Modeling Withdrawal from AgriStability by Ontario Beef Farmers: An Application of Prospect Theory

By

Emma Ferner

A Thesis
Presented to
The University of Guelph

In partial fulfillment of requirements
for the degree of
Master’s of Science
in
Food, Agricultural, and Resource Economics

Guelph, Ontario, Canada

© Emma Ferner, June 2016
ABSTRACT

MODELING WITHDRAWAL FROM AGRISTABILITY BY ONTARIO BEEF FARMERS: AN APPLICATION OF PROSPECT THEORY

Emma Ferner
University of Guelph, 2016
Advisor: Assistant Professor Ying (Jessica) Cao

AgriStability is a government insurance program that protects producers against agricultural risk, and triggers payments based on a historical moving average of the whole-farm profit margin. Though the program fees are highly subsided, participation in the program has been declining over the past decade. This study uses the longitudinal Ontario Farm Income Database (OFID) to investigate Ontario beef farmers' participation behavior in response to farm-level income fluctuations, program payments, farm characteristics, and policy changes between 2003 and 2013. Prospect theory is used to model farmers’ perceived gain and losses, and their resulting withdrawal behavior. Results indicate that larger AgriStability and ad hoc program payments decrease the likelihood of withdrawal, two years of not receiving a payment increases likelihood of withdrawal, and lager farms are more sensitive to changes in net income than program payments. The study aims to provide insight into how farmers perceive and utilize government-funded risk management programs.
ACKNOWLEDGEMENTS

Thank you to my supervisor Dr. Jessica Cao for your guidance and support throughout the entire research process, and to my co-advisor Dr. Alfons Weersink for your invaluable feedback and encouragement, especially near the end. To all the professors in the Department whose courses I attended, thank you for far exceeding my expectations of the program and providing excellence in both teaching and mentorship. I would also like to thank Dr. Nicoleta Uzea from the Ivey Business School for her interest and input in my project.

None of what we do at FARE would be possible without our back-bone, so thank you to Kathryn Selves, Debbie Harkies, and Pat Fleming for all you do behind the scenes. Thank you to my FARE cohort for fostering an environment of encouragement and respect, and especially to those of you who I lived with or who regularly provided me meals – I'll get you back for all the pep talks one day.

Thank you to my family, near and far, for your constant love and confidence in me as a student. Finally, I would like to thank my partner Dave for your infinite patience and wisdom, not to mention that you moved across the world to support me in my pursuit of this degree. For you, I am forever grateful.
# Table of Contents

ABSTRACT .......................................................................................................................... ii

ACKNOWLEDGEMENTS ...................................................................................................... iii
List of Figures ......................................................................................................................... vi
List of Tables ......................................................................................................................... vii

CHAPTER 1: INTRODUCTION ............................................................................................. 1
  1.0 Introduction .................................................................................................................. 1
  1.1 The Problem of Withdrawal from AgriStability ......................................................... 6
  1.2 Purpose and Objectives .............................................................................................. 9
  1.4 Thesis Outline ............................................................................................................ 10

CHAPTER 2: THE ONTARIO BEEF AND CATTLE SECTOR .......................................... 12
  2.0 Chapter Introduction .................................................................................................. 12
  2.1 Industry Trends and Farm Characteristics ................................................................ 12
  2.2 Sector Challenges and Opportunities ....................................................................... 14
  2.3 Risk Management in the Beef Sector ....................................................................... 16
  2.4 Chapter Summary .................................................................................................... 18

CHAPTER 3: RISK AND AGRICULTURE ......................................................................... 19
  3.0 Chapter Introduction .................................................................................................. 19
  3.1 Uncertainty and Risk in Agriculture ......................................................................... 19
    3.1.2 Sources of Risk in Agricultural Production ....................................................... 20
    3.1.3 Responses to Risk in Agricultural Production ................................................. 21
    3.1.4 Government Intervention in Agricultural Risk Markets ................................... 22
  3.2 History of Risk Management Policy in Canadian Agriculture ................................... 24
  3.3 Current Risk Management Programs Overview ....................................................... 26
    3.3.1 AgriStability Overview ..................................................................................... 28
    3.3.2 An Example of the AgriStability Mechanism .................................................... 32
    3.3.3 The Effectiveness of Government Risk Management Programs ..................... 34
  3.4 Chapter Summary .................................................................................................... 35

