7182	-0.5819	-0.7114	0.7219	0.6995	-0.0282
Bookkeep. Comp.	0.36	0.4309	0.4368	0.3636	-0.343	-0.443	0.1301
Off-Farm Inc.	-0.8318	-0.8348	-0.7854	-0.8515	0.7737	0.8106	-0.4924
Livestock	0.064	0.1092	0.1258	0.0828	-0.151	-0.1274	0.3414
$200-249K GFI	0.647	0.6149	0.4787	0.6144	-0.6139	-0.5444	0.0519
$250-499K GFI	0.8002	0.8111	0.732	0.773	-0.7703	-0.7428	0.23
> $500K GFI	0.674	0.6649	0.5914	0.6448	-0.7035	-0.6147	0.1833
Constant	0.3976	0.3009	0.1415	0.3306	-0.4487	-0.4209	-0.3839

	Age	*Bookkeep. Comp.*	*Off-Farm Inc.*	*Livestock*	*$100-249K GFI*	*$250-499K GFI*	*>$500K GFI*
Age	1						
Bookkeep. Comp.	-0.3276	1					
Off-Farm Inc.	0.6015	-0.4393	1				
Livestock	0.0206	0.7181	-0.2664	1			
$200-249K GFI	-0.8013	0.1259	-0.467	-0.1094	1		
$250-499K GFI	-0.8121	0.2976	-0.6246	0.0021	0.8723	1	
> $500K GFI	-0.7129	0.1128	-0.4964	-0.0989	0.8441	0.9198	1
Constant	-0.7804	-0.0204	-0.2664	-0.3681	0.5567	0.4602	0.4583

Table 19: Adoption Model (2) Variance/Covariance Correlation Matrix

	Crop Acreage	*Distance*	*Irrigated*	*Northcentral*	*Southcentral*	*Oilseed*	*Malting Barley*
Crop Acreage	1						
Distance	0.1944	1					
Irrigated	-0.0069	-0.2574	1				
Northcentral	-0.1879	-0.0185	0.0404	1			
Southcentral	0.3261	0.1613	-0.4606	-0.0256	1		
Oilseed	-0.0551	0.1102	-0.1493	-0.0087	-0.0861	1	
Malting Barley	-0.0472	0.1907	-0.2541	-0.0697	-0.3527	0.4857	1
College Grad.	0.16	-0.1186	0.0353	-0.0364	0.3787	-0.4346	-0.381
Internet	-0.2152	0.1684	0.146	0.1214	-0.193	-0.0022	0.042
Age	-0.1429	-0.0594	0.025	0.1103	-0.1558	0.1523	0.1671
Bookkeep. Comp.	-0.0348	-0.0685	0.0509	0.0171	-0.2171	0.2512	0.1024
Off-Farm Inc.	0.118	0.0278	-0.3572	-0.0471	0.2395	0.2644	0.1788
Livestock	-0.1422	-0.3046	0.1698	-0.0125	-0.0749	-0.0343	-0.0285
$100-249K GFI	-0.0555	-0.1507	-0.1943	0.1805	-0.0066	0.2815	0.1864
$250-499K GFI	-0.2294	-0.148	-0.1577	0.2027	-0.0933	0.2996	0.2673
>$500K GFI	-0.3706	-0.1324	-0.2861	0.2014	0.1227	0.0682	0.0548
Constant	0.0202	-0.0584	0.0475	-0.1625	0.1036	-0.3706	-0.2976

	College Grad.	*Internet*	*Age*	*Bookkeep Comp.*	*Off-Farm Inc.*	*Livestock*	*$100-249K GFI*
College Grad.	1						
Internet	-0.2261	1					
Age	-0.3632	0.5407	1				
Bookkeep. Comp.	-0.4628	-0.081	0.3012	1			
Off-Farm Inc.	-0.0444	-0.2279	-0.0085	-0.0223	1		
Livestock	0.0041	0.3225	0.3619	0.3038	-0.0351	1	
$100-249K GFI	-0.0391	-0.3957	-0.0741	0.0499	0.2755	-0.2022	1
$250-499K GFI	-0.0746	-0.328	-0.0588	0.0604	0.2288	-0.0347	0.8602
>$500K GFI	0.2386	-0.3506	-0.1972	-0.2311	0.211	-0.1517	0.6887
Constant	0.3656	-0.5048	-0.8841	-0.3855	-0.1761	-0.3954	-0.1886

