Seed Ownership and Distribution of Rents in an IPPM System: Cases in Canadian Wheat

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Michael L. Gusta

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ABSTRACT

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Supervisor: R. S. Gray

The focus of this thesis is to explore the influence of market power possessed by seed input companies on rent distribution in an identity preserved production and marketing system. This thesis develops a theoretical model to estimate rent distribution between participants in an identity preserved production and marketing system under constrained production and the elicitation of a premium from market development activities in the presence of a range of seed ownership structures. The thesis employs an empirical model to examine rent distribution of two varieties involved in the Canadian Wheat Board's Identity Preserved Contract Program.

The theoretical model demonstrates that market development activities for an identity preserved production and marketing program had a diminished impact on farmers when the seed industry possessed a large degree of market power. The finding of the theoretical model were consistent with that of the empirical model, where the price of certified seed for varieties involved in the identity preserved production and marketing program were priced higher than conventional varieties. The difference in price was found to be greater than the premiums offered by the Identity Preserved Contract Program marketing and/or production contracts for Saskatchewan farmers that received average yields and average prices of grain.

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LIST OF ABBREVIATIONS

ABBREVIATION	NAME	FIRST REFERENCE
CWAD	Canadian Western Amber Durum	5
CWB	Canadian Wheat Board	3
CWHWS	Canadian Western Hard White Spring	6
CWRS	Canadian Western Red Spring	6
CPSR	Canadian Prairie Spring Red	75
CPSW	Canadian Prairie Spring White	75
IP	Identity Preserved	5
IPCP	Identity Preserved Contract Program	3
IPPM	Identity Preserved Production and Marketing	1
IPR	Intellectual Property Rights	2
KVD	Kernel Visual Distinguishability	16
MDCP	Market Development Contract Program	75
RLSC	Revenue Less Seed Cost	91
SAFRR	Saskatchewan Agriculture Food and Rural Revitalization	81
WGRF	Western Grains Research Foundation	84

LIST OF VARIABLES

Q_j^i	quantity of IP seed/grain in scenario *j* with *i* seed ownership structure
Q^{IP}	constrained quantity of IP seed/grain
$\Delta Q_{j,l}^i$	change in quantity from scenario *j* to *l* with *i* seed ownership structure
$\Delta Q_{j,l}^i(crit)$	change in quantity where producer surplus of IP grain is equal in scenario *j* to *l* with *i* seed ownership structure
P_j^i	consumer price of IP grain in scenario *j* with *i* seed ownership structure
P_j^{IP}	constrained consumer price of IP grain in scenario *j*
a	undifferentiable price of IP grain
R	market premium
b	differentiable price of IP Grain
CS_j^i	consumer surplus of IP grain in scenario *j* with *i* seed ownership structure
F_j^i	farmer price of IP grain in scenario *j* with *i* seed ownership structure
α	undifferentiable cost of producing IP grain
α^{Conv}	undifferentiable cost of producing conventional grain
α^{IP}	undifferentiable cost associated with involvement in an IP program
β	differentiable cost of producing IP grain
PS_j^i	producer surplus of IP grain in scenario *j* with *i* seed ownership structure
$\Delta PS_{j,l}^i$	change in producer surplus from scenario *j* to *l* with *i* seed ownership structure
S_j^i	price of IP seed in scenario *j* with *i* seed ownership structure
MR_j	marginal revenue for the demand for IP seed in scenario *j*
MC	marginal cost of IP seed
AC	average cost of IP seed
π_j^i	seed company rents in scenario *j* with *i* seed ownership structure
δ	market power of seed industry
$\delta_{j,l}(crit)$	market power where change in producer surplus equals zero from scenario *j* to *l*

CHAPTER 1
INTRODUCTION

1 Introduction

Consumer preference for grain has been changing, moving away from what is offered by traditional commodity markets thereby creating an opportunity for the development of niche markets. Niche markets are specialty markets that offer a unique product that can be priced at a premium over general commodity markets. This allows farmers an opportunity to sell their product at a premium price. However, niche market products require efficient organization and management of production, transportation, and marketing (Canadian Grain Commission 1998). The delivery of niche market products through conventional supply chains are faced with difficulties because the supply chain is comprised of a number of participants that operate independently and in their own best interest. As a result, the firms in the supply chain require a framework for coordination as well as guidelines to maintain purity, incentives for participation, and a system for assigning liability in the case of a failure. Such a framework can come through an arrangement between firms within the supply chain known as an identity preserved production and marketing (IPPM) system.

Identity preserved production and marketing systems coordinate supply chain activities for the production, transportation, and marketing of a niche market product to consumers.[1] The system involves the participation of multiple firms including, but not limited to; breeders, seed companies, farmers, grain handlers, processors, marketers, and consumers. A series of contracts organize participants in an IPPM system. These contracts, which establish the relationship between participants, are a critical tool for the coordination of activities and provide incentives

[1] Consumers of an IPPM product in the context of this thesis are processors, wholesalers, retailers, or end-use consumers.

for participation (Smyth and Phillips 2001). The contracts allow the IPPM system to align product characteristics with consumer preferences in order to elicit a premium (Reichert and Vachal 2003). In addition, the contracts distribute the premium to participants in the supply chain in the form of economic rents. Identity preserved production and marketing system can theoretically increase returns to participants through a combination of higher margins as well as a guarantee of receipts.

1.1 Market Power and Identity Preserved Production and Marketing Systems

The premium commanded by IPPM systems is distributed throughout the supply chain to create incentives for participation in the program. However, the presence of the premium also creates an incentive for the exertion of market power by opportunistic firms. The exertion of market power results in the redistribution of rents within the system, possibly allowing a firm to capture the majority of the premium generated by the system. If incentives are insufficient at any stage in the IPPM system participation may not occur causing the system to fail (Smyth and Phillips 2002).

Market power, possessed by upstream and downstream participants, arises from the control of an input or service that cannot be easily substituted (National Farmers Union 2000; Harl 2000). Within IPPM systems market power typically results from a critical agricultural input, such as a unique seed variety, protected by intellectual property rights (IPR). In general, a small number of large firms dominate agricultural input markets. These firms can be assumed to possess sufficient information about the rents generated from their input, and price the input in such a way as to capture the greatest possible share of rents (Harl 2004). The ability of a firm to exert market power is dependent upon the contractual arrangements between the participants as well as the policies and requirements of the IPPM system.

1.2 Canadian Wheat Board Identity Preserved Contract Program

The Canadian Wheat Board (CWB) is the single desk seller for Western Canadian wheat and barley for human consumption in export and domestic markets.[2] It has established a reputation that Western Canadian wheat is "the best in the world". As such, the CWB has developed a premium brand for Western Canadian wheat, in which it is the single seller. As a single desk seller, with established marketing channels, and wheat and barley brand make it a good candidate for the development of IPPM systems (Smyth and Phillips 2001). Additionally, the development of new IPPM systems by a credible and trusted institution, such as the CWB, increases the probability of the IPPM systems' success (Smyth and Phillips 2001).

The CWB has taken advantage of its expertise and responded to increasing consumer demand for specialty grains with the creation of an IPPM system called the Identity Preserved Contract Program (IPCP). The IPCP began operation in 1998[3] and has grown and developed to deal with issues arising from the coordination of activities of firms in the Canadian wheat supply chain. The IPCP is composed of two marketing programs, a commercial IPCP that focuses on market penetration, and a developmental IPCP that focuses on market development. Market penetration occurs in established specialty wheat markets where the CWB's objective is to serve the market and increase market share. Market development involves the creation of markets for new varieties that contain unique characteristics, which meets consumer preferences. The combination of these two marketing programs allows the CWB to highlight Canadian wheat and barley production as well as Canadian breeding efforts. However, even though the CWB has a

[2] Within Canada feed wheat and feed barley can be sold outside the CWB. In the remainder of this thesis reference to the wheat and barley supply chain pertains to wheat and barley marketed by the CWB.

[3] The IPCP was initially called the Market Development Contract Program. Its name was later changed to better reflect the goals of the program.

monopoly of Western Canadian wheat and barley and is the developer of the IPCP the CWB is not the sole possessor of market power within the IPCP.

The CWB and seed companies both possess market power in the IPCP. Seed company's market power comes from its ownership of certain varieties that are protected by IPR as well as from the contract structure of the IPCP. The IPR grant the seed company a monopoly over the marketing and price of the seed. The contract structure requires farmers to have a production contract with seed companies in order to participate in the IPCP and to obtain their varieties of seed (CWB 2005b). Control over the production contract grants the seed company control over the distribution of the contracts, as well as control over the contract's policies. Two policies of note for these production contracts are; the requirement for the use of certified seed, and the sale of all grain produced back to the seed company. These policies prevent farmers from saving or obtaining saved seed. The combination of IPR and production contract policies grant seed companies a large degree of market power over the IPCP, providing them with a small and easily identifiable market for the exertion of its market power.

The CWB is in a position to reduce the exertion of the seed industries market power. The CWB's market power comes from its single desk selling authority and from the development of the IPCP program. This combined with the CWB's mandate to return all revenues to farmers less the cost of marketing and administration, allows the CWB to exert market power over the IPCP on behalf of farmers to maximize farmer's profits. As a result, the seed industry, farmers or both can capture the rents generated in the IPCP.

1.3 Thesis Objective

The objective of this thesis is to model and examine the distribution of rents within the IPCP where input suppliers possess significant market power. The hypothesis of this thesis is that seed companies exert market power within the IPCP and extract the majority of the rents. The theoretical model examines the incentives for participants, and the empirical analysis tests the hypothesis.

The theoretical model is developed to examine the IPCP policies under a vertical market, consisting of a market for identity preserved (IP[4]) seed and a market for IP grain. The theoretical model presents two IPCP policies; constrained production, and market development activities.[5] The impact of the two policies will be examined separately and jointly creating four scenarios; base case, constrained supply, market development activities, and a constrained supply with market development activities. In these four scenarios the seed industry will be presented under three seed ownership structures; monopolistic, perfectly competitive, and oligopolistic. Rent distribution and Marshallian surpluses will be measured under each seed ownership structure and compared between scenarios. The scenarios developed in the theoretical model are representative of the empirical analysis cases.

The empirical analysis compares the relative profitability of two commercial IPCP varieties with non-IPCP varieties. The first case, Canadian Western Amber Durum (CWAD), compares the IPCP variety AC Navigator with two non-IPCP varieties AC Avonlea and Kyle. The varieties AC Navigator and AC Avonlea are similar with respect to production characteristics and seed ownership structure, with both owned by the same seed company. The difference between the two varieties is that the production of AC Avonlea is unconstrained, while AC Navigator is restricted to contracted production. The comparison of AC Navigator and Kyle is associated with differences in seed ownership structures, AC Navigator owned by a monopolist

[4] IP within the context of this paper will only refer to identity preservation.

[5] Market development activities should not be confused with the market development IPCP. Market development activities increase the value of a product to its market in order to generate a premium.

and Kyle owned by a competitive oligopoly. The second case, Canadian Western Hard White Spring wheat (CWHWS), compares the IPCP variety Snowbird with a standardized non-IPCP Canadian Western Red Spring wheat (CWRS) variety.[6] This case examines the influence of yield and market fluctuations over time on the profitability of involvement in the IPCP. Each case measures the relative profitability (i.e. revenue less costs that are not common between the two varieties) of the IPCP variety for a representative Saskatchewan farmer[7] in order to provide an estimation of farmer benefit from participation.

1.4 Organization of Thesis

The thesis consists of five chapters, each providing a logical next step to explain; the system, the alignment between the seed companies, farmers and marketer, and how the rents are distributed. The first chapter identifies and describes the problem, introduces key concepts and outlines the testing of the hypothesis. Chapter two provides an explanation of IPPM systems and the suitability of IPPM systems in Canada. The third chapter constructs the theoretical model employed by the study, outlines the structure of the vertical market, and analyzes the impact of IPPM policies and seed industry's market power on farmer welfare. The fourth chapter further examines the CWB's IPCP, and formulates the empirical analysis for two cases of IPCP varieties and tests the hypothesis developed in chapter one. The fifth chapter discusses the results of the theoretical model and the empirical analysis, summarising the conclusions drawn from the thesis, the limitations of the study, and presents suggestions for further research.

[6] The standardized CWRS variety has production characteristics calculated from a weighted average (in terms of proportion of production) of all of the CWRS varieties produced in the year in question.
[7] In the context of this thesis a representative Saskatchewan farmer is a farmer in Saskatchewan that receives average yield at an expected quality for the variety of grain.

CHAPTER 2
REVIEW OF LITERATURE

2 Literature Review

The Canadian Wheat Board's (CWB) Identity Preserved Contract Program (IPCP), is aimed to align the activities of firms within the supply chain in order to develop an identity preserved production and marketing (IPPM) system for Western Canadian wheat, durum and barley. The IPCP is relatively large, the 2008-09 crop year accounted for nearly 620 thousand acres of wheat production within the CWB jurisdiction, which was equal to 2.6% of all seeded acres for all types of wheat (Hilderman 2009).[8] Over the past 10 years, the IPCP has grown and developed to deal with the specific issues arising from the production and handling of specialty grains through the Canadian wheat supply chain. Even though the IPCP has succeeded in meeting its objective for establishing an IPPM system, market power and rent distribution issues remain.

Before examining the IPCP, it is important to explain what an IPPM system is and how it influences, and influenced by, firms in the supply chain. This chapter begins by identifying IPPM system components, including the motivation for the development of an IPPM system, and the encouragement of participation. This is followed by an examination of the agricultural supply chain and its organization; outlining the different firms in the supply chain and their interaction with an IPPM system. The problems and issues that arise from operating an IPPM system are then discussed. The chapter ends by describing the future of IPPM systems in Western Canada, as well as highlighting key aspects of the literature review.

[8] Statistics Canada (2008) reported 23.5 million acres of all wheat seeded in the Prairie Provinces.

2.1 Identity Preserved Production and Marketing (IPPM) Systems

Identity preserved production and marketing systems provide a framework for the delivery of a specialty product from areas of production to areas of consumption. In order for the product to make it to consumers, the supply chain requires organization and to undertake special precautions in order to maintain the product's purity. This organization of firms in the supply chain is not spontaneously generated but is developed by a firm in the supply chain responding to an identified disparity between the current product and consumer preference. Consequently, in order to elicit a response, the developer of the IPPM system must see some capturable benefit for the creation and delivery of the product. However, in order to capture the benefit from the IPPM system the developer requires the participation of the other firms in the supply chain, and as such must distribute some of the capturable benefit to each firm along the supply chain in order to cover the costs of the system and provide incentives for participation. This section provides an overview of the components of IPPM systems, the drivers behind IPPM systems, and the tools required to elicit the participation of firms comprising the supply chain.

2.1.1 Components of an IPPM System

Identity preserved production and marketing systems seek to accomplish three major tasks; the maintenance of product purity, supply chain alignment, and to market the product. Product purity is maintained through segregation and identity preservation (IP) practices. Supply chain alignment involves the coordination of supply chain activities, as well as providing incentives for participation. Finally, the marketing activities promote the product for the generation of a premium sufficient for the system's operation. The successful combination of all these activities allows IPPM systems to operate.

Segregation, IP and IPPM are three systems that can maintain product purity. Each system builds upon the last but differences in focus and goals cause each to stand apart. Segregation is the separation of like and unlike crops and varieties in order to maintain product purity and to prevent contamination or mixing (Smyth and Phillips 2002). Identity preservation includes segregation but also allows for the identification of source and nature of the product as it moves through the supply chain (Kalaitzandonakes *et al*. 2001). Identity preservation production and marketing involves segregation and IP with the added focus on the organization and coordination of firms in the supply chain to produce and market a specific product.

Segregation, the activity of maintaining product purity, comes in two forms; spatial and temporal. Spatial segregation involves the use of a dedicated infrastructure for the storage and delivery of a defined pure product, while temporal segregation involves infrastructure shared by both the segregated and the conventional products. Each type of segregation poses costs to the system; spatial segregation requires an investment in dedicated infrastructure, while temporal segregation requires higher labour cost to prevent contamination (Menrad *et al*. 2009). Regardless of the type of segregation used, the costs can be significant.

Identity preservation is an extension of segregation but with the purpose of maintaining the identity of a product to provide a guarantee of meeting certain standards (Harling 2001). Identity preservation primarily includes two activities in addition to segregation, the establishment of a paper trail, and sampling. These activities are conducted as the product moves through the supply chain, with each stage of the supply chain adding to the paper trail and obtaining their own sample. The paper trail gathers and maintains important information pertaining to production and possibly some quality characteristics; growing conditions, inputs, crop variety, yield, protein content, etc. (Kennet *et al*. 1998). The information provides value to the product by reducing sorting and transaction costs that are associated with specialty grains, by knowing the purity and quality of the product (Soucie 1997). Sampling serves three purposes; detecting failures within the system, enabling the assignment of liability if failure occurs, and to direct measures to prevent future failures (Opara 2003). The combination of maintaining product purity, supplying pertinent information, and sampling make up the major components of an IP system.

An IPPM system integrates segregation and IP but with the added focus coordinating supply chain activities to produce a product that meets the needs of a specific market that is willing to pay a premium. This system builds upon that of an IP system but involves marketing activities in order to make the system viable. If the premium garnered by the IPPM system is insufficient to cover the costs of the system, it becomes imperative to reduce costs through further coordination of supply chain activities. The activities of firms in the supply chain are coordinated through a series of contractual agreements and alignments. The contracts not only reduce inefficiencies, but assists in the prevention of losses due to contamination, and the resultant loss in customer loyalty and product premium. The contracts also provide a means for managing the rent distribution between participants in an IPPM system, providing incentives for participation. The successful marketing of the niche market product generates the rents for the system and its participants.

The marketing of a niche market product can come in two forms market penetration, and market development. Market penetration involves a firm increasing its market share in a pre-existing market, by competing on price or product quality. Market development involves the establishment of a market for a new product by communicating the benefits of a new product with unique characteristics to potential customers (Soucie 1997). Each marketing strategy has its own associated risks; market penetration faces the risk of competition, while market development faces market acceptance and establishment risks. The risks associated with market development are larger but also present greater possible rents (Ansoff 1957). Both marketing forms require an understanding of the market in order to obtain a premium sufficient to make the IPPM system viable.

2.1.2 Demand and Supply Influences of IPPM

The motivation for developing an IPPM system stems from agricultural commodities being highly variable and inconsistent in quality. This results in a commodity that has a wide array of intrinsic characteristics ill suited to meet the changing preferences of consumers and processors (Kalaitzandonakes *et al*. 2001; Kennet *et al*. 1998). Consumer income and increased sophistication regarding food safety, high quality food, and dietary concerns, drive consumer preferences (Phillips and Smyth 2003; Reichert and Vachal 2003; Soucie 1997; Vachal and Reichert 2000). Consumer preferences can also be subjective and difficult to quantify, creating uncertainty for market response (Soucie 1997). In addition to consumers, processors are increasing their demand for high quality and uniform grain (Brester *et al*. 1996; Dahl *et al*. 2004; Kennet *et al*. 1998; Reichert and Vachal 2003). The opportunity to develop an IPPM system occurs when commodity markets do not meet consumer and/or processor preferences and where the communication of changes in preferences is not done in a prompt and cost-effective manner (Kennet *et al*. 1998; Martinez and Stewart 2003; Reichert and Vachal 2003).

Communication up and down the supply chain allow for IPPM systems to operate; this is achieved through promoting a product down the supply chain to find a market, or communication of consumer preference up the supply chain in order to find or develop a product. As a result, downstream firms (consumers, marketers, and processors) and upstream firms (breeders, input suppliers, and farmers) both can have the incentive to develop an IPPM system (Smyth and Phillips 2001). An example of an IPPM system is illustrated in Figure 2.1 with the IPPM product travelling down the supply chain (black lines), and information travelling up and down the supply chain (grey lines). The IPPM system provides a method of communication between multiple stages of a supply chain. The number of stages in an IPPM supply chain can vary, some ranging from farmers to processors, others integrated from breeding through retail (Smyth and Phillips 2001). The development of the majority of IPPM systems are done further down the supply chain by firms able to meet or anticipate changing consumer preferences (Phillips and Smyth 2003). Recently, upstream firms have also become involved in the development of IPPM systems.

Wheat breeding institutions are interested in the development of IPPM systems to maximize the potential benefit of new varieties that meet specific market preferences (Dahl *et al*. 2004; Herring 2005). In the absence of an IPPM system, these varieties would have limited success if blended or pooled with the general commodity. This has encouraged breeding institutions to require an IPPM system in licensing agreements with seed companies in order to realize the potential of new varieties (Herring 2005; Peterson 2005). Regulators can also impose a limited release when there is symmetric risk, when a new variety poses a threat to the general commodity (Smyth and Phillips 2001).

Farmers and farm cooperatives are now becoming more involved in the development of IPPM systems for the production of high value unique grains for specific markets (Reichert and Vachal 2003). In the United States, new generation cooperatives have emerged in the creation of IPPM systems through a pooling of resources and production capacity to meet market demands. Since the ability of farmers and farm cooperatives to market these varieties may be limited to local market levels, they may require access to markets through elevators and private companies (Ransom *et al*. 2006).

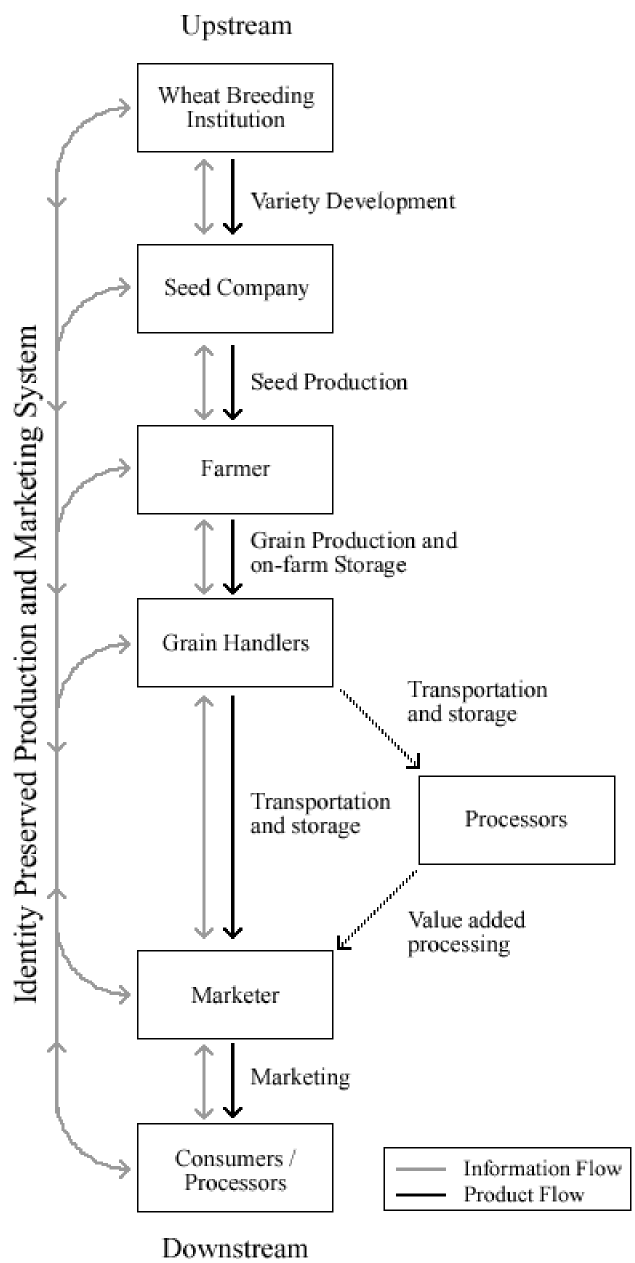


Figure 2.1: Wheat Supply Chain

Regardless of the stage in the supply chain where the IPPM system begins, the primary goal of the system is to increase rents to the developer, which in turn must share a portion of the rents with the rest of the firms in the supply chain. The distribution of rents is of concern for IPPM systems to ensure that rents are sufficient to elicit the participation of firms in the supply chain.

2.1.3 Revenue Generation and Management

As previously stated, IPPM systems present an opportunity to increase revenue of participants, as well as reduce the risks and costs associated with specialty wheat markets. The management of risk and cost, as well as the distribution of revenue is an important activity of IPPM systems (Smyth and Phillips 2001; Wilson 2001). The structure of the IPPM system's contracts and vertical alignments provides a revenue management tool for firms in the supply chain, thus creating a framework for rent distribution between participants (Smyth and Phillips 2001). This framework allows for an overseeing of the distribution of rents ensuring adequate rents to participants to cover the additional costs of involvement as well as the opportunity costs of alternatives (Kennet *et al.* 1998).

Identity preserved production and marketing systems allow for a higher degree of control by upstream and downstream participants over the product than traditional commodity markets. The increased control over the product traveling through the supply chain creates opportunities for achieving greater profits than that of traditional commodity markets (Reichert and Vachal 2003). Farmers are able to market their grain directly at set terms; consumers in turn have a higher level of control over the production, and resultant quality and consistency of the product (Kennet *et al.* 1998; Reichert and Vachal 2003). Opportunities exist within IPPM systems for both backwards and forwards integration; however, this can create new risks and uncertainties for other participants in the IPPM system (Brester *et al.* 1996). Vertical integration provides firms with a greater share of market power as well as creates multiple profit points along the supply chain. The developer of the IPPM system, the bargaining power of the IPPM system's participants, and the orientation of the firms within the supply chain, can all affect the distribution of rents within an IPPM system.

2.2 The Supply Chain for Canadian Wheat

The agricultural supply chain for wheat in Canada consists of a number of stages that require coordination in order to meet the specific needs of an IPPM system. In the context of this study, the supply chain is composed of five stages; wheat breeders, seed companies, farmers, grain handlers, and marketer. The IPPM system provides a framework for the coordination and cooperation within the supply chain. Vertical integration can allow one firm to conduct activities at multiple stages, but vertical integration through the entire supply chain is unlikely thus creating requiring the need for an IPPM system (Preater 2006; Perry 1982). This section examines these firms, outlining their activities and alignments within an IPPM system.