CHAPTER 4: CONCEPTUAL FRAMEWORK ..................................................................... 37
  4.0 Chapter Introduction .................................................................................................. 37
  4.1 The Expected Utility Framework ............................................................................. 38
    4.1.1 Previous Literature ......................................................................................... 38
    4.1.2 Expected Utility Theory .................................................................................. 40
  4.2 An Alternative Model of Choice Under Uncertainty ................................................. 41
  4.3 Overview of Prospect Theory .................................................................................. 42
  4.4 Relevant Applications of Prospect Theory ................................................................ 45
  4.5 Applying Prospect Theory to the Problem of Withdrawal from AgriStability ......... 46
    4.5.1 Deriving Testable Hypotheses ........................................................................ 48
  4.6 Chapter Summary .................................................................................................... 52

CHAPTER 5: DATA AND VARIABLE DESCRIPTION ......................................................... 54
  5.0 Chapter Introduction .................................................................................................. 54
  5.1 The Ontario Farm Income Database ........................................................................ 54
  5.2 Variable Definition .................................................................................................... 60
    5.2.1 Dependent Variable ......................................................................................... 60
    5.2.2 Key Explanatory Variables .............................................................................. 63
    5.2.3 Additional Control Variables ............................................................................ 66
5.3 Summary Statistics

5.4 Chapter Summary

CHAPTER 6: EMPIRICAL METHODS

6.0 Introduction to Chapter

6.2 Empirical Model

6.3 Chapter Summary

CHAPTER 7: RESULTS AND DISCUSSION

7.0 Chapter Introduction

7.2 Policy Implications and Recommendations

7.3 Chapter Summary

CHAPTER 8: CONCLUSION

8.0 Summary of Research and Results

8.1 Research Limitations and Future Research

REFERENCES
List of Figures

Figure 1. Farm Product Price Index for Total Livestock and Animal Products, and Cattle and Calves, Annual (index 2007=100) ..................................2

Figure 2. Ontario Farm Product Proce Index for Total Livestock and Animal Products, and Cattle and Calves, Monthly (index 2007=100) .....................2

Figure 3. Farm Input Price Index for Total Farm Inputs, Crop production, Cattle, and Commercial Feed, Quarterly (index 2002=100) ........................................3

Figure 4. Net Operating Income of Ontario Beef Farms, 2001 - 2009 ..........................5

Figure 5. Reasons for Lack of Participation in AgriStability, Beef Farms, Total Farms and By Size, 2013 .................................................................6

Figure 6. Participation in AgriStability by Ontario Beef Farmers, 2003-2013 .................................................................7

Figure 7. Depiction of BRM Programs and Layers of Risk .............................................27

Figure 8. Average Business Risk (s.d. measure) for Beef Farms, by Size Category, 2006-2011 .................................................................35

Figure 9. A Hypothetical Prospect Theory Value Function ............................................44
List of Tables

Table 1. Example of the Calculation of a Program Year Margin............................................. 29

Table 2. Program payout scenarios under CAIS, AgriStability, and AgriStability under Growing Forward 2, given reference margin of $100,000 and a year margin of $10,000................................................................. 31

Table 3. Example of Returns to AgriStability........................................................................... 33

Table 4. Summary of Explanatory Variables, with Description and Expected Sign.......................................................... 52

Table 5. Inclusion of Farms that Switch-Sectors into the Sample............................................. 55

Table 6. Percentage Sector Type by Year, 2003 - 2013.......................................................... 56

Table 7. Percentage Beef Operation Type by Year, 2003 - 2013............................................. 57

Table 8. Creating a Balanced Panel. ......................................................................................... 58

Table 9. Number (Percentage) of Ontario Beef Farms, 2003 - 2013...................................... 59

Table 10. Number (Percentage) of Producer Participating in AgriStability by Year and Revenue Size, 2003 - 2013.......................................................... 61

Table 11. Number (Percentage) of Producers Withdrawing from AgriStability by Year and Revenue Size, 2003 - 2013......................................................... 62

Table 12. Summary Statistics by Revenue Size Category, by Mean (Standard Deviation).......................... 69

Table 13. Estimated Regression Coefficients Explaining Withdrawal From AgriStability using Expected Utility (EU) and Prospect Theory (PT) Frameworks......................................................... 78

Table 14. Regression results of the effects of Farm Characteristics, Enterprise Diversity, Ad Hoc Payments, and Policy Changes......................................................... 81

Table 15. Regression Results for Full Model by Revenue Category......................................... 83

Table 16. Marginal Effects of a Change in an Explanatory Variable on the Dependent Withdrawal Variable................................................................. 85
CHAPTER 1: Introduction

1.0 Introduction

Risk is broadly defined as the uncertainty in outcomes that may result in income losses or adversity (OECD, 2000). The sources of risk in agricultural production are numerous and often unpredictable, resulting in a risk environment that is unique compared to other sectors of the economy. Not only do producers face market risk, such as price fluctuations and exchange rate variability, but production risk as well, for example from catastrophic weather and disease events (Anton et al, 2011). Additionally, agricultural producers are exposed to other types of risk including changes in government policy and consumer preferences (Gardner & Rausser, 2002).