	$250-499K GFI	*>$500K GFI*	*Constant*
$250-499K GFI	1		
>$500K GFI	0.741	1	
Constant	-0.2113	0.0482	1

Table 20: Adoption Model (3) Variance/Covariance Correlation Matrix

	Crop Acreage	*Distance*	*Irrigated*	*Northcentral*	*Southcentral*	*Oilseed*	*Malting Barley*
Crop Acreage	1						
Distance	0.1944	1					
Irrigated	-0.0069	-0.2574	1				
Northcentral	-0.1879	-0.0185	0.0404	1			
Southcentral	0.3261	0.1613	-0.4606	-0.0256	1		
Oilseed	-0.0551	0.1102	-0.1493	-0.0087	-0.0861	1	
Malting Barley	-0.0472	0.1907	-0.2541	-0.0697	-0.3527	0.4857	1
Any College	0.16	-0.1186	0.0353	-0.0364	0.3787	-0.4346	-0.381
Internet	-0.2152	0.1684	0.146	0.1214	-0.193	-0.0022	0.042
Age	-0.1429	-0.0594	0.025	0.1103	-0.1558	0.1523	0.1671
Bookkeep. Comp.	-0.0348	-0.0685	0.0509	0.0171	-0.2171	0.2512	0.1024
Off-Farm Inc.	0.118	0.0278	-0.3572	-0.0471	0.2395	0.2644	0.1788
Livestock	-0.1422	-0.3046	0.1698	-0.0125	-0.0749	-0.0343	-0.0285
$100-249K GFI	-0.0555	-0.1507	-0.1943	0.1805	-0.0066	0.2815	0.1864
$250-499K GFI	-0.2294	-0.148	-0.1577	0.2027	-0.0933	0.2996	0.2673
>$500K GFI	-0.3706	-0.1324	-0.2861	0.2014	0.1227	0.0682	0.0548
Constant	0.0202	-0.0584	0.0475	-0.1625	0.1036	-0.3706	-0.2976

	Any College	*Internet*	*Age*	*Bookkeep Comp.*	*Off-Farm Inc.*	*Livestock*	*$100-249K GFI*
Any College	1						
Internet	-0.2261	1					
Age	-0.3632	0.5407	1				
Bookkeep. Comp.	-0.4628	-0.081	0.3012	1			
Off-Farm Inc.	-0.0444	-0.2279	-0.0085	-0.0223	1		
Livestock	0.0041	0.3225	0.3619	0.3038	-0.0351	1	
$100-249K GFI	-0.0391	-0.3957	-0.0741	0.0499	0.2755	-0.2022	1
$250-499K GFI	-0.0746	-0.328	-0.0588	0.0604	0.2288	-0.0347	0.8602
>$500K GFI	0.2386	-0.3506	-0.1972	-0.2311	0.211	-0.1517	0.6887
Constant	0.3656	-0.5048	-0.8841	-0.3855	-0.1761	-0.3954	-0.1886

	$250-499K GFI	*>$500K GFI*	*Constant*
$250-499K GFI	1		
>$500K GFI	0.741	1	
Constant	-0.2113	0.0482	1