2.2.1 Wheat Breeders

The supply chain begins with breeders that develop new wheat varieties. Wheat breeding programs in Western Canada are typically publicly funded, or funded through a voluntary levy paid by farmers to the Western Grains Research Foundation (Rowland 2006). Varieties are protected by intellectual property rights (IPR) which are licensed by public institutions to seed companies for a span of 10 years, granting monopoly marketing rights (Hucl 2006). Varieties developed by wheat breeding intuitions can take one of two forms, production traits (higher or more stable yield), or output traits (higher quality, or other characteristics desired by consumers).

Identity preserved production and marketing systems cater to varieties that contain specific output traits that affect the end products quality characteristics. Outside of IPPM systems, output trait varieties may offer little benefit if they are not as agronomically competitive as conventional varieties, having a lower yield or reduced disease resistance, resulting in lower adoption rates (Dahl *et al.* 2004). Quality improvements that are easily measured (protein and test weight) are more easily adopted than functional characteristics (absorption, stability, gluten strength, etc.). Functional characteristics are difficult and expensive to measure and may have no explicit market-determined premium (Dahl *et al.* 2004). Additionally, co-mingling or contamination with conventional varieties can result in diminishing or eliminating the quality improvement of an output trait developed in a new variety (Smyth and Phillips 2001).

Prior to 2008, the development of output trait varieties was restricted by a set of rules called kernel visual distinguishability (KVD) that governed wheat variety licensing (AAFC 2008). The variety registration rules required varietal classes to be visually distinct, allowing for the class of grain to be quick and easy determination at the time of sale, thereby decreasing transaction costs. The relaxation of these requirements in 2008 created additional opportunities for wheat breeders to develop new output trait varieties as well as to release previously developed high yielding, disease resistance, or higher end-user quality varieties that did not previously meet KVD standards. With the relaxation of KVD requirements, it is expected that the number of varieties suitable for niche markets to increase, which in turn will increase the demand for more IPPM systems within Canada.

2.2.2 Seed Industry

The seed industry supplies, and markets, seed that is certified as being a certain variety, an integral component of IPPM systems. The seed industry is an agricultural input supplier that grows specific seed varieties demanded by farmers and their markets. The exclusive licensing of varieties from breeders grants seed companies monopoly rights over the marketing of seed varieties (Rowland 2006). The licensing and the associated IPR grants the seed company market power, allowing it to capture the benefits of the variety (Moschini and Lapan 1997). The seed industry consists of a small number of organizations that operate either as a corporation or as a seed grower group cooperative (Preater 2006). An exclusive license allows corporations to price seed as a monopoly, using seed growers under a contractual basis for seed production. In contrast, grower group cooperatives operate as an oligopoly, where member seed growers pool their resources for the licensing of varieties. Members of the grower group cooperative market the variety independently and compete with each other on price and geography (Preater 2006).

2.2.3 Farmers

Farmers are involved in IPPM systems through a series of contracts for the production and sale of IPPM wheat. Farmers produce IPPM wheat the same way they do for conventional wheat, but with the added requirements of segregation and IP. Farmers are large in number and heterogeneous across a variety of attributes that range from; education, capital, quality of land, location of land, to name a few. Individually farmers have very little market power, as they are competitive with each other on output, and are relatively small in size when compared to the seed industry.

Farmers are involved in IPPM systems through production and/or marketing contracts. The contracts between farmers and other IPPM participants establish the framework for production and handling guidelines, as well as incentives for participation and penalties for non-compliance. Agricultural contracts serve a number of purposes; risk management, increased supply chain and marketing efficiency, and stabilization of production (Perry and Banker 2000).

The framework of the IPCP involves a production contract between input suppliers and farmers, as well as a marketing contract between farmers and the CWB.

Production contracts act as a tool to manage supply and to establish a framework for the relationship between the parties. These contracts stipulate the expected management practices of the farmer, and incentives for participation (Perry and Banker 2000). Additionally, the contract specifies the level of purity required to meet the minimum standards of the IPPM system.

The contractor (seed company) and the contractee (farmer) both benefit from involvement in the production contract. The contractor benefits from the assurance of a product that meets their standards, as well as allowing for inventory management activities through the direction and timing of delivery (Perry and Banker 2000). In return for the production of a specific good, the contractor shares production and marketing risks with farmers as the contractor has contracted control over the commodity being produced (Perry and Banker 2000). However, with the sharing of risk comes some concern in terms of a shift in bargaining power from farmers to the input suppliers (Harl 2004).

In return for participating in the production contract, farmers benefit from management of risk through guaranteed acceptance of delivery usually at a set price or premium as well as other financial incentives for participation. The guarantee of acceptance is dependent on the grain meeting minimum standards stipulated by the contract. The production contracts may not explicitly state price, but in most cases, a premium is stated (United States Department of Agriculture 1996). The premium can come in the form of an input purchase credit to farmers to offset the additional costs of involvement in the contract (Kennet *et al*. 1998). A premium serves as a method of attracting sufficient participation within the program in order to guarantee an adequate and consistent supply (Phillips and Smyth 2003; Soucie 1997). Production contracts remove much of farmer's decision-making ability by stipulating specific input requirements and management practices such as crop rotation, buffer zones, cleaning practices, as well as storage and transportation procedures (Kalaitzandonakes *et al*. 2001). The location of delivery is typically a point owned by the grain company involved in the production contract (CWB 2008b). A key aspect of production contracts is that farmers do not own the grain they produce in the traditional sense, where the contractor maintains ownership for marketing purposes. This causes farmer's margins in a production contract tied to efficiency of production (Perry and Banker 2000). This makes production contracts more attractive to farmers who are efficient, educated, and capitalized (Phillips and Smyth 2003).

Marketing contracts are similar to production contracts but farmers maintain ownership of the grain and control over production and more able to handle production risk (Perry and Banker 2000). Marketing contracts are between farmers and the marketer for the sale of a specific good. The contract establishes the price, quality (grade), quantity, as well as location and time of delivery (Harwood *et al.* 1999). Marketing contracts reduce the farmer's price risk through a fixed price or pricing formula thus avoiding the risk associated with spot markets (Katchova and Miranda 2004; Perry and Banker 2000).

Farmers participating in the CWB's IPCP require a production and marketing contract. The combination of both creates a unique situation where farmers receive the benefit of a guaranteed sale and premiums from the contracts, but are subject to the production and lack of ownership (United States Department of Agriculture 1996). Farmers benefit from having a buyer for their product as well as a stipulated price and the possibility of a premium from both the production and marketing contracts. Unfortunately, farmers experience the same lack of product ownership and decision making abilities associated with a production contract. However, farmers are in a position to benefit from price and market certainty with little economic production risk (Harwood *et al*. 1999).

The contracts used in IPPM systems provide stability of supply, allowing the system to meet market preferences consistently at a quality and quantity sufficient to satisfy market needs. Additionally the contracts act as a revenue management tool to encourage participation in the system. Identity preserved production and marketing systems that are unable to provide a consistent and adequate supply, at a desired quality, run the risk of the consumer market losing confidence in the system, which can result in the programs failure (Smyth and Phillips 2001).

2.2.4 Grain-handling System

The grain-handling systems of Western Canada manage the collection and transportation of agricultural crops from areas of production to exporters, processors, and consumers. The system involves the organization of trucks, rail, and ships for delivery, as well as a network of elevators of varying sizes for storage. The operation of grain-handling system begins at harvest, where the crop is either transported to an on-farm storage facility to be sold at a later date, or directly transported to the local elevator for sale. Once grain enters the elevator it is stored awaiting transportation by rail or truck to an export terminal or a processor/consumer.

The grain-handling industry has been undergoing concentration in terms of number of firms as well as facilities. Between 1962-63 and 2009-10 the grain-handling industry reduced the number of primary elevators across the prairies from 5,223 to 314 although handling capacity fell much less, around 48 percent (Canadian Grain Commission 2009a). The bulk grain-handling system experiences efficiencies of scale, where elevator efficiency increases with size (Janzen and Wilson 2002). This encouraged the consolidation of small elevators into large super-terminals that are able to service the same area. Fewer number of elevators results in savings in terms of fuller utilization of assets as well as lower overhead. As such, the grain-handling industry favours the handling of a limited number of products at few locations. The consolidation of grain-handling industry infrastructure is not well suited to handle IPPM grains as it is primarily structured to handle bulk commodity grains (Kennet *et al*. 1998). The grain-handling industry has also undergone consolidation, vertically integrating with the agricultural supply chain by providing production inputs to farmers (Wilson and Dahl 1999). This has resulted in a concentration of the industry with a small number of firms vertically integrated into the supply chain (Canadian Seed Alliance 2004).

Alignment of the grain-handling system with an IPPM system is through contracts with other participants, leading to increased vertical coordination between buyers and sellers (Kennet *et al*. 1998). As coordination of supply chain participants increases, the efficiency of the segregation activities will also increase lowering associated costs (Kennett *et al*. 1998). The contracts stipulate the requirements of the participants as well as incentives for participation and compliance as well as disincentives for non-compliance. The vertical coordination created by the contracts ensures segregation and IP of the crop as it moves through the supply chain. Kalaitzandonakes *et al*. (2001) describes an IPPM grain-handling system as one that co-mingles discrete lots of grain that meet program requirements into a flow of grain. As the flow increases the IPPM system becomes more akin to a traditional grain-handling system.

2.2.5 Marketer

The marketer plays an important role in IPPM systems. They have direct contact with intermediate and end consumers; can negotiate prices, make arrangements of delivery, and communicate changes in consumer preference. The marketer can be an independent firm, or the instigator of the IPPM system. The marketer engages in contract negotiations with consumers for the purchase of the IPPM product at a set price (or premium over commodity markets), and possibly the quantity. Negotiation of prices between a marketer and consumer requires the marketer to have a firm understanding of the additional costs of producing and delivering an IPPM product. In addition to covering the costs, a premium must also be elicited that is sufficient to provide an incentive for participation of the supply chain in order to make the IPPM system viable (Strayer 2002). Depending on the market, the quantity of product required can be determined, thus providing goals for contracted production. The marketer plays an important role in communicating consumer preference up the supply chain. This function allows the IPPM system to better suit the needs of niche markets, as well as be able to respond to changes in consumer preference. The communication channel also allows the marketer to promote new products entering the market. IPPM systems will be successful if the marketer promotes their products and elicits a sufficient premium for firms in the supply chain.

2.3 Issues with IPPM Systems

Identity preserved production and marketing systems are vulnerable to physical and economic failures (Rosher 2004). Successful IPPM systems require three components; segregation, coordination, and incentives (Rosher 2004). A breakdown in any one of these areas can lead to a reduction in efficiency, and in some cases, complete failure. Proper segregation ensures purity of product through the supply chain and reduces the chance of contamination beyond a specified threshold level. Coordination of participant activities plays an important role not only in reducing the systems inefficiencies, but also helps to reduce the potential of physical and economic failures. Economic failures can result from failure to elicit sufficient premium from the market, or its uneven distribution between participants. Providing a sufficient premium to the components of the supply chain is a significant problem for IPPM systems (Phillips and Smyth

2003). This problem can arise from discrepancies between participating firms' priorities, market structure, and profitability (Soucie 1997). Independent firms are required to enter into close relationships within the supply chain through cooperation, collaboration, information sharing along with showing mutual respect and willingness to share profits and risks (Opara 2003; Soucie 1997).

2.3.1 Segregation Issues

The purpose of segregation within an IPPM system is the prevention of contamination that can occur at any stage in the supply chain: production, transportation, or storage. The disparity between IPPM system requirements and the current grain-handling infrastructure presents opportunities for product purity to be compromised. Identity preservation provides the tools for the detection and determination of the point of origin of contamination, as well as tools for its prevention. The sampling and paper trail of IP act as a liability minimization tool, as failures in segregation can be costly to those responsible. The cost from failures in segregation can take the form of losses in revenue, as well as fines that may result from lawsuits (Smyth and Phillips 2001). Since a number of firms along the supply chain handle an IPPM product, disputes can occur over where contamination occurred. Therefore, in some cases a third party testing facility is required to settle these disputes (Canadian Grain Commission 1998; Phillips and Smyth 2003). The ability to detect and trace segregational failures is important to a fledgling IPPM system experiencing growing pains. Not all failures within the system can be caught, as the testing of every sample may not be feasible due to costs, raising the importance of trust and the reputation of participants (Kennet *et al*. 1998).

As stated earlier, segregation during grain transportation and storage are major areas of concern as mislabelling and co-mingling can devalue the grain to that of a generalized commodity. The cost of segregation increases with the required level of purity in non-dedicated grain paths (Huygen *et al*. 2004; Kalaitzandonakes *et al*. 2001). As a result, tolerance levels for variety impurity are typically around 5% in small lot segregated systems (Smyth and Phillips 2001). Successful segregation for IP and IPPM systems builds on the supply chains experience with grain grading (see appendix A). The success of current IP and IPPM systems in the grain-handling system indicates that these systems are possible; however, there are increased costs and associated liabilities.

2.3.2 Grain-handling Industry Issues

The Canadian bulk grain-handling system was not developed nor designed for the unique demands of IPPM systems. The conventional grain-handling system was designed to handle large quantities of a small number of different grades and classes of grain (Bullock *et al.* 2002; Vachal and Reichert 2000). Consequently, the costs of segregation are higher due the inefficiencies in handling both IPPM varieties and conventional classes (Kalaitzandonakes *et al*. 2001; Smyth and Phillips 2001). Coordination within the grain-handling industry, as well as between the grain-handling industry and farmers, plays an important role to decrease these systems costs and inefficiencies. Other methods of managing segregation including the use of dedicated facilities, increased on-farm storage and containerization

Janzen and Wilson (2002) suggested that grain handlers dedicate separate grain paths for IPPM varieties as a method to decrease costs associated with segregation. A dedicated grain path can be either a facility that only handles IPPM varieties, or one that handles IPPM and conventional varieties with dedicated delivery points for IPPM and non-IPPM grain, as well as grain-handling and storage assets that only deal with IPPM varieties. Dedication of separate grain paths have a higher cost due to the requirement of increased investment in infrastructure, which results in higher operating costs and lowers the grain-handling infrastructures flexibility (Bullock *et al*. 2002). The establishment of dedicated grain paths is a long-term solution to address the unique demands of IPPM systems. Short-term solutions to address the inefficiencies of the elevator system are through the coordination between elevators for exclusive handling of specific grains. It is proposed (Bullock *et al*. 2002; Kalaitzandonakes *et al*. 2001) that using older wooden elevators could address these requirements in a more cost-effective manner.

In contrast to dedicated grain-handling paths, non-dedicated grain paths require cleaning of common grain-handling equipment, which increases labour costs and can result in extensive down time. Increased coordination between elevators and farmers reduces the cost and downtime from cleaning by using on-farm storage. On-farm storage allows for increased elevator efficiencies by being able to coordinate delivery to minimize the cleaning of shared infrastructure. Coordination of delivery also allows farmers to avoid long queues at the elevators due to the additional time required for testing and cleaning (Bullock *et al*. 2002). Identity preserved production and marketing systems can offer storage premiums to encourage farmers to invest in on-farm storage facilities (CWB 2004b).

Containerization can provide a solution to handle the specific needs of IPPM systems (Reichert and Vachal 2003). Containerization is the use of shipping containers that are mountable on tractor-trailers and rail cars that are used to store and transport the grain, minimizing the handling of the grain and the threat of contamination. This concept provides IPPM systems with a method of transporting units of grain that are too small for the traditional bulk handling system (Vachal and Reichert 2000). These containers can enter the IPPM system at the farmer level used for initial storage and for transportation to the market. Shipping containers allow for easy segregation of specialty grains and for quick and easy transportation to the customer. This increases the speed of transit, and allows for just-in-time inventory management of grain, thereby reducing inventory costs and increasing the reliability of the system (Reichert and Vachal 2003). The cost of containerization can be major obstacle for its utilization. In 1999, the cost of containerization for soybeans was 20% more than that of a grain-handling system using a unit train (Vachal and Reichert 2000). While containerization addresses the segregational requirements of an IPPM system, the increase in cost can present a barrier for its adoption.

The current Canadian grain-handling system is not capable of handling a large number of IPPM systems. It is suggested that the grain-handling infrastructure has been suggested to require a doubling if 25% of all grain was involved in an IPPM system (Smyth and Phillips 2001). The proposition of using old wooden elevators as well as containerization and increased on-farm storage present short and long-term solutions to deficiencies in the grain-handling infrastructure.

2.3.3 Production Issues

Farmers play an integral role in IPPM systems as their activities determine the quantity and quality of the product that goes through the supply chain. Problems in quantity or quality can easily destroy consumer confidence and loyalty for a branded product. Therefore, a reliable and consistent supply for end-users is essential for the success of IPPM systems (Soucie 1997). Farmer heterogeneity becomes a challenge in ensuring a reliable and consistent supply. Additionally, the demographic of farmers involved affect the quality and quantity of grain being sold through both IPPM and non-IPPM channels. Farmer participation is encouraged through the contractual arrangement in the form of guaranteed payments and premiums.

There are a number of factors influencing the ability of farmers to participate in an IPPM system. Adopters of IPPM systems tend to be well financed and educated, leaving those farmers who are less educated and poorly financed unable to take full advantage of the rents made available in IPPM systems (Phillips and Smyth 2003). Geography is also a factor in a farmer's ability to participate in IPPM systems as production contracts typically tie farmers to specific elevator companies who will cluster production around specific delivery points in order to minimize infrastructure and segregation costs. The combination of ability and geography result in an uneven distribution of available rents among the population of Western Canadian farmers.

Geographic concentration is favourable for IPPM systems by increasing the efficiency of transportation and storage activities; however, concentration can compromise system stability. A wide production base that is spatially diverse provides stability to an IPPM system. Geographic concentration limits the number of farmers that are sufficiently educated or capitalized to participate in this system. Additionally a concentrated production base increases the impact of a single adverse environmental event (frost, flood, drought, etc) on the quantity and quality of grain moving through the IPPM system. Stability is important in maintaining consumer loyalty and confidence of providing a product at a consistently sufficient quantity at an acceptable quality (Janzen and Wilson 2002).

An issue for the CWB is that the involvement of farmers in IPPM systems may result in a decrease in production of non-IPPM grain (Carriquiry and Babcock 2002). With an increase in IPPM production relative to non-IPPM production, it can expected to result in a decrease in quantity and quality of non-IPPM production as farmers able to produce high quality grain will participate in programs that offer greater return. Additionally, it can be expected that farmers capable of producing high quality grain to participate in IPPM systems more than less capable farmers, as they would face little risk in failing to meet IPPM system requirements. In addition, a narrowing of the production base and associated lower quality of non-IPPM grain may undermine the CWB pooling program (Kennet *et al*. 1998; Phillips and Smyth 2003).

2.3.4 Incentives

As stated earlier, the voluntary nature of IPPM systems requires participation at each stage of the supply chain to operate properly (Phillips and Smyth 2003). Economic costs are present at all stages of the supply chain and if one stage has a disproportionate burden of costs, the system has the potential to fail economically (Sundstrom *et al*. 2002). Participants require an opportunity to capture some of the rents generated by the IPPM system. The system must account for direct and opportunity costs of participants, and must be able to address market power to prevent a single participant from extracting all of the rents. Lack of participation at any stage of the supply chain can result in failure to meet consumer preferences, or a non-functioning system.

Foregone opportunity costs due to infrastructure inefficiencies in the grain-handling industry create disincentives for participation in the IPPM system (Kalaitzandonakes *et al*. 2001). For example, elevators participating in IPPM systems may be unable to take advantage of profit maximizing activities of pooling and blending (Maltsbarger and Kalaitzandonakes 2000). Additionally, since an IPPM system requires product identity and purity, often for small lots, elevator efficiencies decrease with the handling of more products, which causes an underutilization of storage and transportation assets (Maltsbarger and Kalaitzandonakes 2000). This result in the forgoing of storage margins and carrying spreads. The incentives to the grain-handling industry have to be large enough to offset the additional costs and lost revenue-generating activities (Bullock *et al*. 2002). The presence of economic incentives for segregation within the elevator system may be insufficient to cause a rapid overhaul to the system, but vertical integration as well as increased revenues from guaranteed delivery allow for continued participation (Bullock *et al*. 2002).

Grain-handling companies are undergoing vertical integration into the agricultural supply chain (most notably the agricultural input markets). Vertical integration allows the firm to have multiple profit points along the supply chain, and greater control over the IPPM system. The combination of vertical integration and control over critical inputs increases the grain-handling company's market power, this coupled with control over the IPPM policies allow for opportunistic behaviour and the exertion of market power (Boland *et al*. 2000; Wells 2006). Seed companies influence IPPM systems through agreements and alignments with the IPPM proponents that regulate price and the quantity of the IPPM product required to meet market demand (Phillips and Smyth 2003). A seed company that has exclusive rights to the input, such as the IPRs of seed varieties, may extract the majority of the rents from farmers contracted in the IPPM system (Phillips and Smyth 2003). Opportunistic behaviour and exertion of market power is present if the difference in cost of certified seed between an IPPM and conventional varieties is greater than the premium offered by the IPPM system (Boland *et al*. 2000; Wells 2006). This opportunistic behaviour minimizes the benefit to farmers participating in IPPM systems, further limiting the production base as available rents to farmers decrease.

The estimated costs of IPPM systems have a wide range within the literature due to the many variables involved. Examples of these are; opportunity costs, inefficiencies in the grain-handling system, and segregation costs. Phillips and Smyth (2003) estimated the total cost of IPPM systems are $30 to 40/tonne due to the need for extra labour and the sub-optimal use of infrastructure. Huygen *et al*. (2004) estimated the direct cost of segregation, at the 95% purity level, to be $1.26/tonne for a non-dedicated grain-handling system, and $1.16/tonne for a dedicated grain-handling system.[9] The cost of segregation at the farm level was found to be \$1.04/tonne. While segregation costs at the primary elevator level was \$0.11/tonne and 0.03/tonne for a non-dedicated and dedicated system, respectively. Segregation at an export elevator was estimated to be \$0.11/tonne and \$0.09/tonne for a non-dedicated and dedicated system, respectively. The CWB offered a \$1.80/tonne special handling fee to the grain and handling system to address the additional associated costs (Phillips and Smyth 2003).

With the cost of IPPM systems estimated to be 15 to 20% more than conventional product supply chains (Smyth and Phillips 2001), the price premium generated by an IPPM product may be insufficient to cover its additional costs (Sundstrom *et al*. 2002). Improvements in efficiencies are required to bridge the gap between the costs of IPPM systems and the premium for the IPPM product. Efficiencies of IPPM systems improve with coordination and participants focusing on the needs of the next step in the supply chain (Phillips and Smyth 2003).

2.4 Future of IPPM

The future of IPPM systems is dependent upon a number of factors influencing the ability of participants to extract rents from the IPPM system, as well as their perception of other advantages from IPPM systems. Advancements in technology and changing consumer preferences are strong drivers behind the increase in demand for high quality wheat, which encourages future development of IPPM systems (Kennet *et al*. 1998). However, the long-term viability and large-scale feasibility of IPPM programs is unknown as these programs have historically been small in size and short in duration (Phillips and Smyth 2003). Smyth and

[9] The disagreement between Phillips and Smyth (2003) and Huygen *et al.* (2004) is that Huygen *et al.* only examined the direct cost for the act of segregation and not all of the indirect and opportunity costs associated with segregation systems.

Phillips (2001) believe that if trends in consumer preferences continue to influence the supply chain, IPPM systems will become commonplace.

Consumer preference is a strong driver behind the demand for contracted production, resulting in an increase in market share of contracted production across commodity markets (Martinez and Stewart 2003). American exports of wheat have seen a significant shift towards the exporting of premium cultivars since the mid 1990s, which is expected to continue (Reichert and Vachal 2003). In 1999, Bender *et al*. determined that American foreign and domestic markets were encouraging the move towards premium cultivars, and 47% of these premium cultivars were destined for export markets. As the proportion of IPPM systems increases, it is expected that the grain-handling industry will require significant development in its infrastructure to handle the large volume of IPPM grain (Smyth and Phillips 2001).

2.5 Summary

Development of IPPM systems is a complex undertaking requiring the participation of the agriculture supply chain through contracted vertical cooperation. Identity preserved production and marketing systems have been operating successfully in Canada for a number of years but are still being refined and further developed. These systems can still benefit from participant education and development of infrastructure that is suited to meet the needs of IPPM systems. As these factors improve, the risks and associated costs will lessen (Kalaitzandonakes *et al*. 2001). Distribution of rents is very important for securing sufficient supply and delivery of the product from '*field-to-fork*'. Market power, and its exertion, plays an important role in the distribution of rents, possibly reducing the overall benefit of the system and discouraging participation. The next chapter examines a theoretical framework for the distribution of rents under a variety of policies and market conditions to illustrate the effect of market power on IPPM systems, focusing on farmer welfare.

CHAPTER 3
THEORETICAL MODEL

3 Theoretical Model

Identity preserved production and marketing (IPPM) systems are designed for the development of niche markets and ultimately to extract a premium. The niche markets are established or expanded through market development activities that focus on meeting the needs of consumers and aligning production with consumption. The market development activities increase the value of the product to the market, which can in turn increases the premium offered by the market. The distribution of the market premium between IPPM participants is of interest as the existence of market power within the IPPM system influences rent distribution. The distribution of rents influences the decisions of the IPPM system developer for the creation or further development of the niche market.

The theoretical model provides a simulation of the impact of the IPPM policies on rent distribution between participants. Two policies are examined; production constraint, and additional market development. The production constraint provides a representation of a niche market, where the amount of product available to the market is restricted in order to maintain a price premium. In the market development policy, the marketer invests resources into the niche market to further increase the markets willingness to pay for the product. The policies' impacts are examined though a simple vertical model, consisting of two levels. The first level being the market for identity preserved (IP) seed consisting of seed companies acting as the suppliers of IP seed, and farmers acting as the buyer of IP seed. The second level, the market for IP grain, consists of farmers acting as the suppliers of IP grain, and consumers acting as the buyers of IP grain.[10] The vertical model is a mathematical model which uses graphical representation to illustrate rent distribution and to convey the impact of the policies on rent distribution. The model demonstrates the impact of an IPPM system on participant welfare from the implementation of a production constraint and/or market development activities.

The two policies, constrained production and market development, are examined independently and then jointly in the model, creating four scenarios (see Figure 3.1). The first scenario presents the base case where the marketer imposes neither of the policies and acts as a broker organizing the IPPM system and facilitating the transactions between the markets. The second scenario involves the marketer constraining the quantity of IP grain produced by farmers and marketed to the consumers. In the third scenario, the marketer engages in market development activities to elicit a price premium, but does not constrain production. The fourth scenario is the joint implementation of the policies, where the marketer constrains the quantity of IP grain produced and engages in market development activities.

Within each of the four policy scenarios, the seed industry with three different seed ownership structures, demonstrating varying degrees of market power. The three different seed ownership structures are; monopolistic, perfectly competitive, and oligopolistic. The perfectly competitive seed ownership structure is a special case to assist in explaining the influence of the policies on farmer welfare where there is an absence of IPR or is not owned by the seed industry. The monopolistic case is where a single firm owns the IPPM variety, (as is the case with Navigator durum) and oligopolistic case is where ownership in shared among a small number of firms, (e.g. Kyle durum).

[10] The grain-handling industry (elevators and railways) are omitted as they are assumed to be compensated by the IPPM system. Seed companies are also often own elevation and transportation companies, which are rewarded through the delivery requirement of the production contracts. Rail companies are compensated through higher transportation rates for movement of single cars. Therefore, only three participants are included in the model.

The three ownership structures combine with the four policy scenarios to create twelve situations to model. Figure 3.1 depicts the twelve situations created by the four policy scenarios and three ownership structures of the theoretical model.

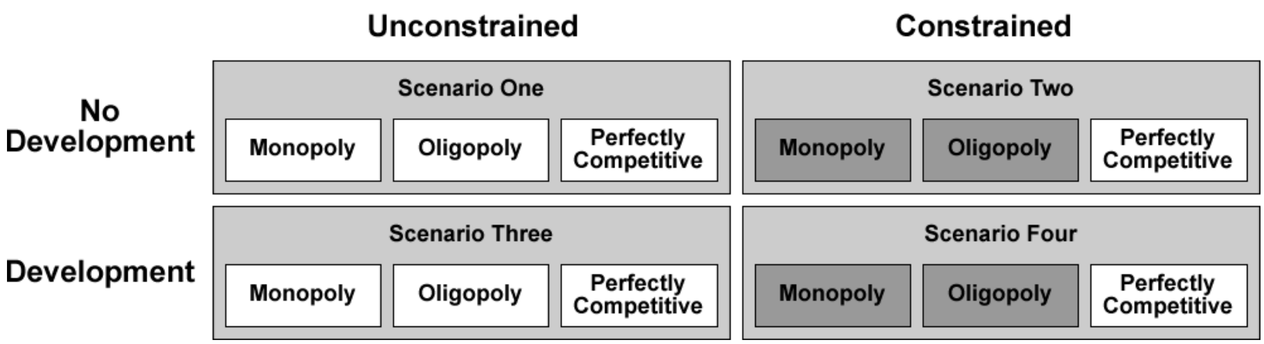


Figure 3.1: Policy Scenarios and Ownership Structures Analyzed in the Theoretical Model

Each situation is modeled as a two stage game involving the decisions and actions made first by the seed industry and then by the farmer. The first stage involves the seed industry (supply of IP seed) setting the price and quantity of IP seed.[11] The second stage involves farmers (demand for IP seed, and supply of IP grain) deciding if they will participate in the IP program, farmers will become involved in the program till the farmer price of IP grain is equal to marginal cost. With consumer and farmers decisions taken as given, the exertion of market power by the marketer and seed industry will determine rent distribution through the determination of the quantity and price of IP seed.

Participants are organized in the vertical alignment using the following assumptions. Seed companies are the marketers of IP seed, and assumed to be rational and profit maximizing. Seed companies produce IP seed at a constant marginal cost equal to average cost. Farmers are numerous and price takers that competitively produce IP grain at marginal cost, which is upward sloping in aggregate production. Consumers of IP grain are price takers, and in aggregate have

[11] In the case of constrained production the seed industry is assumed to set quantity equal to the constraint.

downward sloping demand curve. The IPPM marketer (i.e. the CWB) function as a facilitator for the vertical market representing consumers of IP grain, and is the instigator of the proposed policy scenarios. The marketer only charges the cost of marketing; as such, the consumer price of grain is the marketer's price offered to farmers. The quantity of IP grain and quantity of IP seed have a direct relationship, where one unit of IP seed produces one unit of IP grain.

Model assumptions:

- Demand for IP grain and supply for IP grain are known and transparent
- Market power is only possessed by the marketer and seed companies
- Consumers and farmers are numerous and are price takers
- Farmers are rational and will produce grain till price is equal to marginal cost
- Seed companies are rational profit maximizing firms
- Marginal cost of IP seed is constant and equal to the average cost of seed
- One unit of IP seed produces one unit of IP grain

3.1 Scenario 1: Base Case

The base case provides a measurement tool for examining the impact of the proposed marketer's policies on the welfare of consumer, farmers and the seed industry. As stated in the introduction, a vertical model represents the markets, as illustrated in Figure 3.2. Figure 3.2a represents the market for IP grain, and Figure 3.2b represents the market for IP seed.

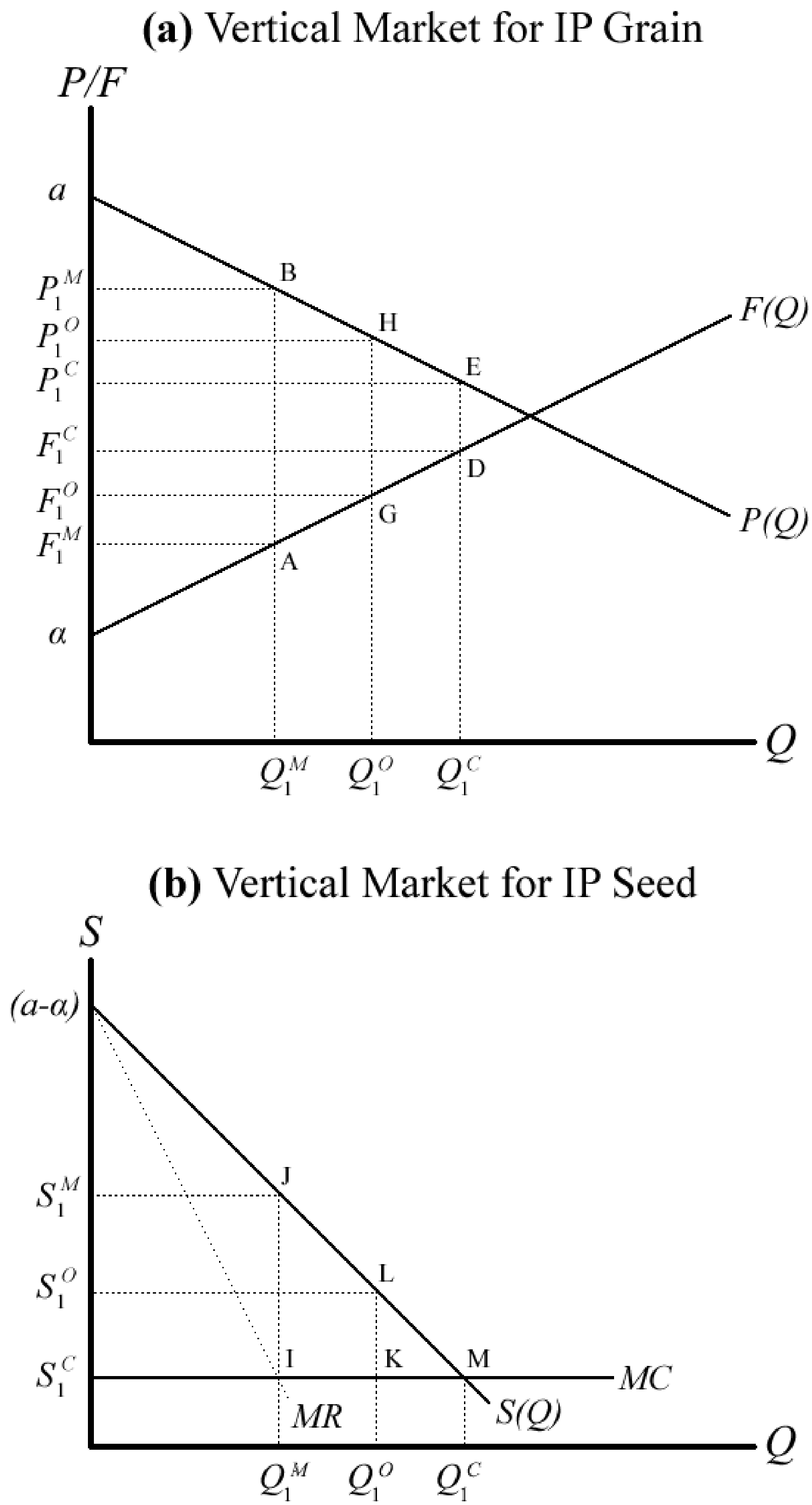


Figure 3.2: Scenario 1 – Base Case

The market for IP grain is composed of consumer demand for IP grain and farmer supply of IP grain. The inverse consumer demand for IP grain, equation (3.1), is assumed to be transparent with a known downward sloping demand curve.

$$P_j^i = a - bQ_j^i \tag{3.1}$$

Where P_j^i = consumer price of IP grain in scenario *j* with *i* seed ownership structure

a = undifferentiable price of IP grain

b = differentiable price of IP grain

Q_j^i = quantity of IP grain in scenario *j* with *i* seed ownership structure

The inverse farmer supply of IP grain, equation (3.2), is assumed to be transparent with a known upward sloping supply curve.

$$F_j^i = \alpha + \beta Q_j^i \tag{3.2}$$

Where F_j^i = farmer price of IP grain in scenario *j* with *i* seed ownership structure

α = undifferentiable cost of producing IP grain

β = differentiable cost of producing IP grain

The upward sloping marginal cost curve of the supply for IP grain represents the heterogeneity of producers, and the increasing cost of producing IP grain on land that is less suitable for IP grain production. It is assumed that the costs of producing IP grain is equal to the costs of producing conventional grain, plus the cost associated with involvement in an IP program (segregation, contracting, etc.) as illustrated in equation (3.3).

$$\alpha = \alpha^{Conv} + \alpha^{IP} \tag{3.3}$$

Where α^{Conv} = undifferentiable cost of producing conventional grain

α^{IP} = undifferentiable cost associated with involvement in an IP program

The market for IP seed is composed of farmer demand for IP seed and seed company supply of IP seed. The inverse demand for IP seed can be obtained from the vertical market orientation from the inverse consumer demand for IP grain, equation (3.1), and the inverse farmer supply of IP grain, equation (3.2), which is represented by equation (3.4) and can be rewritten as equation (3.5).

$$S_j^i = P_j^i - F_j^i = (a-\alpha) - (b+\beta)Q_j^i \tag{3.4}$$

$$Q_j^i = \frac{(a-\alpha) - S_j^i}{(b+\beta)} \tag{3.5}$$

Where S_j^i = price of IP seed in scenario *j* with *i* seed ownership structure

With the marginal revenue for IP seed equal to equation (3.6).

$$MR_j = (a-\alpha) - 2(b+\beta)Q_j^i \tag{3.6}$$

Where MR_j = marginal revenue for the demand for IP seed in scenario *j*

Seed companies marginal cost of IP seed, equation (3.7), is constant and equal to average cost of IP seed.

$$MC = AC = k \tag{3.7}$$

Where MC = marginal cost of IP seed

AC = average cost of IP seed

Distribution of rents is calculated through Marshallian surpluses and seed company rents. Marshallian surpluses take advantage of the linear supply and demand curves producing a consumer surplus of IP grain equal to equation (3.8), and producer surplus of IP grain equal to equation (3.9).[12]

[12] Deadweight loss is not measured in this analysis as part of the dead weight loss is from (foreign) consumers that are not normally considered as part of a domestic policy decision.

$$CS^i_j = \frac{1}{2}\left(Q^i_j\right)\left(a - P^i_j\right) = \frac{b}{2}\left(Q^i_j\right)^2 \tag{3.8}$$

Where CS^i_j = consumer surplus of IP grain in scenario *j* with *i* seed ownership structure

$$PS^i_j = \frac{1}{2}\left(Q^i_j\right)\left(F^i_j - \alpha\right) = \frac{\beta}{2}\left(Q^i_j\right)^2 \tag{3.9}$$

Where PS^i_j = producer surplus of IP grain in scenario *j* with *i* seed ownership structure

The presence of market power in the seed industry creates the opportunity for the seed company to capture rents from the system as illustrated in equation (3.10).

$$\pi^i_j = Q^i_j\left(S^i_j - k\right) \tag{3.10}$$

Where π^i_j = seed company rents in scenario *j* with *i* seed ownership structure

3.1.1 Scenario 1: Monopolistic Seed Ownership Structure

The first case has the seed industry presented with a monopolistic seed ownership structure maximizing profits by setting the price of the IP seed, equation (3.11), where marginal revenue of IP seed, equation (3.6), is equal to the marginal cost of IP seed, equation (3.7).

$$S^M_1 = \frac{\left(a - \alpha + k\right)}{2} \tag{3.11}$$

Quantity of IP seed, equation (3.12), is obtained by substituting equation (3.11) into equation (3.5).

$$Q^M_1 = \frac{1}{2}\left(\frac{a - \alpha - k}{b + \beta}\right) \tag{3.12}$$

Seed company rents, equation (3.13), is obtained by substituting equation (3.11) and (3.12) into equation (3.10). The seed company rents are illustrated in Figure 3.2b by area [S^M_1, S^C_1, I, J].

$$\pi_1^M = \frac{(a-\alpha-k)^2}{4(b+\beta)} \tag{3.13}$$

Consumer price of IP grain, equation (3.14), and farmer price of IP grain, equation (3.15), are obtained by substituting equation (3.12) into equation (3.1) and (3.2), respectively.

$$P_1^M = a - \frac{b}{2}\left(\frac{a-\alpha-k}{b+\beta}\right) \tag{3.14}$$

$$F_1^M = \alpha + \frac{\beta}{2}\left(\frac{a-\alpha-k}{b+\beta}\right) \tag{3.15}$$

Consumer surplus of IP grain, equation (3.16), and producer surplus of IP grain, equation (3.17), are obtained by substituting equation (3.12) into equation (3.8) and (3.9), respectively. The Marshallian surpluses in the market for IP grain is illustrated in Figure 3.2a where consumer surplus of IP grain is illustrated by area [a, P_1^M, B], and producer surplus of IP grain is illustrated by area [F_1^M, α, A].

$$CS_1^M = \frac{b}{8}\left(\frac{a-\alpha-k}{b+\beta}\right)^2 \tag{3.16}$$

$$PS_1^M = \frac{\beta}{8}\left(\frac{a-\alpha-k}{b+\beta}\right)^2 \tag{3.17}$$

3.1.2 Scenario 1: Perfectly Competitive Seed Ownership Structure

The second case of scenario one has the seed industry presented with a perfectly competitive seed ownership structure setting the price of IP seed equal to the marginal cost of IP seed, equation (3.7), resulting in seed company rents being equal to zero. The competitive quantity of IP seed, equation (3.18), is obtained by substituting equation (3.7) into equation (3.5).

$$Q_1^C = \frac{a-\alpha-k}{b+\beta} \tag{3.18}$$

The consumer price of IP grain, equation (3.19), and farmer price of IP grain, equation (3.20), are obtained by substituting equation (3.18) into equation (3.1) and (3.2), respectively.

$$P_1^C = a - b\left(\frac{a-\alpha-k}{b+\beta}\right) \tag{3.19}$$

$$F_1^C = \alpha + \beta\left(\frac{a-\alpha-k}{b+\beta}\right) \tag{3.20}$$

Consumer surplus of IP grain, equation (3.21), and producer surplus of IP grain, equation (3.22), are obtained by substituting equation (3.18) into equation (3.8) and (3.9), respectively. The distribution of Marshallian surpluses to the market for IP grain is illustrated in Figure 3.2a where consumer surplus of IP grain is illustrated by area [a, P_1^C, E], and producer surplus of IP grain is illustrated by area [F_1^C, α, D].

$$CS_1^C = \frac{b}{2}\left(\frac{a-\alpha-k}{b+\beta}\right)^2 \tag{3.21}$$

$$PS_1^C = \frac{\beta}{2}\left(\frac{a-\alpha-k}{b+\beta}\right)^2 \tag{3.22}$$

3.1.3 Scenario 1: Oligopolistic Seed Ownership Structure

The third case presents an oligopolistic seed ownership structure. The price and quantity of IP seed depends on the degree of market power exerted by the seed industry. To illustrate the potential range of prices and quantities conjectural variation is used (Perry 1982). Conjectural variation states that the price of IP seed will exist between the perfectly competitive price of IP seed and the monopolistic price of IP seed. Market power (δ) is presented to have a range of [0,1], zero representing a perfectly competitive market, and one representing a monopolistic market. Conjectural variation of the price of IP seed is represented by equation (3.23).

$$S_j^O = \delta S_j^M + (1-\delta)S_j^C \tag{3.23}$$

Where δ = market power of seed industry [0,1]

The price of IP seed, equation (3.24), is obtained by substituting equation (3.11) and (3.7) into equation (3.23).

$$S_1^O = \delta\left(\frac{a-\alpha-k}{2}\right)+k \tag{3.24}$$

The quantity of IP seed, equation (3.25), is obtained by substituting equation (3.24) into equation (3.5).

$$Q_1^O = \left(\frac{a-\alpha-k}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) \tag{3.25}$$

The consumer price of IP grain, equation (3.26), and farmer price of IP grain, equation (3.27), are obtained by substituting equation (3.25) into equation (3.1) and (3.2), respectively.

$$P_1^O = a - b\left(\frac{a-\alpha-k}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) \tag{3.26}$$

$$F_1^O = \alpha + \beta\left(\frac{a-\alpha-k}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) \tag{3.27}$$

Consumer surplus of IP grain, equation (3.28), and producer surplus of IP grain, equation (3.29), are obtained by substituting equation (3.25) into equation (3.8) and (3.9), respectively. Consumer surplus is illustrated in Figure 3.2a by area [a, P_1^O, H]. Producer surplus of IP grain is illustrated in Figure 3.2a by area [F_1^O, α, G].

$$CS_1^O = \frac{b}{2}\left[\left(\frac{a-\alpha-k}{b+\beta}\right)\left(1-\frac{\delta}{2}\right)\right]^2 \tag{3.28}$$

$$PS_1^O = \frac{\beta}{2}\left[\left(\frac{a-\alpha-k}{b+\beta}\right)\left(1-\frac{\delta}{2}\right)\right]^2 \tag{3.29}$$

The seed company rents, equation (3.30), is obtained by substituting equation (3.24) and (3.25) into equation (3.10). The seed companies rents are illustrated in Figure 3.2b by area [S_1^O, S_1^C, K, L].

$$\pi_1^O = \delta\left(\frac{(a-\alpha-k)^2}{2(b+\beta)}\right)\left(1-\frac{\delta}{2}\right) \tag{3.30}$$

3.2 Scenario 2: Production Constraints

The second scenario introduces a production constraint, where the marketer sets the quantity of IP grain to be sold to consumers. The impact of the production constraint is illustrated in Figure 3.3. The market for IP grain is illustrated in Figure 3.3a, with the market for IP seed illustrated in Figure 3.3b. Figure 3.3 features scenario one and scenario two, each represented by the grey and black lines and text, respectively. The introduction of the policy results in the demand for IP grain becoming kinked at the constrained quantity Q^{IP}, changing the demand curve from $P_1(Q)$ to $P_2(Q)$. The change in the demand curve for IP grain resulting in a kinked demand for IP seed changing the demand curve from $S_1(Q)$ to $S_2(Q)$.

It is assumed that the seed industry produces a quantity of seed sufficient to meet the constrained production set by the marketer, regardless of the market structure of the seed industry ($Q^{IP} = Q_2^M = Q_2^O = Q_2^C$). It is assumed that the constrained quantity of seed lies between that of the monopoly quantity and the perfectly competitive quantity of scenario one ($Q_1^M \leq Q^{IP} \leq Q_1^C$). From the assumption previously stated about consumers being price takers, the constrained consumer price of IP grain will be set equal to equation (3.31) for all cases.

$$P_2^{IP} = a - bQ^{IP} \tag{3.31}$$

Where P_2^{IP} = constrained consumer price of IP grain

Q^{IP} = constrained quantity of IP grain

The consumer surplus of IP grain will remain stationary for all cases as a result of the consumer price of IP grain remaining stationary at P_2^{IP}. The consumer surplus of IP grain, equation (3.32), is obtained by substituting Q^{IP} into equation (3.8). The consumer surplus of IP grain is illustrated in Figure 3.3a by area [*a*, P_2^{IP}, B].

$$CS_2^{IP} = \frac{b}{2}\left(Q^{IP}\right)^2 \tag{3.32}$$

As a result of consumer price of IP grain remaining stationary at P_2^{IP} and quantity set to Q^{IP}, the farmer price of IP grain cannot be obtained using equation (3.2). To calculate the farmer price of IP grain a rearrangement of equation (3.4) is required as illustrated in equation (3.33).

$$F_j^i = P_j^i - S_j^i \tag{3.33}$$

The constraint on quantity allows for farmers to extract rents from the system, thus requiring a different equation for producer surplus of IP grain as illustrated in equation (3.34).

$$PS_j^i = \frac{\beta}{2}\left(Q^{IP}\right)^2 + \left[F_j^i - \left(\alpha + \beta Q^{IP}\right)\right]\left(Q^{IP}\right) \tag{3.34}$$

The basis of comparison between the scenarios is the difference in producer surplus of IP grain between scenarios as illustrated in equation (3.35).

$$\Delta PS_{j,l}^i = PS_l^i - PS_j^i \tag{3.35}$$

Where $\Delta PS_{j,l}^i$ = change in producer surplus under an *i* seed ownership structure from scenario *j* to scenario *l*

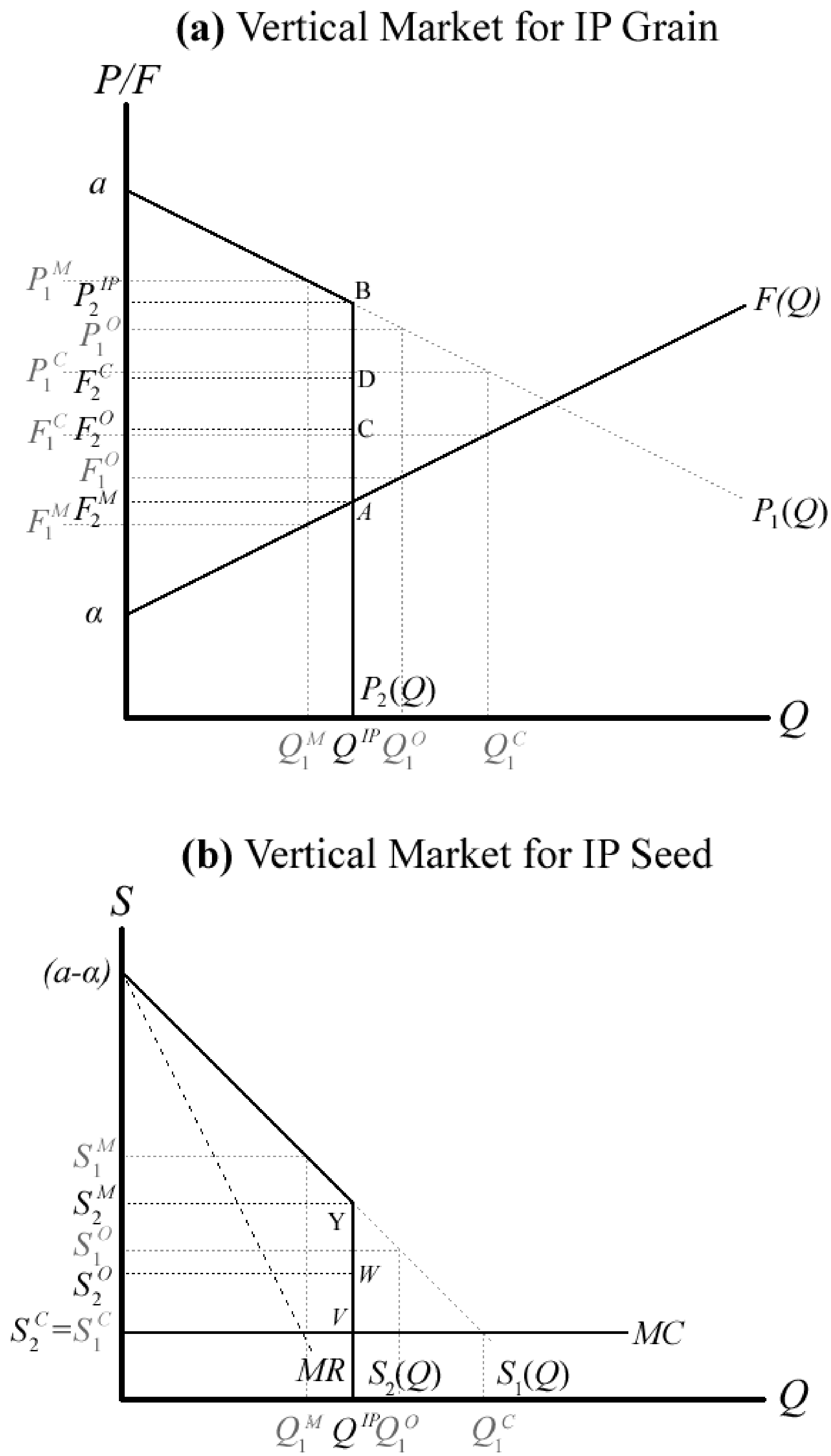


Figure 3.3: Scenario 2 – Production Constraint

In order to compare the producer surplus of IP grain between scenarios the constrained quantity requires modification to show the relationship of the quantities of IP grain between scenarios. Equation (3.36) shows the representation between the constrained and unconstrained quantities. Where $\Delta Q^{i}_{j,l}$ is the absolute change in quantity from scenario *j* to scenario *l*, under ownership structure *i*. Based upon the previously stated assumption that $Q_1^M \leq Q^{IP} \leq Q_1^O \leq Q_1^C$ [13] the sign of the equation will be positive for a monopolistic seed ownership structure, and negative for oligopolistic or perfectly competitive seed ownership structures.

$$Q^{IP} = Q^{i}_{j} \pm \Delta Q^{i}_{j,l} \tag{3.36}$$

Where $\Delta Q^{i}_{j,l}$ = change in quantity from scenario *j* to *l* with *i* seed ownership structure

Figure 3.4 illustrates the relationship between rent distribution and Marshallian surpluses within the vertical market. The figure shows the oligopolistic case of scenario two outlining the producer surplus of IP grain, consumer surplus of IP grain, and seed company rents. The producer surplus of IP grain is represented in Figure 3.4a by the trapezoid [F_2^O, α, A, C], labelled areas M and N. Consumer surplus of IP grain is represented in Figure 3.4a by the triangle [*a*, P_2^{IP}, B], labelled as area CS_2^O. The cost of IP seed to farmers is also included in Figure 3.4a, represented by area [P_2^{IP}, F_2^O, C, B], which is composed of the seed companies cost of producing IP seed (*k*), and seed company rents represented by the area π_2^O. These areas are echoed in the market for IP seed, Figure 3.4b, where the area [(*a*-α), S_2^M, Y] represents the sum of consumer surplus of IP grain as well as a portion of producer surplus of IP grain represented by the area N. Rents extracted by seed industry and farmers is illustrated by the area [S_2^M, *k*, V,

[13] It is assumed that the oligopoly quantity of IP seed discovered in scenario one is greater than the constrained quantity of IP seed. This is further explained in section 3.2.3

Y], composed of seed companies rents, area π_2^O, and a portion of the producer surplus of IP grain represented by area M.