Table 21: Proportion Contracted Model (1) Variance/Covariance Correlation Matrix

	Crop Acreage	*Distance*	*Irrigated*	*Canola*	*Chickpeas*	*Dry Ed. Peas*	*Flax*
Crop Acreage	1						
Distance	-0.0262	1					
Irrigated	0.3576	-0.1002	1				
Canola	-0.1844	-0.0754	-0.08	1			
Chickpeas	-0.2609	-0.1057	0.1653	0.6036	1		
Dry Ed. Peas	-0.2564	-0.1102	0.1395	0.6232	0.6369	1	
Flax	-0.0344	-0.062	0.0541	0.5214	0.5681	0.4503	1
Lentils	-0.2906	-0.0723	0.0763	0.5886	0.5361	0.5622	0.4036
Malting Barley	-0.2825	-0.0657	-0.1988	0.6885	0.5018	0.549	0.479
Mustard	-0.1855	-0.3032	-0.0792	0.6818	0.518	0.5569	0.5289
Safflower	-0.3277	-0.0848	-0.1326	0.6745	0.5511	0.5433	0.4841
Chouteau	-0.1109	-0.0514	0.3385	-0.1275	-0.0535	0.1293	-0.1936
Daniels	0.0761	0.0783	0.3519	0.1327	0.0778	0.1798	0.0721
McCone	0.1689	-0.041	0.479	-0.2527	-0.2177	-0.061	-0.2601
Richland	0.2331	0.0993	0.4493	-0.2679	-0.1809	-0.1015	-0.1304
Roosevelt	0.0897	0.1727	0.4087	-0.2166	-0.216	-0.1257	-0.2446
Sheridan	0.2548	-0.0496	0.4579	-0.1121	-0.1308	-0.0141	-0.156
Valley	0.1712	-0.1322	0.1934	-0.3899	-0.5558	-0.3448	-0.3296
Some College	0.2913	-0.1104	0.1529	-0.1281	-0.1295	-0.1441	-0.08
College Grad.	0.0241	-0.0956	0.2207	-0.1245	0.0633	-0.0369	-0.0272
Internet	-0.1471	-0.1216	-0.0218	0.0863	0.1477	0.2015	0.1845
Age	0.2268	-0.2953	0.0298	-0.0766	0.0378	-0.0027	0.1835
Bookkeep. Comp.	-0.2106	-0.2389	-0.0868	0.2088	0.0212	0.1729	-0.1
Off-Farm Inc.	0.1246	-0.182	0.2486	-0.1935	0.0236	-0.0274	-0.1549
Livestock	-0.4181	-0.5063	0.0468	0.3465	0.3527	0.3978	0.1101
$100-249K GFI	-0.3475	-0.1086	0.1143	-0.0387	0.1036	0.082	-0.0978
$250-499K GFI	-0.5723	-0.0113	-0.038	0.0495	0.1165	0.1798	-0.2032
>$500K GFI	-0.7297	0.0183	-0.1119	0.1573	0.422	0.2536	0.0645
Constant	0.0146	0.4537	-0.3117	-0.1724	-0.2869	-0.3507	-0.2025
SIGMA							
Constant	-0.3434	0.05	0.0478	0.2001	0.2956	0.3979	0.0858

	Lentils	*Malting Barley*	*Mustard*	*Safflower*	*Chouteau*	*Daniels*	*McCone*
Lentils	1						
Malting Barley	0.5963	1					
Mustard	0.5704	0.7257	1				

Table 21: Proportion Contracted Model (1) Variance/Covariance Correlation Matrix (Continued)

	Lentils	*Malting Barley*	*Mustard*	*Safflower*	*Chouteau*	*Daniels*	*McCone*
Safflower	0.5625	0.7487	0.7705	1			
Chouteau	-0.0258	-0.0966	-0.1757	-0.209	1		
Daniels	0.1435	0.2456	-0.0106	0.2031	0.373	1	
McCone	-0.0668	-0.15	-0.317	-0.5223	0.6338	0.3622	1
Richland	-0.1183	-0.1273	-0.26	-0.4884	0.4931	0.3452	0.7462
Roosevelt	-0.0133	-0.116	-0.3147	-0.4095	0.5089	0.3853	0.7676
Sheridan	-0.0045	0.0432	-0.1715	-0.0825	0.4016	0.7399	0.5695
Valley	-0.2433	-0.1218	-0.1643	-0.232	0.3428	0.4297	0.5458
Some College	-0.084	-0.2173	-0.2303	-0.3634	-0.1035	-0.1988	0.1686
College Grad.	-0.0225	-0.2495	-0.2525	-0.3325	-0.0209	-0.3378	0.1354
Internet	0.1142	0.1588	0.341	0.1809	-0.0246	0.036	-0.1196
Age	-0.1035	-0.0929	0.0697	-0.0811	-0.026	-0.0195	-0.0185
Bookkeep. Comp.	0.1724	0.1918	0.2199	0.2746	0.3787	0.3595	0.0952
Off-Farm Inc.	-0.1397	-0.2232	-0.1464	-0.3848	0.1779	-0.3267	0.3858
Livestock	0.3943	0.3245	0.4582	0.5489	0.1697	0.2402	-0.1257
$100-249K GFI	0.0846	0.0329	-0.1433	-0.1571	0.5494	-0.0975	0.4373
$250-499K GFI	0.1829	0.1388	-0.0568	0.0192	0.546	-0.0761	0.2912
>$500K GFI	0.1949	0.1881	0.0662	0.2328	0.3014	-0.117	-0.0935
Constant	-0.2435	-0.2264	-0.3165	-0.108	-0.4436	-0.242	-0.3686
SIGMA							
Constant	0.2556	0.1021	0.1238	0.0711	0.2376	0.0247	0.1552