The impact of the constrained production policy is examined in three cases representing different seed ownership structures; monopolistic, perfect competition, and oligopolistic. The analysis begins by calculating the price of IP seed and farmer price of IP grain, as well as seed company rents and Marshallian surpluses for farmers and consumers. Followed by a comparison between scenario two and scenario one for welfare distribution of each case.

Scenario Assumptions:

- Seed industry will produce the quantity of seed required for the constrained production, regardless of seed ownership structure such that $Q^{IP} = Q_2^M = Q_2^O = Q_2^C$.
- Constrained quantity lies between the unconstrained monopoly and unconstrained perfectly competitive quantities ($Q_1^M \leq Q^{IP} \leq Q_1^C$).
- Consumer price of IP grain remains stationary at P_2^{IP}, and consumer surplus of IP grain remains stationary at CS_2^{IP}.

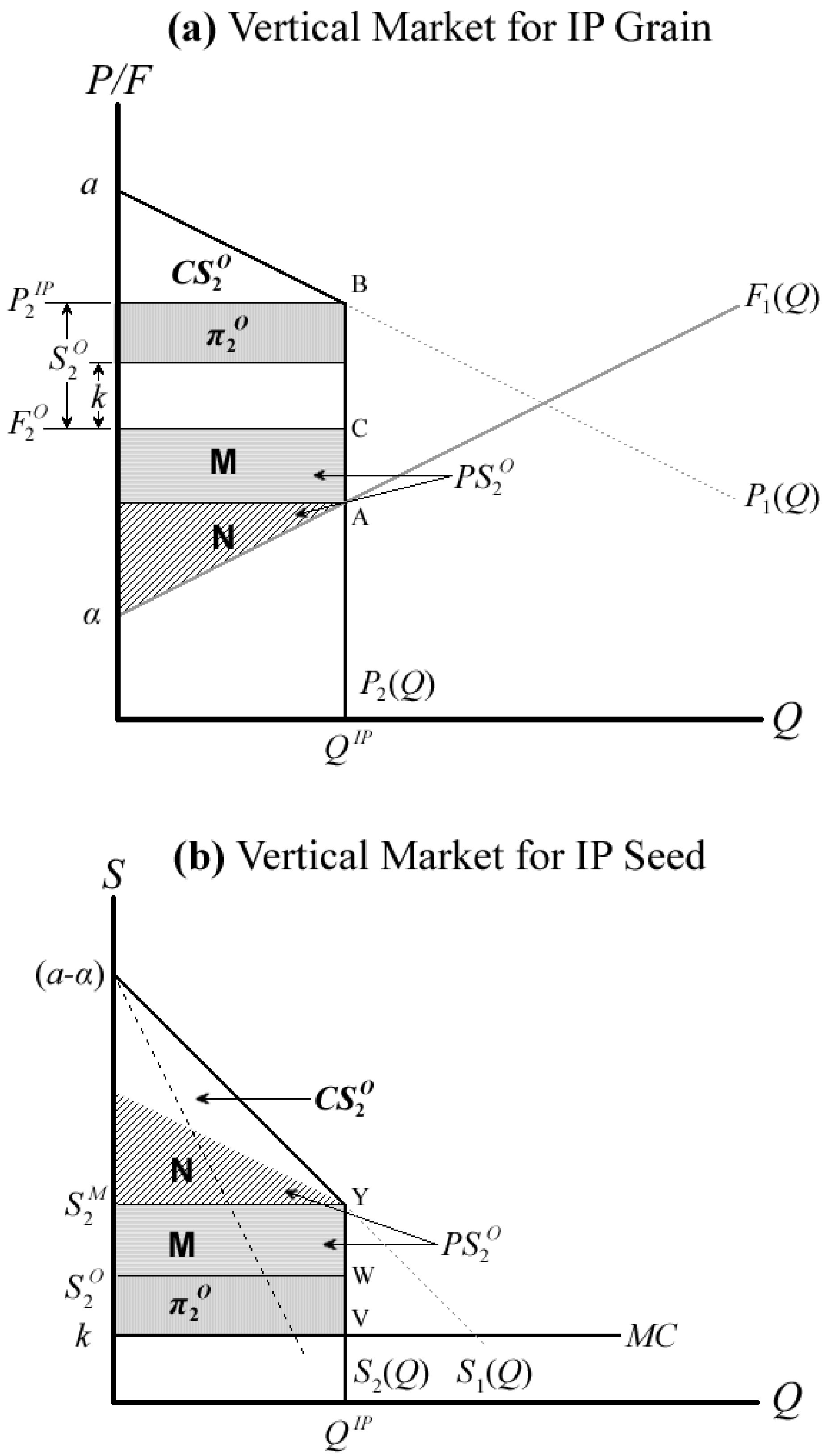


Figure 3.4: Illustration of Distribution of Marshallian Surpluses

3.2.1 *Scenario 2: Monopolist Seed Ownership Structure*

The introduction of a production constraint when there is a monopolistic seed ownership structure requires the seed company to cooperate with the marketer's policy and provide a quantity sufficient to meet supply, as per the assumptions stated in section 3.2. A monopolistic firm operating under the production constraint would charge the highest possible price in order to maximize returns, as per the assumptions about the seed industry being a profit maximizing firm. As a result, the monopolistic firm would arrive at the corner solution for the price of IP seed equal to equation (3.37).

$$S_2^M = (a-\alpha)-(b+\beta)Q^{IP} \tag{3.37}$$

With quantity set to Q^{IP}, seed company rents will be equal to equation (3.38), which is obtained by substituting equation (3.37) and Q^{IP} into equation (3.10). Seed company rents decrease from the constrained supply, as the right hand portion of the equation is negative. Seed company rents are illustrated in Figure 3.3b by the area [S_2^M, S_2^C, V, Y].

$$\pi_2^M = Q^{IP}\left[(a-\alpha-k)-(b+\beta)Q_2^{IP}\right] = \pi_1^M - \Delta Q_{1,2}^M\left[(b+\beta)Q^{IP} - \frac{(a-\alpha-k)}{2}\right] \tag{3.38}$$

The farmer price of IP grain, equation (3.39), is obtained by substituting equation (3.37) into equation (3.33).

$$F_2^M = \alpha + \beta Q^{IP} \tag{3.39}$$

Producer surplus of IP grain, equation (3.40), is obtained by substituting equation (3.39) into equation (3.34).

$$PS_2^M = \frac{\beta}{2}\left(Q^{IP}\right)^2 \tag{3.40}$$

The change in producer surplus of IP grain, equation (3.41), can be obtained by substituting equation (3.17), (3.40) and (3.36) into equation (3.35). This is illustrated in Figure 3.3a by area [F_2^M , α , A].

$$\Delta PS_{1,2}^M = \frac{\beta}{2}\left(\Delta Q_{1,2}^M\right)\left(\Delta Q_{1,2}^M + 2Q_1^M\right) \tag{3.41}$$

Therefore, if $Q^{IP} > Q_1^M$ the production constraint policy increases producer surplus of IP grain.

The impact of a production constraint results in a net increase in welfare for farmers and consumers at the expense of seed company profits. Producer surplus of IP grain increases from the implementation of a production constraint and the associated increase in quantity of seed. From equation (3.41) farmers are determined to be better off from the implementation of a production constraint when faced with a monopolistic seed ownership structure.

3.2.2 Scenario 2: Perfectly Competitive Seed Ownership Structure

A production constraint in a perfectly competitive seed ownership structure maintains the same price of IP seed as the base case, equal to equation (3.7). The consumer price of IP grain is again taken as P_2^{IP} . The farmer price of IP grain, equation (3.42), is obtained by substituting equation (3.7) and (3.31) into equation (3.33).

$$F_2^C = (a-k) - bQ^{IP} \tag{3.42}$$

Producer surplus of IP grain, equation (3.43), is obtained by substituting equation (3.42) into equation (3.34). The producer surplus of IP grain from the implementation of a production constraint is illustrated in Figure 3.3a by area [F_2^C , α , A, B].

$$PS_2^C = \frac{\beta}{2}\left(Q^{IP}\right)^2 + \left[(a-\alpha-k)-(b+\beta)Q^{IP}\right]Q^{IP} \tag{3.43}$$

The introduction of a production constraint in a perfectly competitive seed ownership structure can result in a positive or negative impact on farmer welfare based on the difference between the constrained and unconstrained quantity. The change in producer surplus of IP grain, equation (3.44), is obtained by substituting equation (3.22), (3.36) and (3.43) into equation (3.35).

$$\Delta PS_{1,2}^C = \Delta Q_{1,2}^C\left[bQ_1^C - \left(b+\frac{\beta}{2}\right)\Delta Q_{1,2}^C\right] = \Delta Q_{1,2}^C\left[bQ^{IP} - \frac{\beta}{2}\Delta Q_{1,2}^C\right] \tag{3.44}$$

The change in producer surplus of IP grain is dependent on the degree of reduction in quantity. A reduction in quantity greater than the critical change in quantity results in a decrease in producer surplus of IP grain. The critical change in quantity, equation (3.45), is obtained by equating the partial derivative of equation (3.44) with respect to $\Delta Q_{1,2}^C$, to zero and solving for $\Delta Q_{1,2}^C$.

$$\Delta Q_{1,2}^C(crit) = \frac{\partial \Delta PS_{1,2}^C}{\partial \Delta Q_{1,2}^C} = \frac{bQ_1^C}{2b+\beta} \tag{3.45}$$

Where $\Delta Q_{j,l}^C(crit)$ = the change in quantity where producer surplus of IP grain is equal in scenario *j* and *l*

3.2.3 Scenario 2: Oligopolistic Seed Ownership Structure

The introduction of a production constraint within an oligopolistic seed ownership structure demonstrates the potential to increase or decrease Marshallian surpluses depending on the degree of market power (δ). Producer surplus of IP grain will increase if $\delta > \lambda$ where λ is a value for δ such that $S_1^O > S_2^{IP}$, resulting in an increase in quantity from the unconstrained case ($Q_1^O < Q^{IP}$). Whereas if $\delta < \lambda$ producer surplus of IP grain will change in accordance to the degree of market power possessed by the seed industry, and not result in the monopoly solution. For the purposes of illustration it is assumed that $\delta < \lambda$.

The price of IP seed, equation (3.46), is obtained by substituting equation (3.7) and (3.37) into equation (3.23). The price of IP seed decreases relative to the decrease in the monopoly price of seed [$S_1^O - S_2^O = \delta\left(S_1^M - S_2^{IP}\right)$].

$$S_2^O = \delta\left[(a - \alpha - k) - (b + \beta)Q^{IP}\right] + k \tag{3.46}$$

Seed company rents, equation (3.47), is obtained by substituting equation (3.46) and Q^{IP} into equation (3.10). Seed company rents are illustrated in Figure 3.3b by the area [S_2^O, S_2^C, V, W].

$$\pi_2^O = \delta Q^{IP}\left[(a - \alpha - k) - (b + \beta)Q^{IP}\right] = \pi_1^O + \delta \Delta Q_{1,2}^O\left[(a - \alpha - k) - (b + \beta)\left(\Delta Q_{1,2}^O\right)\right] \tag{3.47}$$

The farmer price of IP seed, equation (3.48), is obtained by substituting equation (3.46) and (3.31) into equation (3.33).

$$F_2^O = (1 - \delta)\left[(a - k) - bQ^{IP}\right] + \delta\left(\alpha + \beta Q^{IP}\right) \tag{3.48}$$

Producer surplus of IP grain, equation (3.49), is obtained by substituting equation (3.48) into equation (3.34), and is illustrated in Figure 3.3a by area [F_2^O, α, A, C].

$$PS_2^O = \frac{\beta}{2}\left(Q^{IP}\right)^2 + Q^{IP}\left\{(1 - \delta)\left[(a - \alpha - k) - (b + \beta)Q^{IP}\right]\right\} \tag{3.49}$$

The change in producer surplus of IP grain, equation (3.50), is obtained by substituting equation (3.29), (3.36) and (3.49) into equation (3.35).

$$\Delta PS_{1,2}^O = \frac{\beta}{2}\left(\Delta Q_{1,2}^O\right)^2 - \beta\left[\left(Q_1^O\right)\left(\Delta Q_{1,2}^O\right)\right] + Q^{IP}(1 - \delta)\left[(a - \alpha - k) - (b + \beta)Q^{IP}\right] \tag{3.50}$$

The change in producer surplus of IP grain is dependent on the degree of market power possessed by the seed industry. As seed market power diminishes Marshallian surpluses decreases as the change from the unconstrained quantity to the constrained quantity ($Q^{IP} < Q_1^O$), increasing the deadweight loss. As with the perfectly competitive case, the increase in farmer rents can offset the decrease in producer surplus in the market for IP grain. Market power determines if the introduction of a production constraint will increase or decrease the producer surplus of IP grain. The degree of market power where there is no change in producer surplus of IP grain from scenario one to scenario two is referred to as the critical value for market power. This critical value for market power, equation (3.51), is calculated by equating the partial derivative of equation (3.50) with respect to δ to zero and solving for δ.

$$\delta_{1,2}(crit) = 2\left(1 - \frac{2\left[F_2^C - F_2^M\right]Q^{IP}}{\beta\left(Q_1^C\right)^2}\right) \tag{3.51}$$

Where $\delta_{j,l}(crit)$ = value of δ where change in producer surplus from scenario *j* to scenario *l* equals zero

3.2.4 Production Constraint: Summary

The introduction of a constrained quantity resulted in shifts of welfare between seed companies, farmers and consumers. The price of IP seed was seen to decrease in the monopoly and oligopoly seed ownership cases. Producer surplus of IP grain was shown to always be increasing in the monopoly case, while experiencing possible losses or gains in the perfectly competitive and oligopolistic cases. The benefit of the policy to farmers in the perfectly competitive seed ownership structure is dependent on the size of the constrained quantity relative to the unconstrained quantity (see equation (3.44)). While producer surplus of IP grain in the oligopolistic seed ownership structure is dependent upon the degree of market power possessed by the seed industry, with producer surplus of IP grain decreasing with market power (see equation (3.51)). The increases to producer surplus of IP grain and seed company profits are a result of the production constraint capturing benefit from consumers of IP grain. The implementation of the policy does present farmers with the opportunity to extract rents from the system under an oligopoly or perfect competitive seed ownership structure, provided there is sufficient market power in the seed industry relative to the change in quantity. In all cases the implementation of this policy results in a decrease in rents for seed companies.

3.3 Scenario 3: Market Development Activities

In scenario three, market development activities are introduced to increase farmer welfare and encourage farmer participation in the IPPM system. The market development activities create a price premium in the market for IP grain, increasing the undifferentiated price of IP grain. The impact of the market development activities on the market for IP grain and market for IP seed is illustrated in Figure 3.5 panel a and b, respectively. Figure 3.5 illustrates the prices and quantities discovered in scenario one and the prices and quantities of scenario three presented as grey and black, respectively. The price premium affects the market for IP grain through a shift in the intercept of the consumer demand of IP grain from a to $(a+R)$, causing the demand curve to shift from $P_1(Q)$ to $P_3(Q)$, represented by equation (3.52).

$$P_3^i = (a+R) + bQ_3^i \qquad (3.52)$$

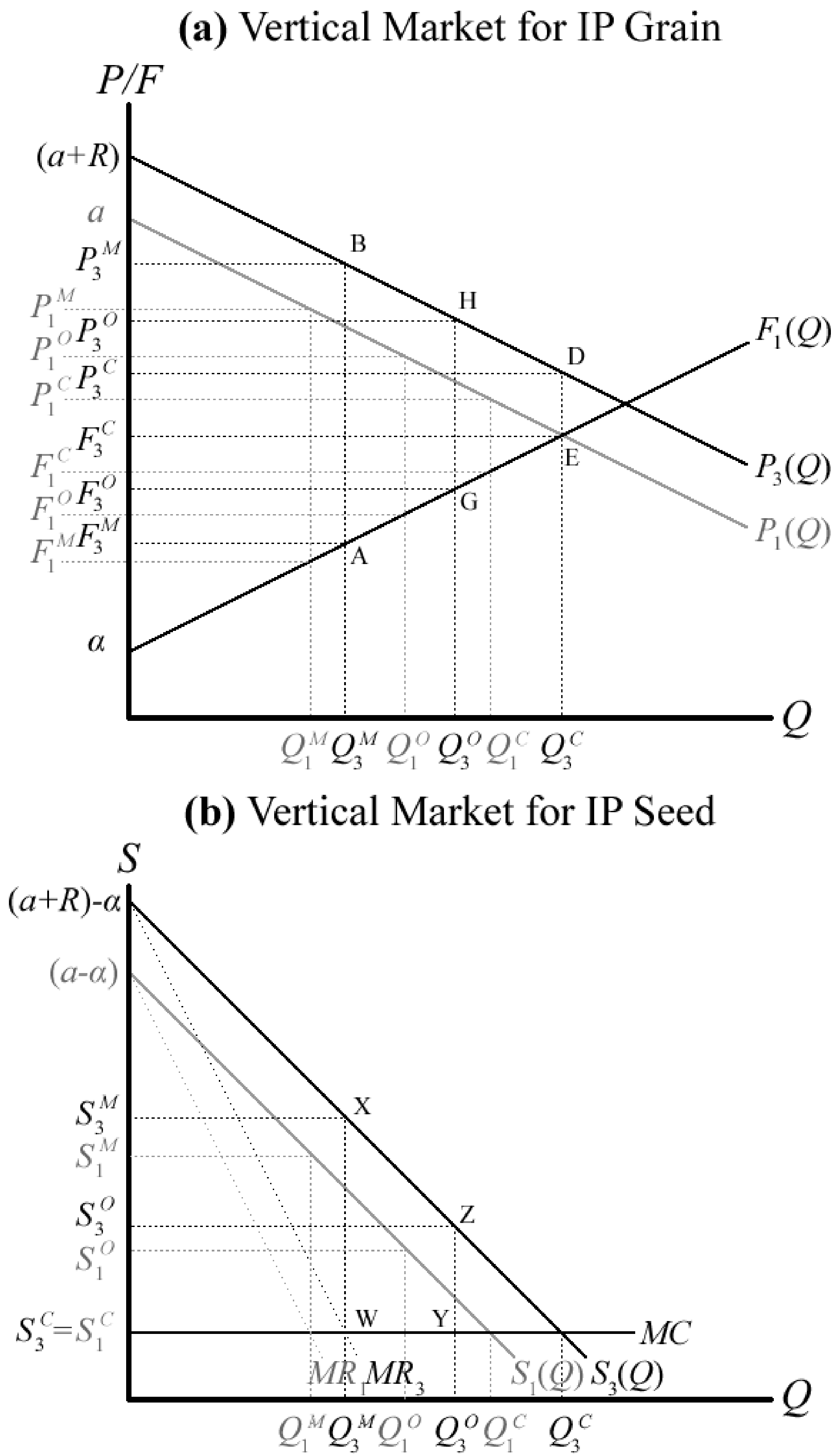


Figure 3.5: Scenario 3 – Market Development Activities

The vertical market structure causes the introduction of market development activities to result in a similar upward shift in the demand for IP seed from $S_1(Q)$ to $S_3(Q)$, illustrated in equation (3.53). This in turn changes the market of IP seed marginal revenue from MR_1 to MR_3, represented by equation (3.54).

$$S_3^i = (a + R - \alpha) - (b + \beta)Q_3^i \tag{3.53}$$

$$MR_3 = (a + R - \alpha) - 2(b + \beta)Q_3^i \tag{3.54}$$

Scenario Assumptions:

- The market development activities create a premium in the market for IP grain as reflected by the upward shift in demand for IP grain

3.3.1 Scenario 3: Monopolistic Seed Ownership Structure

The introduction of market development activities in the monopoly case has the seed industry reacting to the new marginal revenue curve for the demand for IP seed. The monopoly quantity of IP seed is obtained by equating equation (3.54) to equation (3.7), arriving at equation (3.55).

$$Q_3^M = \frac{a + R - \alpha - k}{2(b + \beta)} = Q_1^M + \frac{R}{2(b + \beta)} \tag{3.55}$$

The increase in demand for IP seed also results in an increase in the price of IP seed. The price of IP seed, equation (3.56), is obtained by substituting equation (3.55) into equation (3.4). The price of IP seed increases equal to half of the price premium.

$$S_3^M = \frac{a - \alpha + k + R}{2} = S_1^M + \frac{R}{2} \tag{3.56}$$

The overall impact of the policy on the seed company is a shift in seed company rents to equation (3.57), which is obtained by substituting equation (3.55) and (3.56) into equation (3.10). The seed company rents are illustrated in Figure 3.5b by area [S_3^M , S_3^C , W, X].

$$\pi_3^M = \frac{(a-\alpha-k+R)^2}{4(b+\beta)} = \left[S_1^M + \frac{R}{2}\right]\left[Q_1^M + \frac{R}{2b+\beta}\right] \tag{3.57}$$

Consumer price of IP grain also increases from the base case capturing a portion of the price premium. The consumer price of IP grain, equation (3.58), is obtained by substituting equation (3.55) into equation (3.52).

$$P_3^M = a + R - \alpha\left(\frac{a-\alpha-k+R}{2(b+\beta)}\right) = P_1^M + R\left[1 - \frac{b}{2(b+\beta)}\right] \tag{3.58}$$

The consumer surplus of IP grain will increase from the base case from the increase in consumer price of IP grain and increase in quantity of IP grain. The consumer surplus of IP grain, equation (3.59), is obtained by substituting equation (3.55) into equation (3.8). The consumer surplus of IP grain is illustrated in Figure 3.5a by area [(a+R), P_3^M , B].

$$CS_3^M = \frac{b}{2}\left(Q_3^M\right)^2 = CS_1^M + \frac{bR}{4(b+\beta)}\left(Q_1^M + Q_3^M\right) \tag{3.59}$$

The farmer price of IP grain increases from the increase in quantity. The farmer price of IP grain, equation (3.60), is obtained by substituting equation (3.55) into equation (3.2).

$$F_3^M = \alpha + \frac{\beta(a-\alpha-k+R)}{2(b+\beta)} = F_1^M + \frac{\beta R}{2(b+\beta)} \tag{3.60}$$

The increase in farmer price of IP grain, and quantity of IP grain, results in the producer surplus of IP grain increasing from the base case. The producer surplus of IP grain, equation (3.61), is obtained by substituting equation (3.55) into equation (3.9), which is illustrated in Figure 3.5a by area [F_3^M , α , A].

$$PS_3^M = \frac{\beta}{2}\left(Q_3^M\right)^2 = PS_1^M + \frac{\beta R}{4(b+\beta)}\left(Q_1^M + Q_3^M\right) \tag{3.61}$$

The overall impact of the market development activities is an increase in welfare for all three participants. The increase Marshallian surpluses to all participants are accompanied by an increase in deadweight loss, or portion of uncaptured welfare resulting from the introduction of the market development activities. The majority of the capturable rents are shown to be extracted by the seed company, extracting half of the capturable effect of the market development activities, as can be seen from equation (3.56). The remainder of the premium is distributed between farmers and consumers based on the relative difference of slope coefficients, as can be seen from equation (3.58) and (3.60).

3.3.2 Scenario 3: Perfect Competitive Seed Ownership Structure

Introduction of market development activities with a perfectly competitive seed ownership structure sees the price of IP seed remain the same as the base case, with price of IP seed equal to equation (3.7). The quantity of IP seed increases as a result of the upward shift caused by the market development activities in the demand for IP seed. The quantity of IP seed, equation (3.62), is obtained by substituting equation (3.7) into equation (3.53) and solving for Q_3^C.

$$Q_3^C = \frac{a-\alpha-k+R}{b+\beta} = Q_1^C + \frac{R}{b+\beta} \tag{3.62}$$

The consumer price of IP grain increases from the base case from the increase in quantity of IP grain. The consumer price of IP grain, equation (3.63), is obtained by substituting equation (3.62) into equation (3.52).

$$P_3^C = a + R - \frac{b(a-b-k+R)}{(b+\beta)} = P_1^C + R\left[1 - \frac{b}{(b+\beta)}\right] = P_1^C + \frac{\beta R}{(b+\beta)} \tag{3.63}$$

Consumer surplus of IP grain increases from the base case from the increase in consumer price of IP grain and increase in quantity of IP grain. Consumer surplus of IP grain, equation (3.64), is obtained by substituting equation (3.62) into equation (3.8). The consumer surplus of IP grain is illustrated in Figure 3.5a by area [(*a*+*R*), P_3^C, D].

$$CS_3^C = \frac{\alpha}{2}\left(Q_3^C\right)^2 = CS_1^C + \frac{bR}{2(b+\beta)}\left(Q_1^C + Q_3^C\right) \tag{3.64}$$

The farmer price of IP grain also increases from the base case from the market development activities. This is illustrated in equation (3.65), where equation (3.62) is substituted into equation (3.2).

$$F_3^C = \alpha + \frac{\beta(a-\alpha-k+R)}{(b+\beta)} = F_1^C + \frac{\beta R}{(b+\beta)} \tag{3.65}$$

The producer surplus of IP grain increases from the base case from of the introduction of the market development activities. The producer surplus of IP grain, equation (3.66), is obtained by substituting equation (3.62) into equation (3.9). The producer surplus of IP grain is illustrated in Figure 3.5a by area [F_3^C, α , E].

$$PS_3^C = \frac{\beta}{2}\left(Q_3^C\right)^2 = PS_1^C + \frac{\beta R}{2(b+\beta)}\left(Q_1^C + Q_3^C\right) \tag{3.66}$$

The introduction of the market development activities in the presence of a perfectly competitive seed ownership structure causes an increase in consumer surplus of IP grain and producer surplus of IP grain. The entire premium is shown to be captured by the consumers and farmers and is distributed based on their relative slope coefficients.

3.3.3 Scenario 3: Oligopolistic Seed Ownership Structure

The introduction of market development activities in the presence of an oligopolistic seed ownership structure results in an increase in price of IP seed and quantity of IP seed. The price of

IP seed, equation (3.67), is obtained by substituting equation (3.7) and (3.56) into equation (3.23).

$$S_3^O = \delta\left(\frac{a-\alpha-k+R}{2}\right)+k = S_1^O + \delta\frac{R}{2} \tag{3.67}$$

The quantity of IP seed, equation (3.68), is obtained by substituting equation (3.67) into equation (3.5).

$$Q_3^O = \left(\frac{a-\alpha-k+R}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) = Q_1^O + \left(\frac{R}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) \tag{3.68}$$

The price and quantity solution provides an estimation of the oligopolies rents extracted from the system. The oligopolies rents, equation (3.69), is obtained by substituting equation (3.67) and (3.68) into equation (3.10). Seed company rents are illustrated in Figure 3.5b by area [S_3^O, S_3^C, Y, Z].

$$\pi_3^O = \delta\left(\frac{(a-\alpha-k+R)^2}{2(b+\beta)}\right)\left(1-\frac{\delta}{2}\right) = \pi_1^O + \frac{\delta R}{2}\left(Q_1^O + Q_3^O\right) \tag{3.69}$$

The consumer price of IP grain increases from the increase in price and quantity of IP seed. The consumer price of IP grain, equation (3.70), is obtained by substituting equation (3.68) into equation (3.52).

$$P_3^O = a+R-b\left(\frac{a-\alpha-k+R}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) = P_1^O + R\left[1-\frac{b}{b+\beta}\left(1-\frac{\delta}{2}\right)\right] \tag{3.70}$$

The consumer surplus of IP grain increases from the increase in quantity of IP grain, and the relative decrease in consumer price of IP grain. The consumer surplus of IP grain, equation (3.71), is obtained by substituting equation (3.68) into equation (3.8). The consumer surplus of IP grain is illustrated in Figure 3.5a by area [(a+R), P_3^O, H].

$$CS_3^O = \frac{b}{2}\left(Q_3^O\right)^2 = CS_1^O + \frac{bR}{2(b+\beta)}\left(Q_1^O + Q_3^O\right)\left(1-\frac{\delta}{2}\right) \tag{3.71}$$

The farmer price of IP grain also decreases as a result of the downward shift in the supply of IP grain. The farmer price of IP grain, equation (3.72), is obtained by substituting equation (3.68) into equation (3.2).

$$F_3^O = \alpha + \beta\left(\frac{a-\alpha-k+R}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) = F_1^O + \left(\frac{\beta R}{b+\beta}\right)\left(1-\frac{\delta}{2}\right) \tag{3.72}$$

The impact of the market development activities on the producer surplus of IP grain is positive as a result of the increase in quantity of IP grain and farmer price of IP grain. The producer surplus of IP grain, equation (3.73), is obtained by substituting equation (3.68) into equation (3.9). This is illustrated in Figure 3.5a by area [F_3^O , α , G].

$$PS_3^O = \frac{\beta}{2}\left(Q_3^O\right)^2 = PS_1^O + \frac{\beta R}{2(b+\beta)}\left(Q_1^O + Q_3^O\right)\left(1-\frac{\delta}{2}\right) \tag{3.73}$$

From the results it can concluded that the introduction market development activities in an oligopoly seed ownership structure results in an increase in welfare for all three parties. Distribution of rents is dependent on the degree of market power possessed by the seed companies, with the remainder of rents distributed between the consumer and farmer depending on the slope coefficients of the demand of IP grain and supply of IP grain.

3.3.4 Market Development Activities: Summary

The introduction of market development activities creates an increase in welfare for all three participants in all three seed ownership structures, with seed company rents in the perfectly competitive ownership structure remaining the same. The distribution of rents generated by the market development activities is dependent on the degree of market power possessed by the seed industry as well as the slope coefficients of the supply of IP grain and demand for IP grain. The introduction of market development activities has the desired effect of increasing farmer participation in the program by allowing more land that is marginal for the production of IP grain to become involved in the program, and to increase returns to farmers already participating in the program.

3.4 Scenario 4: Production Constraints and Market Development Activities.

Scenario four is a combination of the policies presented in scenario two and three; constrained production, and market development activities. This scenario illustrates the impact of market development activities in a constrained production on farmer welfare. This scenario addresses the question of “Do farmers benefit from market development activities in a constrained production where the seed industry possesses market power?” The joint introduction of these policies is illustrated in Figure 3.6. Figure 3.6 represents the market for IP grain and market for IP seed in panel a and b, respectively. The black lines and text in Figure 3.6 represent the current scenario, while the grey lines and text corresponding to scenario two. The scenario holds the assumptions stated in scenario two and scenario three. The constrained quantity is assumed to be the same as that in scenario two. In addition the constrained quantity is assumed to be greater than the unconstrained monopoly quantity in scenario three, and less than the unconstrained oligopoly and perfectly competitive quantities in scenario three ($Q_3^M < Q^{IP} < Q_3^O < Q_3^C$).

This scenario examines the impact of market development activities on constrained production with respect to the price of IP seed, farmer price of IP grain, and distribution of rents. The market development activities results in a premium shifting the demand for IP grain from $P_1(Q)$ to $P_3(Q)$. The production constraint results in a kinked demand for IP grain at Q^{IP}, shifting the demand for IP grain curve from $P_3(Q)$ to $P_4(Q)$. The culmination of the shift in the supply and demand curves in the market for IP grain results in a series of shifts in the demand for IP seed from $S_1(Q)$ to $S_3(Q)$ and then to $S_4(Q)$.

From the impact of the production constraint and the assumptions from scenario two, the consumer price of IP seed will be equal to equation (3.74) for all seed ownership structures, which is obtained by substituting Q^{IP} into equation (3.52).

$$P_4^{IP} = (a + R) - bQ^{IP} \tag{3.74}$$

As per the assumptions, the consumer surplus of IP grain will remain at equation (3.75) for all seed ownership structures, which is obtained by substituting Q^{IP} into equation (3.8). The consumer surplus of IP grain is illustrated in Figure 3.6a by area [(a+R), P_4^{IP} , A].

$$CS_4^{IP} = \frac{b}{2}\left(Q^{IP}\right)^2 \tag{3.75}$$

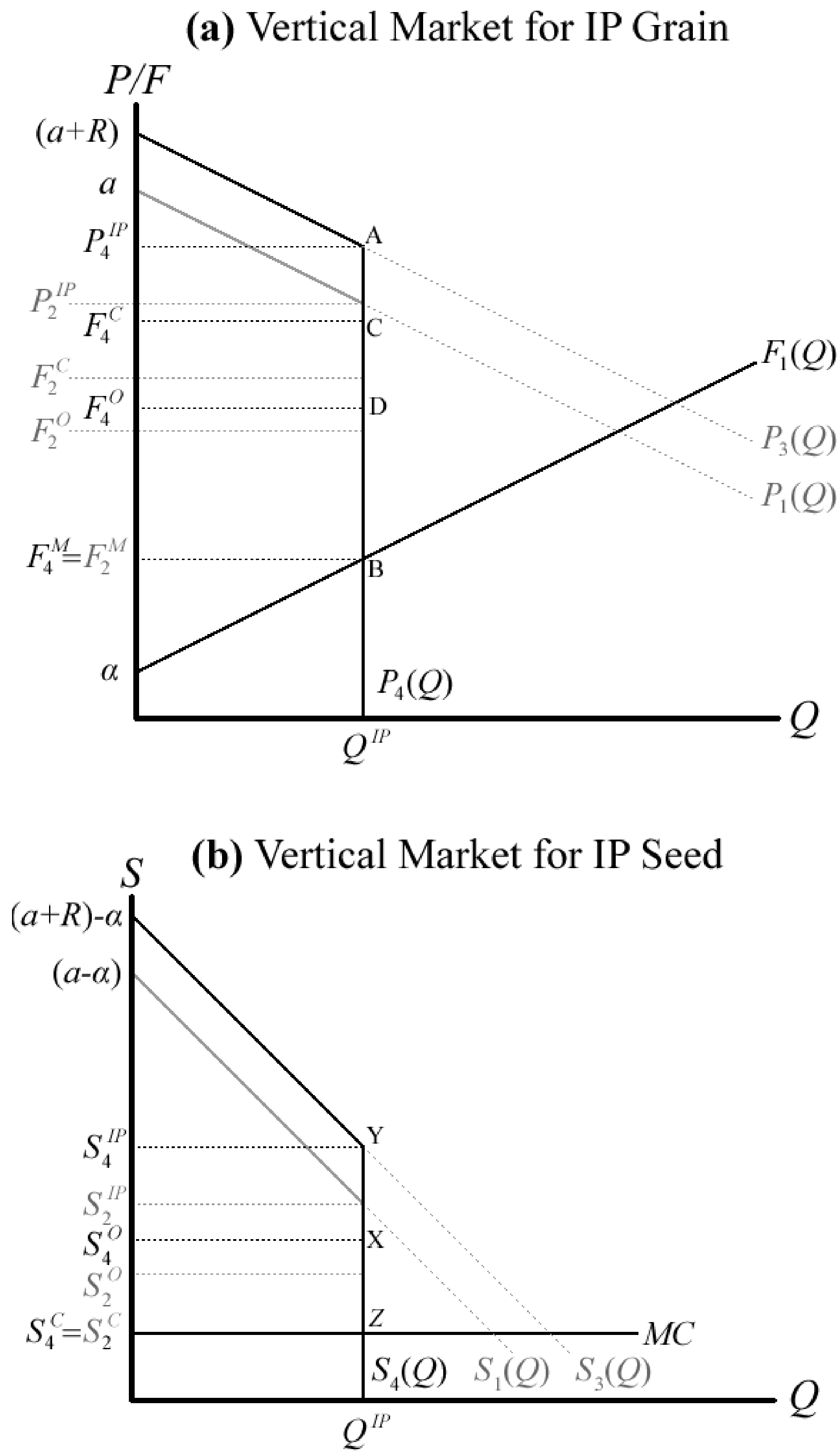


Figure 3.6: Scenario 4 – Market Development Activities and Production Constraint

The following assumptions are held for scenario four:

- Seed industry will produce the quantity of seed required for the constrained production, regardless of seed ownership structure such that $Q_4^{IP} = Q_4^M = Q_4^O = Q_4^C$
- Constrained quantity is greater than the unconstrained monopoly quantity in scenario three, and less than the unconstrained oligopoly and perfectly competitive quantities in scenario three ($Q_3^M < Q^{IP} < Q_3^O < Q_3^C$)
- Constrained quantity is the same as in scenario two
- Consumer price of IP grain remains stationary at P_4^{IP}, and consumer surplus of IP grain remains stationary at CS_4^{IP}

3.4.1 Scenario 4: Monopolistic Seed Ownership Structure

The monopolistic seed company is faced with being unable to charge the profit maximizing price and will charge the highest possible price arriving at the corner solution. The price of IP seed, equation (3.76), is obtained by substituting Q^{IP} into equation (3.53). The seed industry is shown to capture the entire premium through the increase in the price of IP seed.

$$S_4^M = (a - \alpha + R) - (b + \beta)Q^{IP} = S_2^M + R \tag{3.76}$$

Seed company rents, equation (3.77), are obtained by substituting Q^{IP} and equation (3.76) into equation (3.10). Seed company rents illustrate the capturing of the price premium and all of the rents generated by it. The seed company rents are illustrated in Figure 3.6b by area [S_4^{IP}, S_4^C, Z, Y].

$$\pi_4^M = Q^{IP}\left[(a - \alpha - k + R) - (b + \beta)Q^{IP}\right] = \pi_2^M + RQ^{IP} \tag{3.77}$$

The farmer price of IP grain will remain unchanged from the farmer price of IP grain found in scenario two. The farmer price of IP grain, equation (3.78), is obtained by substituting equation (3.74) and (3.76) into equation (3.33).

$$F_4^M = \alpha + \beta Q^{IP} = F_2^M \tag{3.78}$$

The market development activities have no impact on in the farmer price of IP grain, resulting in no transfer of benefit from the market development activities to farmers. This is echoed in the producer surplus of IP grain remaining the same as that found in scenario two. The producer surplus of IP grain, equation (3.79), is obtained by substituting equation (3.78) into equation (3.34). The producer surplus of IP grain is illustrated in Figure 3.6a by area [F_4^M , α, B].

$$PS_4^M = \frac{\beta}{2}\left(Q^{IP}\right)^2 = PS_2^M \tag{3.79}$$

The introduction of the market development activities and constrained production policies results in an increase in farmer price of IP seed from S_2^{IP} to S_4^{IP}, which is equal to *R*. Farmer welfare increased as a result of the constrained production, as was demonstrated in scenario two, but failed to increase as a result of the market development activities as seen in scenario three. The change in producer surplus of IP grain from scenario one to scenario four, equation (3.80), is obtained by substituting equation (3.17) and (3.79) into equation (3.35), which is equal to the change in producer surplus between scenario one and scenario two.

$$\Delta PS_{1,4}^M = \frac{\beta}{2}\left(\Delta Q_{1,4}^M\right)\left(\Delta Q_{1,4}^M + 2Q_1^M\right) = \Delta PS_{1,2}^M \tag{3.80}$$

3.4.2 Scenario 4: Perfect Competitive Seed Ownership Structure

The introduction of the policies jointly into a perfectly competitive seed ownership structure will demonstrate the maximum benefit available to farmers. The price of IP seed will be equal to equation (3.7), and the consumer price of IP grain will remain equal to equation (3.74), as per the assumptions. The farmer price of IP grain, equation (3.81), is obtained by substituting equation (3.7) and (3.74) into equation (3.33).

$$F_4^C = (a + R - k) - bQ^{IP\,C}_{\;2} = F_2^C + R \tag{3.81}$$

The producer surplus of IP grain, equation (3.82), is obtained by substituting equation (3.81) and Q^{IP} into equation (3.34). Producer surplus of IP grain is illustrated in Figure 3.6a by area [F_4^C , α , B, C], capturing the entire price premium.

$$PS_4^C = \frac{\beta}{2}\left(Q^{IP}\right)^2 + \left[(a - \alpha - k + R) - (b + \beta)Q^{IP}\right]Q^{IP} = PS_2^C + RQ^{IP} \tag{3.82}$$

As seen in scenario two, the introduction of the production constraint can positively impact farmer welfare by allowing farmers to extract rents by the system. The inclusion of the market development activities allow for the rents available to farmers to increase. The change in producer surplus of IP grain from scenario one to scenario four, equation (3.83), is obtained by substituting equation (3.29) and (3.82) into equation (3.35).

$$\Delta PS_{1,4}^C = \Delta Q_{1,4}^C\left(\alpha Q^{IP} - \frac{\beta}{2}\Delta Q_{1,4}^C\right) + RQ^{IP} \tag{3.83}$$

The overall impact of the policies on farmer welfare is dependent on the degree of reduction in quantity, similar to the observation in scenario two. Any reduction in quantity greater than the critical value will result in a decrease to producer surplus of IP grain. The critical change in quantity, equation (3.84), is obtained by equating the partial derivative of equation (3.83), with respect to $\Delta Q_{1,4}^C$, to zero and solving for $\Delta Q_{1,4}^C$.

$$\Delta Q_{1,4}^C(crit) = \left(\frac{bQ_1^C + R}{2b + \beta}\right) = \Delta Q_{1,2}^C(crit) + \frac{R}{2b + \beta} \tag{3.84}$$

The critical change in quantity is increases from the value discovered in scenario two as a result of the market development activities. This is seen by comparing equation (3.45) to equation (3.84). The introduction of market development activities in a competitive seed ownership structure allows for a greater constraint in production when market development activities are introduced, with producer surplus of IP grain remaining indifferent between scenario four and scenario one.[14]

3.4.3 Scenario 4: Oligopolistic Seed Ownership Structure

The oligopoly case allows the impact of seed industry market power on farmer welfare to be calculated for an IPPM system that has constrained production and market development activities. The price of IP seed decreases as a result of the introduction of a constrained quantity and increases as a result of the premium from market development activities. The price of IP seed, equation (3.85), is obtained by substituting equation (3.7) and (3.76) into equation (3.23).

$$S_4^O = \delta\left[(a-\alpha-k+R)-(b+\beta)Q^{IP}\right]+k = S_2^O + \delta R \tag{3.85}$$

The seed industry rents, equation (3.86), are obtained by substituting equation (3.85) and Q^{IP} into equation (3.10). Seed industry rents are illustrated in Figure 3.6b by area [S_4^O, S_4^C, Z, X].

$$\pi_4^o = \delta Q^{IP}\left[(a-\alpha-k+R)-(b+\beta)Q^{IP}\right] = \pi_2^o + \delta R Q^{IP} \tag{3.86}$$

The farmer price of IP grain, equation (3.87), is obtained by substituting equation (3.85) and (3.74) into equation (3.33).

$$F_4^O = \left[(a+R)-bQ^{IP}\right]-\delta\left[(a-\alpha-k+R)-(b+\beta)Q^{IP}\right] = F_2^O + (1-\delta)R \tag{3.87}$$

[14] The CWB would constrain production to this point in order to maintain a niche market in order to maintain a premium.

The producer surplus of IP grain, equation (3.88), is obtained by substituting equation (3.87) into equation (3.34). Producer surplus of IP grain is illustrated in Figure 3.6a by area [F_4^O , α, B, D].

$$PS_4^O = \frac{\beta}{2}\left(Q^{IP}\right)^2 + (1-\delta)\left[(a-\alpha-k+R)-(b+\beta)Q^{IP}\right]Q^{IP} = PS_2^O + (1-\delta)RQ^{IP} \tag{3.88}$$

The change in producer surplus of IP grain, equation (3.89), is obtained by substituting equation (3.29) and (3.88) into equation (3.35).

$$\Delta PS_{1,4}^O = \frac{\beta}{2}\left(\Delta Q_{1,4}^O\right)^2 - \beta\left[\left(Q_1^O\right)\left(\Delta Q_{1,4}^O\right)\right] + Q^{IP}(1-\delta)\left[(a-\alpha-k+R)-(b+\beta)Q^{IP}\right] \tag{3.89}$$

The redistribution of rents from the production constraint and market development activities is dependent on the degree of market power possessed by the seed industry. The production constraint prevents a change in welfare for consumers, leaving the market development activities able to improve the welfare of farmers and the seed industry. If market power of the seed industry is lower than a certain value producer surplus of IP grain will decrease, as seen in scenario two. This critical value for market power, equation (3.90), is obtained by equating the partial derivative of equation (3.89), with respect to δ to zero, and then solving for δ.

$$\delta_{1,4}(crit) = 2\left(1 - \frac{2\left[F_4^C - F_4^M\right]Q^{IP}}{\beta\left(Q_1^C\right)^2}\right) \tag{3.90}$$

The critical value for market power for scenario four can be compared with that of scenario two, comparing equation (3.90) to equation (3.45). Given that $F_4^C > F_2^C$ and $F_4^M = F_2^M$ one can conclude that $\delta_{1,4}(crit) < \delta_{1,2}(crit)$. The introduction of market development activities allows producer surplus to remain unchanged when a stricter production constraint is imposed when the seed industry has a low degree of market power (i.e. perfectly competitive, or a competitive oligopoly). This result echoes that found in the perfectly competitive case when examining the critical change in quantity from scenario one to scenario four.

3.4.4 Production Constraints and Market Development Activities: Summary

Scenario four demonstrates the interaction of market development activities and a production constraint. The analysis demonstrates the influence of the policies on the producer surplus of IP grain. The production constraint creates a stronger tie between the distribution of the benefit from market development activities and market power as demonstrated in equation (3.88). The market development activities allow for a greater reduction in quantity before the change in producer surplus of IP grain is equal to the base case ($\Delta PS_{1,4}^{C} = 0$), as demonstrated in equation (3.84). This in turn is influenced by the degree of market power held by the seed industry, where the introduction of market development activities decreases the critical market power, as demonstrated in equation (3.90).

The impact of the market development activities on producer surplus of IP grain is inversely related to the degree of market power of the seed industry, with it having no positive impact when faced with a monopolistic seed industry. An IPPM system in the presence of a seed industry with a large degree of market power will result in the benefit generated from market development activities to primarily increase seed company rents, leaving little for farmers.

3.5 Summary of Theoretical Model

The four scenarios discussed in this chapter outline the impact of an IPPM system's policies on farmer welfare. The two examples of an IPPM system, constrained production (scenario two) and constrained production in the presence of market development activities (scenario four), demonstrate the influence of market power on rent distribution. The monopolistic and oligopolistic seed ownership structures provide insight into actual seed variety ownership and the impact of the creation and development of an IPPM system on farmer welfare.

The development of an IPPM system and the implementation of the two policies examined in this chapter can provide a variety of changes to farmer welfare depending on market power and of their introduction separately or jointly. Constrained production was shown to increase farmer welfare from an unconstrained market provided the constrained quantity was greater than equation (3.45). The market development activities was shown in the unconstrained case to positively impact farmer welfare, consumer welfare, as well as seed company profits (equation (3.73), (3.71) and (3.69), respectively). The combined policies were shown to have similar impact as to the individual policies but lessened the impact of the farmer premium when production was constrained. It is shown that a large degree of market power by the seed industry results in diminished impact of the benefit of market development activities to farmers. As a result of these findings it can be concluded that the development of an IPPM system and its policies are dependent on the degree of market power held by seed companies over varieties. If seed company market power is high, the introduction of a constrained production is beneficial, yet provides little incentive for the market to be developed in order to provide a higher premium to increase farmer welfare.

In chapter four we examine an empirical analysis of two IPCP varieties that are involved in an IPPM system as illustrated in scenario four, constrained production with market development activities. The empirical analysis demonstrates the correlation of extraction of premium elicited from market development activities and market power.

CHAPTER 4

EMPIRICAL ANALYSIS OF THE CANADIAN WHEAT BOARD'S IDENTITY PRESERVED CONTRACT PROGRAM

4 Empirical Analysis

It is hypothesized that the seed industry is exerting market power on farmers involved in the Canadian Wheat Board's (CWB) Identity Preserved Contract Program (IPCP). The impact of the exertion of market power by the seed industry on IPPM systems is presented in the four scenarios of the theoretical model, with scenario two and four representing the IPCP. The empirical analysis provides a tool to detect and quantify the exertion of market power by the seed industry on farmers, measuring the re-distribution of rents and the total rents captured by the seed company.

This chapter begins by describing the CWB's IPCP; outlining farmer's contract structure, the environment the IPCP operates in, and the factors affecting its development. The empirical analysis follows, examining two IPCP wheat varieties; AC Navigator and Snowbird. Identity Preserved Contract Program varieties are compared with conventional non-IPCP varieties to determine an average relative benefit to farmers involved in the program. The average relative benefit provides a tool for the detection of the exertion of market power by seed companies and measures the total re-distribution of IPCP premiums from farmers to seed companies. It is theorized that the exertion of market power can be detected if a farmer's benefit of producing an IPCP variety would be equal to or less than that of a non-IPCP variety. The chapter concludes explaining the limitations of the empirical analysis.

4.1 Canadian Wheat Board's Identity Preservation Program

The CWB's first step towards a national IPPM system was in 1998 and was called the Market Development Contract Program (MDCP) (Hilderman 2009). The initial goal of the program was to match production to the market in order to re-establish and maintain the reputation of Western Canada for producing high quality wheat, durum, and barley. The MDCP showcased the ability of Canadian farmers to produce high quality grain, as well as demonstrating the ability of Canadian plant breeders to produce new and high valued varieties. Varieties included in the program contained valuable properties demanded by consumers, but are not easily distinguished from conventional varieties (CWB 2004a). As the program progressed it was renamed the Identity Preserved Contract Program to better reflect its added focus on the development of an IP system for the CWB (CWB 2004a).

The IPCP consists of two individual core activities; the market development IPCP, the commercial IPCP (CWB 2004a). The market development IPCP focuses on testing the niche market potential of new high quality varieties that contain unique characteristics in domestic and international markets. The commercial IPCP focuses on market penetration of Canadian varieties into already established niche markets to increase market share. The CWB assumed that accurately meeting a market's preferences allows for more value to be extracted from the market. The goal of the IPCP is to meet the objectives of the core activities in a manner that transfers the maximum amount of value generated by the program back to farmers.