	Richland	*Roosevelt*	*Sheridan*	*Valley*	*Some College*	*College Grad.*	*Internet*
Richland	1						
Roosevelt	0.7218	1					
Sheridan	0.5113	0.5881	1				
Valley	0.4707	0.4871	0.5853	1			
Some College	0.1682	0.1993	0.0611	-0.0117	1		
College Grad.	0.1352	0.1329	-0.1706	-0.1573	0.8282	1	
Internet	0.2378	-0.1164	-0.1145	0.065	-0.3945	-0.2484	1
Age	-0.0052	-0.219	0.0711	0.1738	0.0415	0.0293	0.246
Bookkeep. Comp.	-0.1205	0.0217	0.2617	0.1814	-0.5855	-0.6369	0.0916
Off-Farm Inc.	0.1697	0.1731	-0.0423	-0.1355	0.2878	0.2978	-0.2383
Livestock	-0.2931	-0.1811	0.0715	0.0106	-0.2797	-0.147	0.243

Table 21: Proportion Contracted Model (1) Variance/Covariance Correlation Matrix (Continued)

	Richland	*Roosevelt*	*Sheridan*	*Valley*	*Some College*	*College Grad.*	*Internet*
$100-249K GFI	0.213	0.315	-0.1279	-0.0293	0.1979	0.4352	-0.2889
$250-499K GFI	0.0708	0.256	-0.0938	-0.1194	-0.0361	0.2121	-0.1905
>$500K GFI	-0.1584	-0.0396	-0.2623	-0.4395	-0.1443	0.1926	-0.0809
Constant	-0.3263	-0.1632	-0.299	-0.2507	-0.0416	-0.1257	-0.396
SIGMA							

	Age	*Bookkeep. Comp.*	*Off-Farm Inc.*	*Livestock*	*$100-249K GFI*	*$250-499K GFI*	*>$500K GFI*
Age	1						
Bookkeep. Comp.	-0.046	1					
Off-Farm Inc.	0.0408	-0.2083	1				
Livestock	0.0196	0.6062	-0.2397	1			
$100-249K GFI	-0.2868	0.0032	0.368	0.1091	1		
$250-499K GFI	-0.4475	0.2313	0.2758	0.3008	0.8407	1	
>$500K GFI	-0.3251	0.121	0.1261	0.3598	0.65	0.8004	1
Constant	-0.6363	-0.2524	-0.1853	-0.4363	-0.2026	-0.1227	-0.0632
SIGMA							
Constant	-0.0208	0.2119	0.1455	0.2002	0.2147	0.3021	0.2782

Table 22: Proportion Contracted Model (2) Variance/Covariance Correlation Matrix

	Crop Acreage	*Distance*	*Irrigated*	*Oilseed*	*Malting Barley*	*College Grad.*	*Internet*
Crop Acreage	1						
Distance	0.287	1					
Irrigated	0.2628	-0.0088	1				
Oilseed	0.1072	0.0799	-0.202	1			
Malting Barley	0.1135	0.0997	-0.3693	0.7383	1		
College Grad.	-0.3354	-0.1791	0.2518	-0.2108	-0.1498	1	
Internet	-0.1259	-0.0524	-0.0849	-0.0234	-0.1571	-0.0635	1
Age	0.2674	0.0061	0.1179	-0.2426	-0.1374	0.1542	0.1306
Bookkeep. Comp.	-0.3139	-0.2798	-0.2245	0.0017	-0.1192	-0.1431	0.1618
Off-Farm Inc.	-0.0249	-0.3334	-0.0621	-0.0292	0.0664	-0.0554	-0.3839
Livestock	-0.5676	-0.4892	-0.1039	-0.2156	-0.2341	0.1695	0.2243
$100-249K GFI	-0.5507	-0.4255	-0.2356	-0.0913	0.1563	0.3868	-0.4309