Initially the IPCP covered Canada Western Amber Durum (CWAD), Canadian Prairie Spring Red wheat (CPSR), and Canadian Prairie Spring White wheat (CPSW) varieties. However, the program has grown where in the 2006-07 crop year, the program consisted of 14 varieties including the CWAD variety AC Navigator and the new wheat class Canada Western

Hard White Spring wheat (CWHWS) (CWB 2005c). The varieties selected for the program represented significant breeding advancements of varieties that possessed unique traits that had niche market potential. Varieties remained in the program as long as are viable; some varieties only lasting a single season whereas others lasting for over a decade.

One of the objectives of the IPCP is to organize the agricultural supply chain to handle IP systems for wheat and barley. Important to the system is providing sufficient incentives for participation in all sectors of the supply chain, with farmers being of special importance to the CWB. Exertion of market power by any of the participants within the IPCP has the potential to re-distribute the incentives provided by the IPCP and could result in the system's failure.

4.1.1 Farmer Activities and Incentives

Farmer participation in an IPPM system producing a stable supply of high quality grain is the basis of an IPPM system's success. Farmer adoption of IPCP varieties and their participation in the IPCP requires sufficient incentives to overcome the real and perceived difficulties of involvement in the program (Maltsbarger and Kalaitzandonakes 2000). An adequate production base is critical for the success of a branded IP system as supply interruptions can prove to be detrimental to consumer confidence and its continued success (Janzen and Wilson 2002).

An objective of the IPCP, as previously stated, is to transfer the maximum amount of value generated from the system back to farmers. This assists in raising farmer confidence in the program and thereby promotes the maintenance of an adequate production base. The CWB provides a variety of cash and non-cash incentives to meet this objective, such as; guaranteed acceptance, on-farm storage premiums, protein premiums, and a delivery premium (CWB

2004b).[15] Guaranteed acceptance removes marketing risk of producing niche market grains. The escalating on-farm storage premium reduces the threat of losses associated with decreasing grain quality associated with on-farm storage. The escalating on-farm storage premium varies within the program depending on the IPCP variety, the premium ranges from $0.03 to $0.05/tonne per day (CWB 2004b). The escalating on-farm storage premium also functions as a logistical tool for alignment, and optimal use, of transportation and storage assets. Premiums directly tied to quality and quantity are included in the IPCP, which fluctuate year to year in accordance to the market (CWB 2004a, 2005c). The combination of premiums can potentially provide farmers a benefit of $14/acre, taking into account the additional costs of involvement (CWB 2005a).[16]

Production and marketing contracts establish the incentive for farmer participation in the IPCP as well as for agricultural input companies. These contracts create a framework for participation in a closed loop system for the production of specific varieties at specific grades and protein levels. The contracts and system are not stagnant but change and evolve over time to deal with problems that arise within the system. In addition to creating incentives for participation, the contract structure of the IPCP establishes the distribution of market power and relationships between participants.

4.1.2 Market Power and Failures of the Identity Preserved Contract Program

The IPCP's policies and alignment of supply chain activities develop and change as new problems arise within the system. The program has experienced growing pains in the first few years of operation in terms of inefficiencies and handling failures (Rosher 2004). These problems have been addressed through participant education and streamlining of activities in order to

[15] These incentives are not included for all IPCP varieties.
[16] The recipient of the CWB's 2005 Master Grower award for Canada Western Red Winter Select wheat reported the $14/acre benefit.

minimize future losses. Identity preserved production and marketing systems have two major areas of concern; the first is to maintain product purity, the second to maintain an adequate supply to allow the program to succeed.

Maintenance of product purity in the IPCP has had difficulties. The IPCP has a 95% variety purity requirement, which provides an adequate purity level for consumer products while minimizing costs. Problems with meeting purity requirements occurred during the early years of the IPCP. As the program grew, and participants became experienced operating within an IPPM system, problems associated with the IPPM system were able to be addressed and diminished (Rosher 2004). These problems were a result of contamination during handling, storage and transportation, and from seed purity issues.

The difficulties with product segregation were a result of poor record keeping by firms in the supply chain. The poor record keeping allowed grain to be mislabelled and pooled with conventional varieties (Rosher 2004). In these cases, the IP system allowed for the discovery of where in the supply chain the failure occurred, allowing the cause of the failure to be addressed and corrected to prevent future failures (Rosher 2004).

Identity preserved production and marketing systems manage seed purity using acceptable seed; certified seed, verified seed. Certified seed provides a guarantee, by a seed merchant, of the purity of the seed. The guarantee provides farmers with a liability mitigation tool if the seed is found to be substandard (Canadian Seed Trade Association 2003). The alternative of certified seed is a type of farmer saved seed called verified seed. Verified seed is grain produced using certified seed in a previous year, and then used as seed in a subsequent year (Canadian Grain Commission 1998). The authenticity of verified seed is supported by certified seed tags or invoices and possibly testing to prove purity. Farmer saved seed does not have the same guarantees of purity, and can present an opportunity for contamination at the field level if proper agronomic practices are not followed (Cooper 1984).

In the beginning of the IPCP, farmers had the option of using saved seed for subsequent year's production. This policy made the IPCP more in line with conventional farming practices where farmers did not purchase certified seed every year allowing farmers to spread the cost of certified seed over a number of years. The use of saved seed allowed the program to be more economically viable to a larger production base. The use of saved seed proved an obstacle for the IPCP with the use of substandard saved seed. This created purity issues resulting in the program failing to meet market purity requirements (Rosher 2004). As a result, stricter seed requirements were introduced. Resulting in certified seed being required for the first three years a variety was involved in the program (CWB 2005b). Saved seed was still allowed within the program, but is required to meet acceptable purity levels in subsequent years. Arguments have been made for and against the use of saved seed within an IPPM system. Saved seed has been argued to be of lower quality and creates an opportunity for contamination (Cooper 1984; Edwards and Krenzer 2006). It has also been argued that with the use of proper agronomic practices the purity of saved seed can be equal to that of certified seed (Edwards and Krenzer 2006). Even though saved seed is allowed within the program, the CWB maintains the right to impose pedigreed (certified) seed requirements on a case by case basis (CWB 2005b).

Farmers involved in the IPCP are allowed by the CWB to use saved seed, but are not allowed to use saved seed because of the IPCP's contract structure. As previously stated, farmers are involved in a marketing contract with the IPCP, as well as a production contract with agricultural input companies. The production contract requires the use of certified seed, which results in the IPCP requiring certified seed, thus allowing the seed input companies to exert market power over the system. The requirement of certified seed can pose a deterrent to farmers if the premium offered by the program is insufficient to offset the additional seed cost. Other obstacles are also present within the system such as delivery contracts tied to a single elevator, preventing farmers from shopping their grain around to obtain a higher grade.

4.1.3 Summary of the IPCP

The IPCP was developed to create an IP system for Western Canadian wheat and barley farmers. The contract structure of the IPCP governs the interactions and relationships between participants. The contractual requirements have been changed and adjusted over time to deal with failures in the system. The changes in the contracts between farmers and seed companies have shifted more bargaining (market) power to the hands of the seed companies. An empirical analysis follows to detect if the seed companies are exerting market power over farmers involved in the IPCP, and extracting the majority of the rents.

4.2 Empirical Analysis Cases

Farmer participation in the CWB's IPCP is dependent upon the rents made available to them through the IPPM system (Janzen and Wilson 2002). Rent distribution is dependent on the relative bargaining power between participants. Farmers negotiate with the marketer for the price of grain, as well with input suppliers for the price of seed. The marketer (CWB) is assumed to exert no bargaining power over farmers, and is assumed to provide farmers with the highest price possible for their wheat. Additionally the CWB is assumed to return all revenues from the system to farmers, minus the cost of marketing. Negotiations between the input supplier and farmer have an unknown outcome and are the subject of this empirical analysis. The distribution of rents between farmer and input supplier will be measured, as well as the entire rents and premiums made available to farmers in the system.

The empirical analysis examines two cases of IPCP varieties AC Navigator, a CWAD variety, and Snowbird, a CWHWS variety. These two varieties, AC Navigator and Snowbird, are involved in the Commercial IPCP and have been included since 2000 and 2003, respectively. Markets for AC Navigator and Snowbird are assumed to be well established, as is a developed production base to supply the market. Participants are assumed to have full understanding of the markets/programs costs and revenues allowing participants to price their activities/products in a manner that is perfectly aligned with their relative market power.

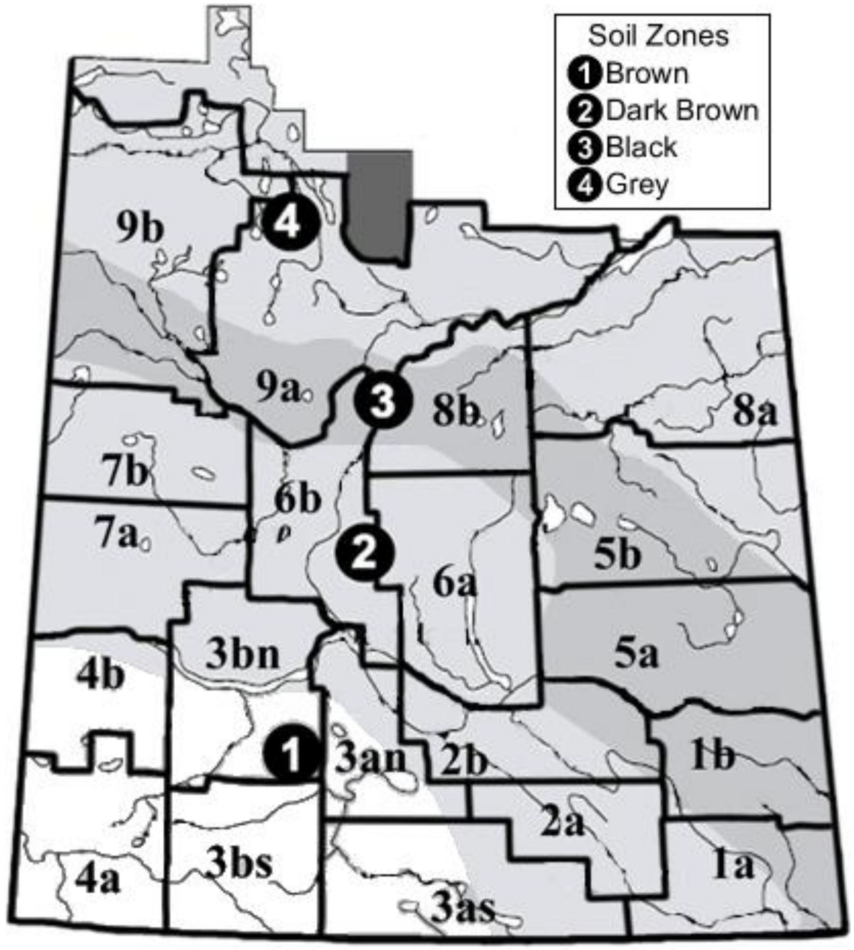
The analysis examines the profitability of involvement in the IPCP for a Saskatchewan farmer that receives average yields and price of grain (henceforth referred to as a representative Saskatchewan farmer) in the Brown, Dark Brown, Black, and Grey soil zones (represented by areas one, two, three and four in Figure 4.1, respectively). Production practices for IPCP and non-IPCP varieties were assumed to be identical; inputs, agronomic practices, quality of land, and environmental factors such as sunlight, temperature, and moisture. Crop yield data was obtained from the Saskatchewan Agriculture Food and Rural Revitalization (SAFRR) Crop Planning Guide (SAFRR 2006a).[17] Yield and protein were adjusted to represent the genetic potential of the varieties, which was obtained from the SAFRR Variety of Grain Crops (SAFRR 2006b). Prices were taken as the final payment made by the CWB for No. 1 wheat, at the varieties relative protein level. Certified seed prices were obtained through a telephone survey and industry data (Duvenaud 2006). Seed prices were unavailable for Snowbird and CWRS varieties over the period of the study, as such the seed variable expenses from the SAFRR Variety of Grain Crops

[17] Saskatchewan Agriculture Food and Rural Revitalization name was changed in 2005 to Saskatchewan Agriculture and Food, and further changed in 2007 to Saskatchewan Ministry of Agriculture.

were used (SAFRR 2006b, 2007b, 2008b). Actual price of seed for Snowbird and CWRS varieties were not critical to the study as Snowbird is typically priced at a $4/bu premium over conventional CWRS varieties (Alderson 2009). Seeding rates were obtained from the SAFRR Crop Planning Guide (2006a).

The two cases chosen for the empirical analysis provide a comparison between different seed ownership structures and the impact of fluctuations in price and yield on farmer profitability. The first case, AC Navigator, examines the IPCP variety against two comparable non-IPCP varieties that have different ownership structures (monopoly and oligopoly). The second case, Snowbird, examines the IPCP variety against a weighted average of Canadian Western Red Spring (CWRS) varieties over a three-year period to determine the impact of fluctuations in yield and price on farmer opportunity cost.

The difference in the price of seed between an IPCP variety and that of conventional varieties can be assumed to be relative to the capturable benefit of the IPCP variety over the conventional. The price of seed for a variety is assumed to be based on its production characteristics that relate to its agronomic performance in regards to yield, protein level, and resistance to biotic and abiotic stresses. The ownership structure can be assumed to influence price by allowing the seed company to capture a relative portion of the benefit from the production characteristics of each variety. In the case of the IPCP, the premiums offered by the program provide another benefit that can be captured by the seed industry.



Source: Crop Districts - SAFRR (2006c)
Crop Production Zones - SAFRR (2006b)

Figure 4.1: Overlay of Saskatchewan Crop Districts and Soil Zones

The hypothesis tested in this chapter is that seed companies are exerting market power within the IPCP and extracting the majority of the rents. Each case describes the IPCP variety, the varieties market potential, and the market's consumers and competitors. An empirical analysis follows comparing the IPCP variety to a non-IPCP variety, which is representative of its class. A per acre revenue is calculated for both the IPCP and non-IPCP varieties and compared to determine the opportunity cost of involvement with the program for a representative Saskatchewan farmer in each of the three soil zones.

Empirical Analysis Assumptions:

- Markets for AC Navigator and Snowbird are well established
- Participants have a full understanding of costs and revenues for participating in the IPCP
- Profitability of IPCP is based on a representative Saskatchewan farmer in each soil zone
- Production practices of IPCP and non-IPCP varieties are identical
- Pricing of seed is based on measurable agronomic traits: yield, protein content, and variety premiums

4.2.1 Case 1: AC Navigator

AC Navigator is a CWAD variety preferred by consumers for its strong yellow pigmentation and high gluten strength. In 1997, AC Navigator had a limited release, with production beginning in 1999 (Dexter 2008). This variety possesses a gluten strength double that of conventional varieties at the time, and was the first attempt in the creation of a new class of wheat, extra strong durum. AC Navigator failed to meet the envisioned requirements of the new extra strong durum class, and subsequently reclassified as CWAD.[18] The variety is licensed by Viterra, an agri-product company, which is vertically integrated into the supply chain engaging in wheat breeding efforts, transportation, shipping, value added processing, and marketing (Viterra 2009). The variety was developed in a joint effort between the Western Grains Research Foundation (WGRF) and the Saskatchewan Wheat Pool (which later merged with Agricore United in 2007, the new entity was later named Viterra).

[18] Since AC Navigators introduction in 1997 newer varieties have been introduced with much higher gluten strength meeting the requirements of the Extra Strong Durum class such as Commander (94% gluten index to AC Navigators 74%) resulting in its reclassification as a CWAD.

The introduction of AC Navigator demonstrated that the gluten strength of CWAD varieties could be increased dramatically. Initial market reaction to higher gluten strength in the CWAD class was unknown, prompting regulators to give the variety a limited release and to require the creation of an IP system for AC Navigator (Dexter *et al*. 2007). This variety was unique to the IPCP as there was symmetric risk between AC Navigator and the general CWAD commodity (Smyth and Phillips 2003). In 2003, AC Navigator was recommended for full release and as of 2005 was granted full registration, allowing it to be blended with other CWAD varieties (DePauw *et al*. 2003; Dexter 2008).

Market demand for AC Navigator is driven by niche premium pasta markets because of its bright yellow colour (DePauw *et al*. 2003, Dexter *et al*. 2007). Processors prefer AC Navigator for its higher semolina yield, allowing for higher extraction rates (Dexter 2008). Markets demanding AC Navigator are predominantly in the United States, Italy, and South America (DePauw *et al*. 2003, Dexter *et al*. 2007). AC Navigator is typically blended with lower quality durums to produce a blended product with a stronger yellow pigment and higher gluten strength. AC Navigator competes with a number of varieties for market share; Southwestern American desert durums, and similar Australian varieties (DePauw *et al*. 2003).

AC Navigator is a unique IPCP variety in that production of the variety occurs both inside and outside of the IPCP. Total production of AC Navigator in 2006 accounted for less than 10% of all CWAD produced in Canada, of which 60% marketed through the IPCP. Viterra controls the distribution of AC Navigator IPCP contracts, which is restricted to their "AC Navigator Loyal Growers" program. Farmers who are not members of the "AC Navigator Loyal Growers" are able to obtain non-IPCP AC Navigator production contracts through Viterra (Viterra 2008). Non-IPCP AC Navigator farmers are able to take advantage of series A delivery contracts, but still require full delivery to Viterra. The non-IPCP production receives regular operations premium, which is less than the IPCP delivery contract $2.00/tonne premium.[19] Production outside of the IPCP demonstrates that farmers are able to compensate for the increase in seed cost and the absence of the $4.50/tonne premiums associated with the IPCP. Assuming that farmers are rational profit maximizers, it can be reasonably assumed that they are able to achieve returns that are equal to or greater than that of other durum varieties.

The AC Navigator IPCP is placed into context by first examining the major areas of production. This is followed by a measurement of the total layout by the CWB and Viterra for the AC Navigator IPCP. Knowing the total rents made available to farmers, measurements could then be undertaken to determine what proportion of these rents a representative Saskatchewan farmer could capture. The expected costs and revenues for AC Navigator, AC Avonlea and Kyle are calculated to estimate the revenue on a $/bu basis of the three varieties. Expected yields in bu/acre are then calculated, followed by an estimation of the relative profitability of AC Navigator to AC Avonlea and Kyle in the Brown and Dark Brown soil zones. Knowing the relative profitability of the three varieties distribution of AC Navigator was then estimated within Saskatchewan to determine the relative weighted average benefit to Saskatchewan farmers in terms of $/acre.

Production of Canadian durum is primarily in Saskatchewan, with few acres in Alberta, Manitoba and British Columbia. Saskatchewan accounts for over 80% of AC Navigator production, with Alberta producing the remainder (Table 4.1). On average 60% of AC Navigator is produced under contract for the IPCP, with the remainder under contract with Viterra. Estimation of AC Navigator production was calculated by cross referencing the percentage of

[19] The regular operations premium is variable depending on the point of delivery.

CWAD acres seeded to AC Navigator in each prairie province (CWB 2006b) with the number of seeded acres of CWAD in each prairie province (Statistics Canada, Various Years).

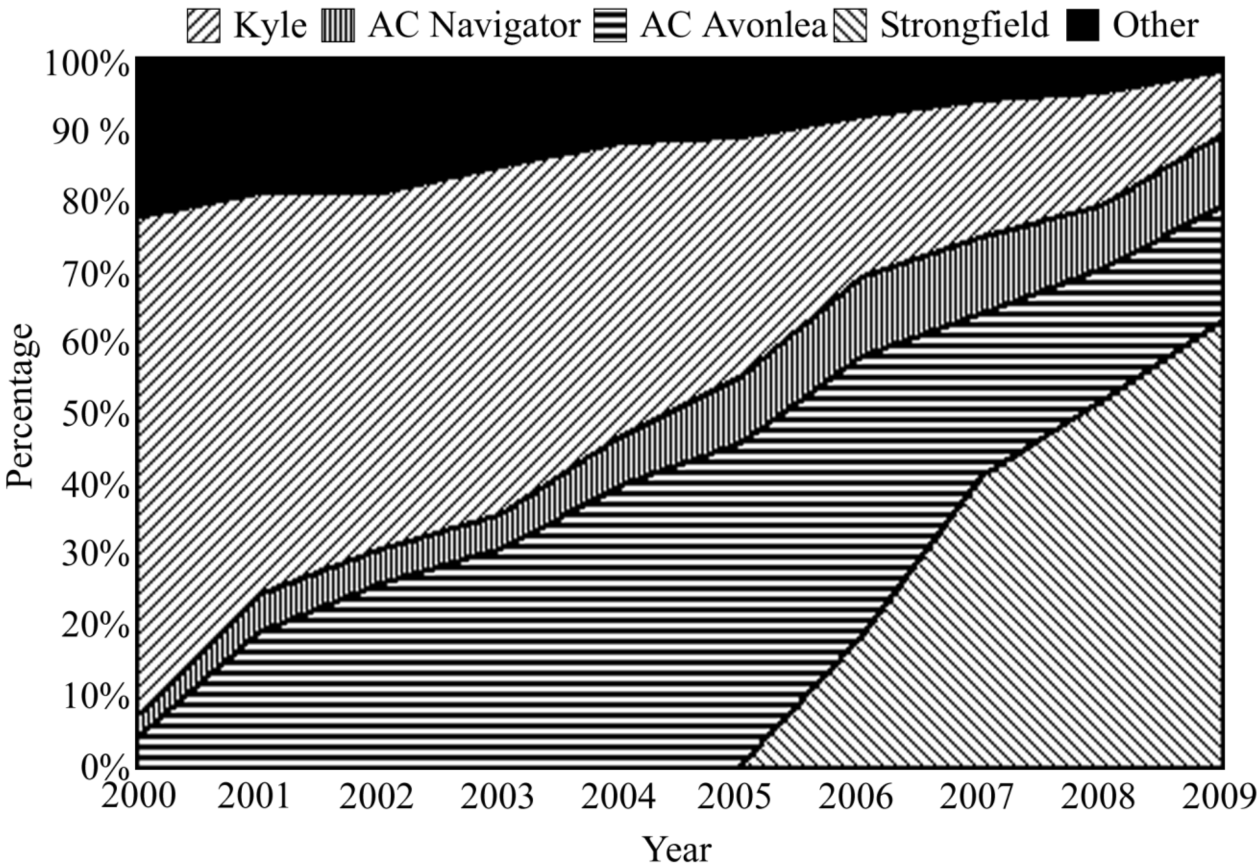
Table 4.1: AC Navigator Production Distribution and Contracted Acres in Western Canada

	AC Navigator Production (Acres)[i]				CWB Contracted	Total Prairie
	Manitoba	Saskatchewan	Alberta	Total	Acres[ii]	CWAD Acres
2008	0	433,500	110,670	544,170	325,000	5,970,000
2007	0	449,550	84,915	534,465	300,000	4,760,000
2006	0	380,504	43,949	424,453	260,000	3,750,000
2005	0	463,200	68,800	532,000	335,000	5,630,000

[i] Source: Authors calculation utilizing Statistics Canada CANSIM Table 001-0017 and CWB Variety Survey 2005, 2006, 2007, 2008
[ii] Source: Rosher 2009

Production of CWAD varies from year to year while the composition of varieties shifts from year to year towards newer higher yielding varieties. AC Navigator makes up a relatively small proportion of all seeded acres of CWAD in Western Canada. AC Navigator is compared to non-IPCP varieties AC Avonlea and Kyle. AC Avonlea has similar yield characteristics as AC Navigator; as well, it was introduced in the same year. Kyle is an established variety that has been falling out of favour to newer higher yielding varieties such as AC Avonlea and Strongfield. Figure 4.2 illustrates the change in seeded acres of different CWAD varieties across the prairies from 2000 to 2009.

The AC Navigator IPCP offers farmers a delivery premium of \$2.50/tonne in addition to a \$2.00/acre production premium offered by Viterra (Churko 2009). The IPCP operates through a contract that specifies the number of acres seeded to AC Navigator, and grants a premium based on yield (tonnage). In order to estimate the total premium outlay, average CWAD yields were applied to the AC Navigator acreage. The total outlay for AC Navigator by the CWB and Viterra is estimated in Table 4.2, accounting for 2.24 million acres and \$8.8 million in premiums over the past decade.



Source: Canadian Wheat Board

Figure 4.2: Prairie Average Seeded Acres of CWAD Varieties

Table 4.2: AC Navigator Contracted Acres and Farmer Premiums

Year	Contracts[i] (Acres)	Delivery Premium[ii] ($/Tonne)	Production Premium[iii] ($/Tonne)	CWAD Average Yield[iv] Tonne/Acre	Total Premium $
2001	52,000	2.50	2.00	0.60	411,401
2002	184,000	2.50	2.00	0.70	579,143
2003	155,000	2.50	2.00	0.71	497,350
2004	276,000	2.50	2.00	0.95	1,176,308
2005	335,000	2.50	2.00	1.05	1,583,654
2006	260,000	2.50	2.00	0.89	1,044,439
2007	300,000	2.50	2.00	0.77	1,043,431
2008	325,000	2.50	2.00	0.93	1,353,290
2009	250,000	2.50	2.00	1.00	1,125,000
Total	2,237,000				8,814,015

[i] Source: Rosher 2009

[ii] Source: CWB 2004a, 2005c, 2006a, 2008a
The premium was assumed to be $2.50/tonne for missing years.

[iii] Source: Churko 2009

[iv] Source: Authors calculation using Statistics Canada CANSIM Table 001-0010 and 001-0017 (2009 estimated at 1.00 tonne/acre)

The return from agricultural crop production is dependent on the cost of inputs, crop yield, grain quality, and the price of grain. Crop production data, seeding rate and yield, were taken from the SAFRR Crop Planning Guide (2006a). Crop price was taken as the CWB final payments for No. 1 wheat in the 2006-07 crop year at the variety's relative protein level outlined in the SAFRR Varieties of Grain Crops (SAFRR 2006b). The CWB lists the price of AC Navigator CWAD separately from the CWAD class. The price of AC Navigator and the CWAD class are often identical but have occasionally diverged for specific protein levels in specific years. Seed prices were obtained through a seed grower survey in the summer of 2006. Durum production was examined in the Brown and Dark Brown soil zones of Saskatchewan, under the assumption that similar production practices are conducted for all varieties in each soil zone. The variables affecting the relative profit are; cost of seed, cost of segregation, price based on relative protein level, relative yield, and production and delivery premiums.

The seeding cost for the three varieties is calculated in Table 4.3. The cost of certified seed was found to be $9.50/bu for AC Navigator, $7.21/bu for AC Avonlea, and $6.11/bu Kyle (Duvenaud 2006). A seeding rate of 1.5 bu/acre was used as well assuming the same seeding rate in the Brown and Dark Brown soil zones. Cost of seeding for AC Navigator was calculated to be $14.25/acre, with AC Avonlea at $10.81/acre, and Kyle at $9.16/acre.

Table 4.3: Seeding Cost for CWAD Varieties in 2006

	AC Navigator	AC Avonlea	Kyle
Seed Price ($/bu)	9.50	7.21	6.11
Seeding Rate (bu/acre) [i]	1.5	1.5	1.5
Seed Cost ($/acre)	14.25	10.81	9.16

[i] Seeding rate was assumed to be constant at 1.5 bu/acre for all varieties across all soil zones
Source: Duvenaud 2006

The crop price and net price for CWAD varieties are calculated in Table 4.4. The net price is taken as the price of the crop plus the premiums offered by the IPCP for that variety, less the cost of segregation for that variety. Crop price is determined by the relative protein levels of the varieties and were taken as 13.7, 14.2, and 13.9 for AC Navigator, AC Avonlea and Kyle, respectively (SAFRR 2006b). The crop price for AC Navigator was determined to be $6.22/bu, AC Avonlea at $6.28/bu, and Kyle at $6.25/bu (CWB 2006c). The premium offered by CWB for AC Navigator in 2006-07 totalled $4.50/tonne or $0.122/bu, composed of a $2.50/tonne delivery contract premium and a $2.00/tonne production contract premium. The cost of segregation was taken as $1.04/tonne, or $0.03/bu (Huygen *et al*. 2004). This resulted in a net price of $6.31/bu for AC Navigator, $6.28/bu for AC Avonlea, and $6.25/bu for Kyle.

Table 4.4: Price of Grain, Segregation Cost and Net Price of CWAD Varieties in 2006

	AC Navigator	AC Avonlea	Kyle
Protein Content (%) [i]	13.7	14.2	13.9
Crop Price ($/bu) [ii]	6.22	6.28	6.25
Production and Delivery Premium ($/bu) [iii]	0.12	0	0
Gross Price ($/bu)	6.34	6.28	6.25
Segregation Cost ($/bu) [iv]	0.03	0	0
Net Price ($/bu)	6.31	6.28	6.25

[i] Source: SAFRR Varieties of Grain Crops 2006, 2007, 2008
[ii] Source: CWB 2006c
[iii] Source: CWB 2006a and Churko 2009
[iv] Source: Huygen *et al*. 2004

The yields of AC Navigator, AC Avonlea and Kyle are outlined in Table 4.5. The average CWAD yields in 2006 were 35.1 bu/acre in the Brown soil zone, and 36.2 bu/acre in the Dark Brown soil zone (SAFRR 2006b). Yield indices for the Brown and Dark Brown soil zone for AC Navigator and AC Avonlea were identical (106%) and greater than that of Kyle (100%) (SAFRR 2006b).

Table 4.5: Estimated Yield of CWAD Varieties in 2006

	AC Navigator	AC Avonlea	Kyle
Brown Soil Zone (35.1 bu/acre)[i]			
Relative Yield (%)[ii]	106	106	100
Estimated Yield (bu/acre)	37.21	37.21	35.1
Dark Brown Soil Zone (36.2 bu/acre)[i]			
Relative Yield (%)[ii]	106	106	100
Estimated Yield (bu/acre)	38.37	38.37	36.2

[i] Source: SAFRR 2006b
[ii] Source: SAFRR 2006a

The revenue less seed cost (RLSC) of AC Navigator, AC Avonlea and Kyle in the Brown and Dark Brown soil zones in the 2006/07 crop year are displayed in Table 4.6. Revenue less seed cost is calculated as the yield from one acre multiplied by the calculated net price for each variety. The RLSC of AC Navigator is then compared to that of AC Avonlea and Kyle in $/acre and as percent advantage (disadvantage) of the non-IPCP variety. In the 2006-07 crop year, the RLSC of AC Avonlea compared to AC Navigator was $2.14 and $2.13/acre higher in the Brown and Dark Brown soil zones, respectively. The RLSC of Kyle compared to AC Navigator was found to be $10.49 and $10.94/acre lower in the Brown and Dark Brown soil zones, respectively. Differences in RLSC between AC Navigator and AC Avonlea are based on the difference in cost of certified seed, relative protein content, and IPCP crop premium. Of the three varieties, Kyle yielded on average 5% less, which accounts for its lower profitability.

Table 4.6: Calculated Revenue and Benefit of AC Navigator Durum Production vs. Competing Varieties in 2006

	AC Navigator		AC Avonlea		Kyle	
Soil Zone	Brown	Dark Brown	Brown	Dark Brown	Brown	Dark Brown
Net Price ($/bu)[i]	6.31	6.31	6.28	6.28	6.25	6.25
Estimated Yield (bu/acre)[ii]	37.21	38.37	37.21	38.37	35.10	36.20
Revenue ($/acre)	234.95	242.27	235.65	240.98	219.38	226.25
Cost of Seeding ($/acre)[iii]	14.25	14.25	10.81	10.81	9.16	9.16
Revenue Less Seed Cost ($/acre)	220.70	228.03	222.84	230.16	210.21	217.09
vs. AC Navigator ($/acre)[iv]			2.14	2.13	-10.49	-10.94
vs. AC Navigator (%)[iv]			1%	1%	-5%	-5%

[i] Net price is the average price for the wheat variety plus production and delivery premiums less the cost of segregation.
[ii] Estimated yield is the average yield for the soil zone multiplied by the varieties yield index.
[iii] Cost of seeding is at reported prices by Duvenaud (2006) at a seeding rate of 1.5 bu/acre.
[iv] This is the comparison of the RLSC of AC Avonlea and Kyle less the RLSC of AC Navigator.
Source: SAFRR Crop Planning Guide 2006

Three factors affect the RLSC of AC Navigator compared to AC Avonlea; seed cost, relative protein, and relative yield. Protein content and yield are variables dependent on environmental conditions and production inputs. The assumption of similar growing conditions makes their impact on relative profitability moot. A difference in initial seed price is the only variable that can change between the two varieties. Comparing the RLSC between AC Navigator and AC Avonlea shows that if the price of AC Navigator seed were decreased by $1.42/bu (or $1.43/bu for the Dark Brown soil zone) the RLSC would be equal.[20] Since the same seed company markets these two varieties, it can be assumed that the higher cost of AC Navigator is not related to its agronomic traits but to the premium offered by the IPCP program. It can also be assumed that the price premium for AC Navigator seed relates to the other benefits offered to farmers for participation in the IPCP, such as guaranteed acceptance and the escalating storage premium.

[20] The difference in the higher cost of seed due to the seed price premium for AC Navigator between the Brown and Dark Brown soil zones on a per bushel of output is due to the higher yield in the dark brown soil zone. The higher price of seed is calculated by comparing the revenue less seed cost between AC Navigator and AC Avonlea and dividing by the seeding rate.

The profitability of producing AC Navigator is impacted directly by yield, which can vary quite dramatically depending on the year and soil zone. In order to determine the profitability of producing AC Navigator, the distribution of AC Navigator production within Saskatchewan is required to be calculated. Distribution of AC Navigator production was calculated using the CWB Variety Survey (2007 and 2008) and SAFRR Saskatchewan Crop District Crop Production (2007 and 2008). Crop district data was used to estimate CWAD acreage in each crop production zone. Due to crop districts and crop production zones not sharing common borders, crop districts were visually assigned to a crop production zone based on an overlay of crop production zones in crop districts (see Figure 4.1). Crop districts were assigned to crop production zones based on geographic dominance. In Figure 4.1 the crop production zones are represented by the different shades of grey and white numbers in black circles, with crop districts represented by thick black lines and text.

From Figure 4.1, it is estimated that two thirds of Saskatchewan AC Navigator production occurs in crop production zone one, with crop production zone two making up the last third (Table 4.7).[21] It is estimated that production of AC Navigator in Saskatchewan accounted for 432,000 acres in 2007, and 430,906 acres in 2008 (Rosher 2009). Production of AC Navigator remained relatively constant in Saskatchewan even though durum acreage has increased between 2007 and 2008. This resulted in the acreage proportion of AC Navigator decreasing from 10.9% in 2007 to 8.7% in 2008.

[21] Trace amounts of AC Navigator production occurs in Black and Grey soil zones.

Table 4.7: Distribution of AC Navigator Production (% and Acres) in Saskatchewan

	2008		2007		Average	
Soil Zone	% Production	Acres	% Production	Acres	% Production	Acres
Brown	71.6%	308,432	65.2%	281,795	68.4%	295,113
Dark Brown	28.2%	121,706	34.0%	147,046	31.1%	134,376
Black	0.2%	768	0.8%	3,317	0.5%	2,043
Grey	0%	0	0%	0	0%	0
Total	100	430,906	100	432,158	100	431,532

Source: Authors calculation utilizing CWB Variety Survey for Saskatchewan 2007, 2008 and SAFRR: Saskatchewan Crop District Crop Production 2007, 2008.

The overall benefit of producing AC Navigator durum can be estimated based on both its distributional information (Table 4.7), and its relative value (Table 4.6). The distribution of AC Navigator in Saskatchewan could not be determined due to the absence of data for 2006, however it is assumed that 2007 and 2008 are representative of 2006. The average of the distribution over these two years is used to represent the production in 2006 (Table 4.7).[22] The estimated contracted acres are the number of IPCP contracts in Saskatchewan in 2006, assuming a weighted distribution of IPCP contracts based on production. The distributional data combined with the relative profitability (Table 4.6) allow for the total relative profitability of involvement in the AC Navigator IPCP over that of producing the non-IPCP varieties Kyle and AC Avonlea (Table 4.8). The overall benefit to farmers involved in the AC Navigator IPCP compared to Kyle is estimated to be over $2.48 million (a 5% benefit). In contrast, the economic loss for of involvement in the AC Navigator IPCP compared to producing AC Avonlea is $498,789 (a 1% loss).

[22] The Brown and Dark Brown soil zones account for 99.53% of all AC Navigator production. The absence of Black soil zone production values requires the percentages to be proportionally adjusted to 100% to calculate a weighted average.

Table 4.8: Estimated Farmer Benefit of AC Navigator vs. Kyle and AC Navigator vs. AC Avonlea Production in 2006

	AC Navigator vs. Kyle	AC Navigator vs. AC Avonlea
Brown Soil Zone		
Relative Difference in RLSC ($/acre)[i]	10.49	-2.14
% of CWAD acres	69%	69%
Weighted Benefit $/acre	7.24	-1.48
Dark Brown Soil Zone		
Relative Difference in RLSC ($/acre)[i]	10.94	-2.13
% of CWAD acres	31%	31%
Weighted Benefit $/acre	3.39	-0.66
Average Weighted Benefit ($/acre)	10.63	-2.14
Estimated Contracted Acres[ii]	233,079	233,079
Total Benefit (Opportunity Cost) ($)	2,477,630	-498,789

[i] Relative Difference in revenue less seed cost (RLSC) is the RLSC of AC Navigator less the RLSC of Kyle and AC Avonlea

[ii] Source: Authors calculation utilizing Statistics Canada CANSIM Table 001-0017 and CWB Variety Survey 2006 and Rosher 2009.

4.2.2 Case 2: Snowbird and Canadian Western Hard White Spring Wheat

In 2002, a new class of wheat was introduced called Canadian Western Hard White Spring wheat. Initially the class consisted of two varieties Snowbird and Kanata. The varieties were included in the IPCP to take advantage of the marketing opportunities of hard white spring wheat. Of the two varieties, Snowbird was the only commercial success. Even though Kanata has had limited success, it was still included in the program (Hilderman 2009). Agriculture and Agri-food Canada developed snowbird and Kanata with funding support from the WGRF. Quality Assured Seeds (later becoming FarmPure Genetics) license these two varieties, with the IPCP production contracts handled by Patterson Grain.

Hard white wheat is virtually identical to hard red wheat in terms of production requirements, but has a white bran and different milling and product characteristics preferred by the noodle and leavened bread markets (Ransom *et al*. 2006). Market reaction by consumer and processors is favourable due to its appearance and less bitter taste. Hard white wheat allows for the production of a white bread in terms of appearance and taste while maintaining the nutritional characteristics of whole wheat bread (Ransom *et al*. 2006). Asian markets prefer hard white wheat for high-protein noodle and bread products (Ransom *et al.* 2006). Processors demand for hard white wheat centers around the higher extrusion rates, and the lower requirement of additional inputs as that of hard red wheat in order to achieve a marketable whole grain product (Boland and Dhuyvetter 2002).

Hard white wheat may be a new class of wheat for Canada but has an established market and competitors (Janzen and Wilson 2001). Markets for hard white wheat exist in a large number of countries including Canada, United States, Ecuador, Peru, Venezuela, Mexico, Columbia, Chile, Guatemala, Caribbean, Taiwan, Vietnam, Malaysia, Thailand, Singapore, China, Philippines, Pakistan, Indonesia, Sudan, and the United Arab Emirates (Janzen and Wilson 2001). Canada's competitors for hard white wheat are China, South-Asia, the United States, and Australia (Janzen and Wilson 2001). Australia is a major producer of hard white wheat producing a low protein hard white wheat for Asian noodle markets (Ransom *et al*. 2006). Asian markets, however, prefer high protein white wheat (Janzen and Wilson 2001). In order to meet these levels, Australian hard white wheat is blended with high protein red wheat to produce desirable protein levels. The discrepancy between Australia's low protein hard white wheat and the high protein demands of the Asian noodle markets allows their market share to be easily threatened by the high protein CWHWS (Ransom *et al*. 2006). As of 2006, only 20% of the Australian hard white wheat exported to Asian markets was high protein. This represents a 2 million tonne annual market that CWHWS can potentially capture (Worden 2006). The basis for competition in Asian markets is price, quality, and reliability of supply. When compared with other wheat's, CWHWS ranks among the best for the Asian instant noodle, wanton noodle, and cracker markets. It is also suitable for the Asian bread and steamed bread markets (Worden 2006). The CWB's reputation for a consistent supply and high quality wheat has generated international consumer confidence that enhances market penetration.

The Snowbird IPCP has fluctuated through its development, reaching a maximum of 1,095,000 acres in 2005 and a minimum of 160,000 acres in 2009 (Hilderman 2009). Production of CWHWS in 2008 accounted for only 0.6% of all the wheat produced in Western Canada. This small production base had trouble in meeting the IPCP standards. In 2005, nearly one-third (31%) of the CWHWS production was No. 3 wheat and thus unsuitable for the IPCP. Table 4.9 illustrates the distribution of CWHWS production in the three Prairie Provinces. Production decreased between 2006 and 2008 by 82%, most significantly in Saskatchewan (an 89% decrease in acres) compared to Alberta and Manitoba (76% and 77% decrease in acres, respectively). In 2008, Manitoba produced almost half of all CWHWS in Canada (44.2% of CWHWS production), with Saskatchewan and Alberta producing the remainder (27.3% and 28.5% respectively).

Table 4.9: CWHWS Production and Contracted Acres in Western Canada

	CWHWS Production (Acres)[i]				CWHWS Contracts[ii]
Year	Alberta	Manitoba	Saskatchewan	Total	(Acres)
2008	41,070	63,700	39,375	144,145	150,000
2007	45,480	84,100	105,912	235,492	210,000
2006	171,990	277,950	372,070	822,010	565,000

[i] Source: Authors calculation utilizing Statistics Canada CANSIM Table 001-0017 and CWB Variety Survey 2006, 2007, 2008.
[ii] Source: Rosher 2009.

The value of the CWHWS program is relative to the amount of grain moved through the IPCP. Over the seven-year period after its introduction, the CWHWS IPCP has issued 3.17 million acres worth of contracts. The CWHWS program offered a premium of $7.50/tonne for the first two years of operation, later reduced to $2.50/tonne in 2005 and has since remained unchanged (CWB 2003, 2004, 2005c, 2006a, 2008a). From the number of reported CWB IPCP contracts for Snowbird it is estimated that the program has paid out $12.9 million to farmers in the form of premiums (Table 4.10).[23]

Table 4.10: CWHWS Snowbird Contracted Acres and Premium per Tonne in Western Canada

	Contracts	Premium	
Year	Total Acres	$/ tonne	Total ($)
2009	160,000	2.50	400,000
2008	150,000	2.50	375,000
2007	210,000	2.50	525,000
2006	565,000	2.50	1,412,500
2005	1,095,000	2.50	2,737,500
2004	745,000	7.50	5,587,500
2003	245,000	7.50	1,837,500
Total	3,170,000		12,875,000

Source: Rosher 2009

The CWHWS class consists of only IPCP varieties, preventing a comparison between CWHWS varieties that are inside and outside of the IPCP. A comparable class is Canadian Western Red Spring, which is similar to CWHWS in terms of having virtually identical production requirements (Ransom *et al*. 2006). Canadian Wheat Board pricing of CWRS and CWHWS are as two distinct classes, but prices for the same grade and protein content are identical in almost every period. The identical production requirements allow for the assumption that production costs are similar. Thus with identical costs and prices the two classes can be compared as equivalents.

Seed prices for many CWRS varieties were unavailable during the period of 2006-09; this required the creation of a standardized CWRS variety for comparison purposes. The production characteristics (relative yield and relative protein) of the standardized CWRS variety are a weighted average of CWRS varieties according to their proportion of seeded acres in

[23] This is based on the assumption that one acre of land produces one tonne of grain.

Saskatchewan for the 2006-07, 2007-08, and 2008-09 crop years. The price of seed for the standardized CWRS variety was taken from the average seed cost according to the Crop Planning Guide published by SAFRR (2006a, 2007a, 2008a). The pricing of Snowbird is typically \$4.00/bu more than the average seed cost of CWRS varieties (Alderson 2009). Seeding rate was assumed to be 1.5 bu/acre for both the standardized CWRS variety and Snowbird (SAFRR 2006a, 2007a, and 2008a). Table 4.11 outlines the cost of seeding Snowbird and the standardized CWRS variety.

Table 4.11: Seed Costs of Snowbird and the Standardized CWRS Variety

	2006-07		2007-08		2008-09	
	Snowbird	CWRS	Snowbird	CWRS	Snowbird	CWRS
Seed Price (\$/bu)	12.97	8.97	14.05	10.05	16.68	12.68
Seeding Rate (bu/acre)	1.5	1.5	1.5	1.5	1.5	1.5
Seed Cost (\$/acre)	19.46	13.46	21.08	15.08	25.02	19.02

Source: SAFRR 2006a, 2007a, 2008a
Patterson Grain 2009

The price of wheat is a function of grain grade, protein content, and world demand. Grade is dependent upon production practices and condition of grain at time of delivery. Protein content is a function of growing conditions, condition of grain at time of delivery and genetic potential. With the assumption of identical production practices and growing conditions, the only variation in price would be due to the genetic potential. The relative protein level was obtained from the Saskatchewan Varieties of Grain Crops Guide (SAFRR 2006b), and was assumed to remain constant for the duration of the study. Prices for CWRS and CWHWS were identical over the period of 2003 to 2008, allowing for direct comparison between the two classes. The grade of the grain is assumed to be No. 1 CWRS and No. 1 CWHWS. Prices were obtained from the final wheat board payments for No. 1 CWRS and No. 1 CWHWS for 2006 to 2008 at the relative protein content for the varieties. The relative protein content for Snowbird was reported as 14.2 and the standardized CWRS varieties was calculated to be 14.2 in 2007 and 2008, and 14.1 in

2006. In addition to the price of grain, a delivery premium of $2.50/tonne was offered for Snowbird through the IPCP (CWB 2005c, 2006a, and 2008a). The cost of segregation was also included as an additional cost incurred by farmers participating in the IPCP; equal to $0.03/bu. Table 4.12 outlines the relative prices for Snowbird and the standardized CWRS variety.

Table 4.12: Price of Grain, Segregation Cost and Net Price for Snowbird and the Standardized CWRS Variety

	2006-07		2007-08		2008-09	
	Snowbird	CWRS	Snowbird	CWRS	Snowbird	CWRS
Protein Content (%)[i]	14.2	14.1	14.2	14.2	14.2	14.2
Price of Grain ($/bu)[ii]	5.88	5.87	10.21	10.21	7.48	7.48
Premium ($/bu)[iii]	0.07	0	0.07	0	0.07	0
Gross Price ($/bu)	5.95	5.87	10.28	10.21	7.48	7.48
Segregation Cost ($/bu)[iv]	0.03	0	0.03	0	0.03	0
Net Price ($/bu)	5.92	5.87	10.25	10.21	7.52	7.48

[i] Source: SAFRR Varieties of Grain Crops 2006, 2007, 2008
[ii] Source: Price of No. 1 CWRS. CWB Final Payments 2006-07, 2007-08, 2008-09
[iii] $2.50/tonne delivery premium converted at 36.74 bu/tonne
[iv] $1.02/tonne segregation cost converted at 36.74 bu/tonne

Crop production was examined in the three Saskatchewan soil zones: Brown, Dark Brown and Black. Crop yields were obtained from SAFRR for spring wheat in the three soil zones for the period of 2006 to 2008 (SAFRR 2006a, 2007a, 2008a). Expected yields of varieties were obtained from the Saskatchewan Variety of Grain Crops (2006b) and assumed to remain constant over the duration of this study. The expected yield for Snowbird compared to the standardized CWRS variety was reported to be 99% for the Brown and Dark Brown soil zones, and 102% for the Black soil zone. The weighted average yield adjustment for CWRS was calculated on a year by year basis for the three soil zones, resulting in a variation in relative yield for all three production years (Table 4.13).

Table 4.13: Estimated Yield of Snowbird and Standardized CWRS Variety

	2006-07		2007-08		2008-09	
	Snowbird	CWRS[i]	Snowbird	CWRS[i]	Snowbird	CWRS[i]
Brown Soil Zone Yield (bu/acre)	24.7	24.7	26.0	26.0	26.9	26.9
Relative Yield (%)	99	99.7	99	100.3	99	100.5
Estimated Yield (bu/acre)	24.5	24.6	25.7	26.1	26.6	27.0
Dark Brown Soil Zone Yield (bu/acre)	36.4	36.4	30.7	30.7	31.7	31.7
Relative Yield (%)	99	99.7	99	100.3	99	100.5
Estimated Yield (bu/acre)	36.0	36.3	30.4	30.8	31.4	31.9
Black Soil Zone Yield (bu/acre)	36.0	36.0	36.4	36.4	37.5	37.5
Relative Yield (%)	102	99.68	102	99.4	102	99.5
Estimated Yield (bu/acre)	36.7	35.9	37.1	36.2	38.3	37.3

[i] The standardized CWRS variety % yield is the weighted average for CWRS varieties
Source: SAFRR 2006a, 2007a, 2008a

The overall benefit to farmers from the Snowbird IPCP is dependent on the yield and protein content of the grain, which in turn is influenced by the soil type and environmental conditions during the growing season. Table 4.14 outlines the distribution of CWHWS acres across the four Saskatchewan crop production zones. Production of CWHWS in Saskatchewan has dominantly been in the Brown soil zone, accounting for 73.5% of the production in 2008, and 46.8% of the production in 2007. Estimated seeded acres of CWHWS in Saskatchewan in 2008 was 39,790 acres (0.3% of acres seeded to wheat in Saskatchewan) which is a decrease by 63% from 2007 when 107,083 acres were seeded (0.9% of acres seeded to wheat in Saskatchewan). The decrease in CWHWS production occurred across all soil zones except in the Grey soil zone; where production remained relatively stable (4,134 acres in 2008 and 4,073 acres in 2007). Crop districts were aligned with soil zones according to Figure 4.1 for the estimation of the distribution of CWHWS production.

Table 4.14: Distribution of CWHWS Snowbird Production (% and Acres) in Saskatchewan

	2007		2008	
Soil Zone	% Production	Acres	% Production	Acres
Brown	46.8	50,165	73.5	29,216
Dark Brown	32.2	34,515	15.8	6,281
Black	17.1	18,329	0.4	159
Grey	3.8	4,073	10.4	4,134
Total	100	107,083	100	39,790

Source: Authors calculation utilizing CWB Saskatchewan Variety Survey 2007, 2008
SAFRR: Saskatchewan Crop District Crop Production 2007, 2008

The revenue less seed cost (RLSC) of Snowbird over the standardized CWRS variety demonstrates the per acre advantage or disadvantage of involvement in the Snowbird IPCP to an average farmer in each of the three soil zones (Table 4.1). Yield played an important role in determining the relative profitability of Snowbird. The lower grain yield of Snowbird compared to the standardized CWRS variety in the Brown and Dark Brown soil zones plus the higher initial cost in seed (relative profitability on average of -2.8% and -3.3% respectively, Table 4.15) was greater than the market premiums returned to farmers. The Black soil zone appeared to provide yields that compensated for the increase in seed price, providing an average benefit over the three years of 0.6% above the standardized CWRS variety. With these results an average farmer in the Brown and Dark Brown soil zones would not be able to benefit from participation in the Snowbird IPCP as the premium offered by the CWB was insufficient to overcome the costs of involvement in the program (seed price and segregation cost).

The measurement of the total benefit of participating in the IPCP is relative to the opportunity cost of engaging in another activity, growing a CWRS variety. With the difference in RLSC being the measure of opportunity cost of involvement in the IPCP, the total opportunity cost for representative Saskatchewan farmers involved in the IPCP in 2006, 2007 and 2008 is outlined in Table 4.16. Grey soil zone production was grouped with the Black soil zone as production data was unavailable. Since Snowbird production in 2006 is unknown it was assumed to be the same as that in 2007. The difference in RLSC was weighted across the soil zones based on percentage of CWHWS acres, providing a weighted average difference in RLSC.