Table 22: Proportion Contracted Model (2) Variance/Covariance Correlation Matrix (Continued)

	Crop Acreage	*Distance*	*Irrigated*	*Oilseed*	*Malting Barley*	*College Grad.*	*Internet*
$250-499K GFI	-0.6574	-0.396	-0.2651	0.1247	0.2273	0.4284	-0.2261
>$500K GFI	-0.7846	-0.4239	-0.2423	-0.0254	0.0622	0.5289	-0.1698
Constant	0.0176	0.2807	0.0627	-0.0253	-0.078	-0.2572	-0.3383
SIGMA							
Constant	-0.0974	0.0997	0.0102	-0.2741	-0.2165	-0.2429	0.1297

	Age	*Bookkeep. Comp.*	*Off-Farm Inc.*	*Livestock*	*$100-249K GFI*	*$250-499K GFI*	*>$500K GFI*
Age	1						
Bookkeep. Comp.	-0.1484	1					
Off-Farm Inc.	-0.0203	-0.1264	1				
Livestock	-0.1581	0.5863	-0.026	1			
$100-249K GFI	-0.2196	0.1505	0.4945	0.4082	1		
$250-499K GFI	-0.399	0.1726	0.3251	0.4599	0.7705	1	
>$500K GFI	-0.322	0.1528	0.2364	0.5712	0.7876	0.8408	1
Constant	-0.772	-0.2326	-0.1153	-0.2505	-0.056	0.005	-0.0232
SIGMA							
Constant	-0.0562	0.087	-0.0999	0.1508	-0.2368	-0.2839	-0.1382

Table 23: Proportion Contracted Model (3) Variance/Covariance Correlation Matrix

	Distance	*Irrigated*	*Oilseed*	*Malting Barley*	*Any College*	*Internet*	*Age*
Distance	1						
Irrigated	-0.1051	1					
Oilseed	0.0918	-0.3154	1				
Malting Barley	0.0681	-0.4463	0.7594	1			
Any College	-0.266	0.328	-0.2088	-0.0514	1		
Internet	0.1246	-0.2082	0.0722	-0.0753	-0.5055	1	
Age	-0.1305	0.0247	-0.3248	-0.1765	0.3374	-0.0182	1
Bookkeep. Comp.	-0.0336	-0.2538	0.1463	0.0208	-0.6506	0.3051	-0.165
Off-Farm Inc.	-0.41	0.0225	-0.084	0	0.2883	-0.4752	0.0754
Livestock	-0.4249	0.0274	-0.2259	-0.2457	0.0763	0.1569	0.0161
$100-249K GFI	-0.4069	0.0462	-0.1399	0.1518	0.7023	-0.6875	0.1425
$250-499K GFI	-0.3519	-0.1534	0.2839	0.4195	0.2823	-0.4273	-0.2754
>$500K GFI	-0.382	-0.048	0.0406	0.1706	0.4468	-0.524	-0.1384

Table 23: Proportion Contracted Model (3) Variance/Covariance Correlation Matrix (Continued)

	Distance	*Irrigated*	*Oilseed*	*Malting Barley*	*Any College*	*Internet*	*Age*
Constant	0.3587	0.0754	0.0309	-0.0976	-0.4847	-0.021	-0.8043
SIGMA							
Constant	0.0984	-0.0043	-0.1936	-0.1701	-0.1455	0.1752	-0.0863

	Bookkeep. Comp.	*Off-Farm Inc.*	*Livestock*	*$100-249K GFI*	*$250-499K GFI*	*>$500K GFI*	*Constant*
Bookkeep. Comp.	1						
Off-Farm Inc.	-0.2309	1					
Livestock	0.3808	-0.0455	1				
$100-249K GFI	-0.4031	0.6151	0.1537	1			
$250-499K GFI	-0.0838	0.4757	0.1305	0.5917	1		
>$500K GFI	-0.2588	0.4903	0.2645	0.7125	0.633	1	
Constant	0.0433	-0.2499	-0.3033	-0.3607	-0.0839	-0.1318	1
SIGMA							
Constant	0.0759	-0.1348	0.1509	-0.2724	-0.3829	-0.3197	0.1384