Table 4.15: Calculated Revenue and Benefit of Producing Snowbird CWHWS Compared to a Standardized CWRS variety in Saskatchewan

	2006-07		2007-08		2008-09	
	Snowbird	CWRS[iii]	Snowbird	CWRS[iii]	Snowbird	CWRS[iii]
Brown Soil Zone						
Net Price	5.95	5.87	10.25	10.21	7.52	7.48
Yield	24.5	24.6	25.7	26.1	26.6	27
Revenue	145.04	143.82	266.5	265.46	202.288	201.212
Seed Cost	19.46	13.46	21.08	15.08	25.02	19.02
RLSC ($/acre)[i]	125.58	130.36	245.42	250.38	177.27	182.19
Difference in RLSC ($/acre) [ii]	-4.78		-4.96		-4.92	
Difference in RLSC (%)	-3.7%		-2%		-2.7%	
Dark Brown Soil Zone						
Net Price	5.95	5.87	10.25	10.21	7.52	7.48
Yield	36	36.3	30.4	30.8	31.4	31.9
Revenue	213.12	213.08	311.60	314.47	236.13	238.61
Seed Cost	19.46	13.46	21.08	15.08	25.02	19.02
RLSC ($/acre) [i]	193.66	199.60	290.52	299.39	211.11	219.59
Difference in RLSC ($/acre) [ii]	-5.94		-8.87		-8.48	
Difference in RLSC (%)	-3%		-3%		-3.9%	
Black Soil Zone						
Net Price	5.95	5.87	10.25	10.21	7.52	7.48
Yield	36.7	35.9	37.1	36.2	38.3	37.3
Revenue	217.26	210.73	280.28	369.60	288.02	279.00
Seed Cost	19.46	13.46	21.08	15.08	25.02	19.02
RLSC ($/acre) [i]	197.80	197.25	359.20	354.52	263.00	259.98
Difference in RLSC ($/acre) [ii]	0.55		4.67		3.01	
Difference in RLSC (%)	0.3%		1%		1.2%	

[i] Revenue less seed cost (RLSC)
[ii] Difference in RLSC is the RLSC of Snowbird less the RLSC of the standardized CWRS variety.
[iii] Standardized Canadian Western Red Spring Wheat variety is a weighted average for all CWRS varieties.

Table 4.16: Estimated Farmer Benefit of CWHWS Production Compared to a Standardized CWRS Variety in Saskatchewan

	2006	2007	2008	Total
Brown Soil Zone				
Difference in RLSC ($/acre)	-4.78	-4.96	-4.92	
Percent of CWHWS Acres	46.8	46.8	73.5	
Weighted Difference	-2.24	-2.32	-3.62	
Dark Brown Soil Zone				
Difference in RLSC ($/acre)	-5.94	-8.87	-8.48	
Percent of CWHWS Acres	32.2	32.2	15.8	
Weighted Difference	-1.91	-2.86	-1.34	
Black Soil Zone[i]				
Difference in RLSC ($/acre)	0.55	4.67	3.01	
Percent of CWHWS Acres	20.9	20.9	10.8	
Weighted Difference	0.11	0.98	0.33	
Average Weighted Benefit ($/acre)	-4.04	-4.20	-4.63	
Estimated Contracted Acres	372,070	105,912	39,375	517,357
Relative Profitability	-1,503,163	-444,830	-182,306	-2,130,299

[i] The Black soil zone includes production in the Grey soil zone

[ii] Difference in revenue less seed cost (RLSC) is the difference between the RLSC of Snowbird less the RLSC of the standardized CWRS variety

The estimated opportunity cost of involvement in the CWHWS IPCP for a representative Saskatchewan farmer is overwhelmingly negative. The price premium of Snowbird certified seed, which was $4.00/bu over other CWRS varieties, more than compensates for both the premium offered by the CWB and the yield and protein advantages of Snowbird. The estimated average weighted benefit for producing Snowbird decreased in absolute value over the three year period from -$4.04/acre in 2006 to -$4.63/acre in 2008. The decrease in absolute value was a result of acreage shifting to the Brown soil zone, from the Dark Brown and Black soil zones. Yield appeared to be the determining factor where snowbird was marginally lower than CRS yield. A yield improvement of 3-4% for Snowbird would result in producers being indifferent between producing the Snowbird IPCP and the standardized CWRS variety. The estimated total accumulated opportunity cost for representative Saskatchewan farmers involved in the Snowbird IPCP from 2006 to 2008 is around $2.13 million (an accumulated opportunity cost of 2.05%). It is important to note that this opportunity cost is not what was actually experienced by

Saskatchewan farmers, but a projection of the profitability of involvement in the CWHWS IPCP by a representative Saskatchewan farmer.

4.3 Limitations of the Empirical Model

The empirical analysis required the use of weak data and many assumptions in order to provide insight into the exertion of market power by the seed industry. The data used in the study was limited by only providing a snapshot of seed prices at a few locations, which may not provide an accurate representation of actual average certified seed prices. Stronger panel data would have provided seed prices that was more directly comparable. The comparison of profitability required the alignment of crop production zones to soil zones, resulting in inaccuracies in acreage assigned to soil zones and the total benefit (opportunity cost) of farmer participation in the IPCP. As well, the production of AC Navigator was both within and outside of the IPCP preventing an accurate estimation of where production occurred.

4.4 Summary

The objective of this chapter was to compare the relative profitability of Snowbird and AC Navigator to non-IPCP varieties. The basis of comparison was on the assumption of a representative Saskatchewan farmer would participate in the IPCP in each of the three soil zones. In both cases, the initial cost of seed for AC Navigator and Snowbird exceeded the IPCP premiums and agronomic trait advantage of the varieties with respect to non-IPCP varieties. As such, farmer participation in the IPCP must be either by farmers with above average ability to produce the grain, or compensated by other benefits made available through the IPCP. Chapter five will delve into the policy implications of the price premium on rent distribution of the IPCP.

CHAPTER 5
RESULTS, DISCUSSION AND CONCLUSION

5 Results, Discussion and Conclusion

With the development of the Identity Preserved Contract Program (IPCP) the Canadian Wheat Board (CWB) was able to create an identity preservation (IP) system for Canadian wheat. The IPCP creates an opportunity for farmers to increase their revenue through diversification and an opportunity to produce a product that commands a premium from the market. Marketing programs such as the IPCP are vulnerable to the exertion of market power by critical agricultural input suppliers extracting the majority of the rents. The objective of this study was to model and examine the distribution of rents within the IPCP where input suppliers possess significant market power. The hypothesis was that seed companies are exerting market power within the IPCP and extracting the majority of the rents. When examining the IPCP the majority of the results indicated that, a farmer getting average yields and selling the grain at an average price would likely not receive sufficient compensation in the form of a premium to cover the increased seed costs (see chapter four). As well, the presence of a production constraint increases the ability of a seed company with market power to extract premiums provided to farmers participating in the IPCP (see chapter three). Overall, the combination of policies and market power of the seed industry resulted in the IPCP having limited profitability for representative Saskatchewan farmers as the seed industry captures the premium offered to farmers by the IPCP. The results of the theoretical and empirical model prevent the rejection of the hypothesis of this thesis. This indicated that the seed companies are extracting the majority of the rents, leaving little of the premium for the representative Saskatchewan farmer.

This section continues to discuss the results of the theoretical and empirical analysis, drawing conclusions from the results. Followed by an examination of the limitations of this study, as well as providing suggestions for further research.

5.1 Theoretical Model

The theoretical model examined the impact of constrained production and market development activities on rent distribution between farmers and the seed industry under a variety of different seed ownership structures. Two scenarios of the theoretical model represent the IPCP; scenario two with the policy of constraining production, and scenario four with the policies of constrained production and market development activities. The purpose of the theoretical model was to determine the presence of incentives for the marketer to engage in market development activities with the goal of increasing farmer welfare.

The base case and scenario three (market development activities in the absence of a production constraint) illustrate the impact of market power on consumer and farmer welfare. In the base case total economic surplus is maximized in the absence of market power by the seed industry (the perfectly competitive case), and minimized in the presence of a monopoly. Exertion of market power by the seed industry results in a restricted supply of seed, which results in the transfer of consumer and producer surplus of IP grain to the seed company. In scenario three, the introduction of market development activities demonstrates that a monopolistic seed ownership structure results in the seed industry capturing half of the premium generated by the market development activities, with the rest of the premium distributed between consumers and farmers dependent on their relative slope coefficients.

The introduction of the production constraint amplified the ability of the seed industry to extract rents from the market. In the case of a seed industry that has a monopolistic or a concentrated oligopolistic ownership of varieties (where $\delta > \lambda$), farmer and consumer welfare were seen to increase as a result of the constrained production quantity being greater than the unconstrained quantity. In cases where market power of the seed industry was low, perfectly competitive or competitive oligopoly seed industry (where market power was below equation (3.51), farmer producer surplus was shown to decrease but provided a greater opportunity for participating farmers to extract rents from the system. Consumers obtained the least benefit from this policy, showing a redistribution of consumer surplus to farmers and seed industry when faced with a perfectly competitive or competitive oligopoly seed ownership structures. Introduction of the production constraint results in sub-optimal profits for the seed industry, reducing the rents the seed company could extract. Farmer welfare was shown to increase as a result of the implementation of the production constraint in the presence of market power being exerted by the seed industry. However, farmer welfare decreased in the absence in market power exerted by the seed industry. From a policy perspective, the implementation of the production constraint succeeded in increasing farmer welfare (producer surplus of IP grain) in the presence of a seed industry exerting market power.

The introduction of market development activities with constrained production resulted in a variety of welfare effects. With the assumption that consumers are price takers, the price premium generated by the market development activities is divided between the seed company and farmers, relative to their degree of market power. Oligopoly or monopolistic seed ownership structures resulted in the majority of the price premium being captured by the seed industry, as illustrated in equation (3.76). The production constraint allows for the market development activities to have a greater impact on farmer welfare when presented with a competitive oligopoly or perfectly competitive seed ownership structure. In a case where there is an oligopolistic seed ownership structure the introduction of the market development activities increases the ability of farmers to benefit from participating in the IPCP, comparing equation (3.90) to equation (3.45). From a policy perspective the implementation of market development activities on a constrained production will have limited success as farmer welfare may not increase where the seed industry is exerting market power and extracting the majority of the premium. In conclusion farmers in an IPPM system that is faced by a seed industry with a high degree of market power will receive little benefit from market development activities that improve the market premium.

The uneven distribution of rents within an IPPM system can be addressed through two methods; cost sharing and vertical integration. Cost sharing between the marketer and seed industry allows the correlation between the distribution of cost for market development activities and the distribution of benefits from the elicited premium. Vertical integration provides ownership over the marketing activities by the seed company, or variety ownership by the marketer. Seed industry vertical integration results in the formation of a private IPPM system where the seed industry forms production contracts with farmers and markets the product. This situation would result in the monopoly solution as seen in scenario two and four, where the seed industry captures the entire benefit of market development activities as well as covers the cost of the IPPM system and costs of market development activities. Vertical integration by the marketer proposed in this study would result in the perfectly competitive solution for scenario two and four, where farmers would be able capture the majority of the benefit from market development activities, less the additional costs of licensing and seed multiplication.

Development of IPPM systems in the presence of a high degree of market power possessed by the seed industry significantly influences rent distribution between participants as well as providing disincentives for market development activities. Addressing the discrepancies between distribution of market development costs and the extraction of rents results in the removal of the disincentives and increases the profitability for all participants in the IPPM system.

5.2 Empirical Analysis

The two case studies of the empirical analysis (AC Navigator and Snowbird) provided evidence of the exertion of market power by the seed industry. The varieties examined represent scenario four of the theoretical model of having constrained production with market development activities. The case of AC Navigator examined the difference in industry structure on seed pricing, providing insight into the pricing decision between two comparable varieties with the same ownership structure, as well as between a monopolistic and oligopolistic ownership structure. The Snowbird case compared the IPCP variety to a non-IPCP variety over a three-year period to examine the impact of changes in grain prices and yield on the relative profitability of involvement in the IPCP.

5.2.1 AC Navigator

This study examined 2006 survey price data for AC Navigator, AC Avonlea, and Kyle. The three varieties demonstrated the three different marketing structures; a monopoly IPCP variety (AV Navigator), a monopoly non-IPCP variety (AC Avonlea), and a competitive oligopoly variety (Kyle). The comparison of AC Navigator to AC Avonlea, and to Kyle, demonstrated the pricing behaviour of the seed industry. The comparison between AC Navigator and AC Avonlea follows the model of a monopolistic seed industry, as Viterra owns both varieties, allowing for a comparison between similar varieties that are under a similar pricing structure. The variety Kyle is under an oligopolistic ownership structure allowing for its comparison with AC Navigator to show the impact of a monopolistic ownership on seed price.

The comparison between AC Navigator and AC Avonlea allows for the examination of the influence of the IPCP on variety pricing. With both varieties owned by Viterra, a similar pricing formula of varieties can be assumed. AC Navigator's lower protein level and increased cost of seeding resulted in a decrease in profitability found to be greater than the delivery and production premiums offered by the IPCP. The opportunity costs of a representative Saskatchewan farmer involved in the AC Navigator IPCP, instead of growing AC Avonlea, was found to be $2.14/acre or 1% of revenue less seed cost (RLSC) (from Table 4.6). Based on the opportunity costs, AC Navigator seed can be reasonably assumed to be overpriced by $1.43/bu. From these results, the seed industry is shown to be exerting market power, resulting in a price of certified seed that is greater than the premiums offered by the AC Navigator IPCP where a farmer receiving average yields and prices. As a result, the null hypothesis cannot be rejected in this case.

The comparison between AC Navigator and Kyle illustrates the influence of different seed ownership structures on profitability of involvement in the IPCP vs. that of a conventional well-established variety. In 2006, a representative Saskatchewan farmer participating in the AC Navigator IPCP would have received $10.63/acre more than what they would have received if they had purchased and planted Kyle. This provided a measurement of the total rents that were made available to farmers as a result of participating in the AC Navigator IPCP, where cumulative involvement by representative Saskatchewan farmers would have resulted in a benefit of $2.75 million. These results fall in line with reports by farmers being able to achieve a benefit of $14/acre from involvement with the AC Navigator IPCP (CWB 2005a). This case results in the rejection of the hypothesis as farmers extract rents from the system.

The AC Navigator case illustrates the impact of a release of the variety outside of the IPCP. Viterra controls all AC Navigator production, where production outside of the IPCP is under a different production contracts. A wider release allows for varieties that are agronomically competitive to have a higher value to the seed company by being able to compete for a greater market share. The comparison between AC Navigator and Kyle, where a representative Saskatchewan farmer is able to obtain $10.63/acre more revenue illustrates either that the presence of a non-limited release of AC Navigator resulted in a lower price, or that the certified seed price of Kyle is underpriced, or that some variable was not included in the variety valuation.

Comparison between AC Navigator and other contemporary durum varieties (AC Avonlea) demonstrates price premium offered by the IPCP does not compensate for the higher price of seed. In cases where AC Navigator is compared to older varieties (Kyle) its yield and quality improvements assist in overcoming the higher seed price, irrespective of the presence of the price premium. This creates a caveat for the null hypothesis posed by this study. The hypothesis cannot be rejected when compared to current varieties, but must be rejected when compared to older established varieties.

5.2.2 Snowbird

The study examined the relative profitability of Snowbird over a period of 3 years, measuring the impact of its production characteristics relative to a standardized Canadian Western Red Spring (CWRS) variety. Three variables influenced relative profitability: standard protein content, relative yield, and relative seed prices. Over the three-year period, the higher price of seed resulted in lower profitability for farmers participating in the CWHWS IPCP who receive average yields and average prices. The results showed that the price of Snowbird seed to be overpriced by $2.74/bu. The overpricing of seed resulted in a 3% lower profitability to a representative Saskatchewan farmer from participating in the Snowbird IPCP when compared to the standardized CWRS variety.

Yield improvements were closely tied to profitability, as indicated by the different soil zones. Yields in the Black soil repeatedly showed to be able to compensate for the higher cost of seeding through greater yields than that of the Brown or Dark Brown soil zones. With production of CWHWS primarily found in the Brown and Dark Brown soil zones, the areas reported with the lowest average yield, geographic participation in the IPCP is centered around specific Patterson Grain delivery points and not the areas where production would be the most profitable. The persistence of the CWHWS IPCP in the Brown and Dark Brown soil zones demonstrates that there is some benefit conveyed to farmers beyond relative yield, relative protein and the IPCP premium.

The relative decrease in profitability to an average farmer from involvement in the Snowbird IPCP in 2006 was underestimated because actual reported production of CWHWS was 30% greater than that contracted by the CWB, resulting from low quality grain. Insufficient data of the distribution of substandard IPCP Snowbird grain prevents an accurate estimation due to the associated loss. The total estimated cost of a farmer being unable to sell CWHWS in the IPCP is equal to the increase in seeding cost of $6.00/acre and the loss of the $2.50/tonne contract premium, resulting in an estimated additional loss of $8.50/acre, excluding the expected differences in price between No. 3 wheat and No. 1 or No. 2 .[24]

[24] Assuming 1 acre of land produces 1 tonne of grain.

The difference in profitability for the involvement in the Snowbird CWHWS IPCP compared to standardized CWRS variety was consistently negative for all three years. The average difference in profitability, including the delivery premium, ranged between $-3.83 to $-6.08/acre. The consistent relative decrease in profitability for the involvement of a representative Saskatchewan farmer in the Snowbird CWHWS IPCP does not allow for the hypothesis set out by this study to be rejected.

5.3 Conclusions and Implications of the Study

The CWB achieved its goals for the IPCP by creating an IP program for Western Canadian farmers, but showed limited ability to prevent rents intended for farmers extracted by upstream participants. The empirical analysis showed that for both Snowbird, a CWHWS variety, and AC Navigator, a CWAD variety, that the seed companies were charging a premium for certified capturing most of the rents. Thus, there is limited profitability for a representative Saskatchewan farmer to be involved in these two programs, where the direct benefit of involvement is close to zero. Attribution to the increase in cost of certified seed for IPCP varieties can be made to the production contract, the CWB IPCP premium, limited release of the IPCP varieties, and other benefits from involvement in the IPCP. As a result, the price of certified seed for IPCP varieties is linked to the IPCP premium, and its removal/absence should result in little impact on farmer welfare, providing the absence of the premium would result in an equivalent decrease in price of certified seed.

The theoretical model illustrated what was occurring in the empirical model. Both IPCP varieties were represented by scenario four; production constraint with market development activities. Seed company market power arises from the ownership/licensing of varieties, allowing the seed company to extract the IPCP premium from farmers. The introduction of the IPCP premium resulted in little or no increase in farmer welfare, as seed companies extracted the premium. Market development activities primarily benefit the owners (licensers) of the seed varieties, creating little incentive for the CWB to conduct market development activities in the name of increased farmer returns. The results of the empirical analysis concurred demonstrating that seed companies were potentially extracting $12.9 million worth of premium from the CWHWS IPCP, and $8.8 million worth of premium from the AC Navigator IPCP.

A major constraint for farmer profitability lies within the production contracts requiring farmers to utilize certified seed and to sell all of the grain produced to the seed company. Removal of these clauses would allow farmers to keep and utilize saved seed for future year's production, allowing the cost of certified seed to be amortized over a number of years. The removal of the clauses increases the value of certified seed to farmers, allowing for a higher generation of revenue off a single purchase of certified seed. The increase in value to farmers would be expected to result in an even higher cost of certified seed, allowing the seed industry to capture some of the benefit of saved seed. The increase in certified seed cost from the removal of the clauses would still be limited from the deterrence of farmers entering in the IPCP, lessening farmer participation and the market for the varieties seed. An alternate solution is to address the ownership issue of IPCP seed varieties. If a public institution (or benevolent third party) maintained ownership, seed industry market power would abate, allow the IPCP premium to be captured by farmers.

Identity preserved production and marketing systems require a balance of obligations and incentives to operate properly. The absence of the premium offered to farmers by the CWB, could cause an impact in other sectors involved in the IPCP, by decreasing the amount of rents available for upstream participants to extract. As previously discussed, an absence of sufficient incentives could result in failure of the IPCP. The extraction of the farmer premium by the seed industry may satisfy the seed companies rent distribution requirement, compensating other supply chain activities that they are involved in, or to compensate for the limited release for the variety. As such, the farmer premium may play an important role satisfying seed company compliance and participation, but fails to improve the profitability for a representative Saskatchewan farmer participating in the IPCP.

5.4 Limitations of the Study

The study limited ultimately by the availability of seed price data, and distributional data for farmer involvement in the IPCP. Improved data would allow for a better estimation of the total transfer of rents from the CWB to farmers and from farmers to seed companies. The study is also limited in its scope by only examining two IPCP varieties, as well as having poor benchmarks for comparison. Additionally, the farmer examined in this study is assumed to have average yields and prices, which may not be reflective of the farmers that self selected to participate in the IPCP. Because of these limitations, an accurate estimation cannot be made of the exertion of market power by seed companies on farmers participating in the IPCP.

5.5 Suggestions for Further Study

This study provides groundwork for further study into the exertion of market power by the seed industry on farmers involved in IPPM systems. The policies of an IPPM system provide the framework for its operation, as well as providing incentives for participation by all members of the agricultural supply chain. The inclusion or removal of a single policy can have drastic effects on the distribution of rents within the system possibly resulting in a system failing to meet its goals by providing insufficient incentives to one sector of the supply chain.

The benefit to farmers involved in the CWB's IPCP go beyond that of the per tonne premium offered. Farmers are presented with other opportunities to increase or stabilize their revenue, such as escalating on-farm storage premiums and the guaranteed acceptance. Taking into account these other factors, the benefit to farmers from involvement in the IPCP could be greater than that estimated in this study. As a result, the measurements conducted to detect the exertion of market power by seed industries may weaken the results, demonstrating that the seed company may not extract all of the rents but only the majority of the rents.

Further research can examine the impact of removal or inclusion of policies into an IPPM system similar to the IPCP. The farmer premium can influence seed industries willingness to participate in an IPPM system. This incentive increases in importance when the variety being included can compete agronomically with conventional varieties. As well, the inclusion of the premium may provide compensation for other activities the seed company engages in, resulting from their vertically integrated into the agricultural supply chain.

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7 Appendix A: Canadian Grain Grading System

The Canadian grain grading system segregates grain into different groups by meeting certain standards. Canadian wheat is grouped into seven classes each consisting of five different grades No. 1, No. 2, No. 3, No.4 and feed, and then within the grades by protein content (measured at the 13.5% moisture content), excluding feed wheat. The grain grading system's purpose is to facilitate transactions by balancing customer expectations and returns to producers, as well as preserving the quality of individual parcels of grain (Canadian Grain Commission, 2009b).

The grading of grain is determined along five characteristics: test weight, varietal purity, soundness, vitreousness, and presence of foreign material (not including dockage). Each grade of grain is dependent on the minimum standards for the grain, creating a range of quality attributes within grades. The characteristics are measured either visually or mechanically. All characteristics are measured after dockage is removed as defined by the cleaning procedures for each class of grain. The test weight is a measure of the un-compacted grain measured in kg/hl. Varietal purity measures the presence of grain of contrasting classes and wheats of other classes. Contrasting classes are classes that have a different colour of wheat, while wheats of other classes or varieties can be of other classes that can blend. Soundness pertains to maturation of the grain and the condition of the grain in terms of damage (broken or shrunken seed, as well as disease). Vitreousness is the translucent appearance of the grain associated with high protein and hard kernels, and influenced by the class of wheat and the growing conditions.

Table 7.1 provides an example of the Canadian grain grading system for Canadian Western Hard White Spring wheat.

Table 7.1: Grain Grading for CWHWS

	Standard of quality				Foreign material					
Grade name	Minimum test weight kg/hl (g/0.5L)	Variety	Minimum protein %	Degree of soundness	Ergot %	Excreta %	Matter other than cereal grains %	Sclerotinia %	Stones %	Total %
No.1 CWHWS	75 (365)	Any variety of the class CWHWS designated as such by order of the Commission	10	Reasonably well matured, reasonably free from damaged kernels	0.01	0.01	0.2	0.01	0.03	0.6
No. 2 CWHWS	75 (365)	Any variety of the class CWHWS designated as such by order of the Commission	No minimum	Fairly well matured, may be moderately bleached or frost-damaged, reasonably free from severely damaged kernels	0.02	0.01	0.3	0.02	0.03	1.2
No. 3 CWHWS	72 (350)	Any variety of the class CWHWS designated as such by order of the Commission	No minimum	May be frost-damaged, immature or weather-damaged, moderately free from severely damaged kernels	0.04	0.015	0.5	0.04	0.06	2.4
No. 4 CWHWS	68 (330)	Any variety of the class CWHWS designated as such by order of the Commission	No minimum	May be severely frost-damaged, immature or weather-damaged, moderately free from other severely damaged kernels	0.04	0.015	0.5	0.04	0.06	2.4
CW Feed	65 (315)	Any class or variety of wheat excluding amber durum and General Purpose	No minimum	Reasonably sweet, excluded from other grades of wheat on account of damaged kernels	0.1	0.03	1	0.1	0.1	10

	Wheats of other classes or varieties		Artificial stain, no residue %	Dark, Immature %	Degermed %	Fireburnt %	Fusarium damage %	Grass green %	Grasshopper, army worm %	Heated	
Grade name	Contrasting classes %	Total %								Binburnt, severely mildewed, rotted, mouldy %	Total %
No.1 CWHWS	3	3	Nil	1	4	Nil	0.25	0.75	1	1 kernel per 1000 g	0.05
No. 2 CWHWS	3	3	5K	2.5	7	Nil	1	2	3	4 kernels per 1000 g	0.4
No. 3 CWHWS	5	5	10K	10	13	Nil	2	10	8	6 kernels per 1000 g	1
No. 4 CWHWS	5	5	10K	10	13	Nil	2	10	8	6 kernels per 1000 g	1
CW Feed	No limit-but not more than 10% amber durum and/or General Purpose		2	No limit	No limit	2	5	No limit	No limit	2.5	2.5

Source; Canadian Grain Commission 2009b