The market risk that Ontario beef sector face mirrors that of most other agricultural sectors, with the annual farm product price index for total livestock and animal production, and for cattle and calves increasing steadily from 2002 to 2013 (see Figure 1). There is greater variability in the monthly farm price index for Ontario livestock producers, as shown in Figure 2, with an especially large drop in prices in 2003 with the onset of the Bovine Spongiform Encephalopathy (BSE) crisis. The quarterly farm input price index illustrated in Figure 3, has trended upward between 2003 and 2013. The cost of production for cattle generally follows this trend, except for the significant rise in 2013, likely due to increased crop feed prices.
Figure 1. Farm Product Price Index for Total Livestock and Animal Products, and Cattle and Calves, Annual (index 2007=100)
Source: Statistics Canada, CANSIM Table 002-0069

Figure 2. Ontario Farm Product Price Index for Total Livestock and Animal Products, and Cattle and Calves, Monthly (index 2007=100)
Source: Statistics Canada, CANSIM Table 002-0068
Besides continued levels of market risk, the beef sector in Ontario has been exposed to other events that make effective farm-level risk-management more difficult. In 2003, a case of BSE was confirmed in Alberta causing widespread industry losses. Forty countries closed their borders to Canadian cattle and beef products, causing a large decline in slaughter cattle prices. Ontario farmers did not see the same pre-BSE prices again until May 2007 (Le Roy et al., 2007). In addition to disease events, trade policies have caused some level of income risk to beef and cattle producers in Ontario, particularly if the regulation increases cost-of-production or decreases market access.

Canada is a net exporter of beef, with 31.75% of all beef produced in the country sent to international markets in 2012. This export position exposes producers to trade regulation, border closures, and rapid exchange rate appreciation (FAO, 2015). The introduction of Country of Origin Labeling legislation in the United States has been

Figure 3. Farm Input Price Index for Total Farm Inputs, Crop production, Cattle, and Commercial Feed, Quarterly (index 2002=100)

Source: Statistics Canada, CANSIM Table 328-0015
disruptive to the Canadian beef industry, since the United States is Canada’s single largest export destination for beef, accounting for 41% of all beef exports\(^1\). The next largest export region for Canadian beef is Europe at 31% of the share, where new regulation under the EU-Canada Comprehensive Economic and Trade Agreement (CETA) requires beef to be produced hormone-free (National Farmers Union, 2014).

Finally, changing consumer demands due to substitution toward other protein sources can have considerable effects on producer welfare, although losses to the sector due to changing consumer preferences and decreased demand for beef and beef products have not been quantified (FCC Ag Economics, 2015).

One of the major consequences of the numerous and unpredictable sources of risk in agricultural production is income instability. Figure 4 illustrates net farm income for beef farms in Ontario between 2001 and 2009 (Statistics Canada, Table 002-0027). In order to manage this income risk and decrease their susceptibility to large income shocks, farmers adopt risk-mitigating strategies at the farm-level, for example enterprise diversification or the use of futures contracts, among others (OECD, 2000). However, although farmers are active in managing risk at the farm business level, the unique nature of risk in agricultural production, including catastrophic events like BSE that affect an entire sector, has justified intervention in the agricultural risk market by most OECD governments.

\(^1\) See COOL dispute (Lim et al, 2013)
\(^2\) Other applications of prospect theory are limited, but can be found in the industrial organization, contract choice, labour supply, trade theory, consumption choice and the endowment effect literature.
In Canada, risk management has been at the core of agricultural policy since the Agricultural Stabilization Act (ASA) was passed in 1958, and since then there has always been at least one major program income stabilization program of a national scale that aims to stabilize returns to farming (Antón et al., 2011). In general since their inception, agricultural stabilization programs have moved away from price and yield stabilization mechanisms (i.e., commodity-specific revenue insurance) and toward individual income-based whole-farm safety net programs (Chen & Meilke, 1996). The current major stabilization program is called AgriStability, which was introduced in 2008 under the Growing Forward policy framework, born out of the Canadian Agricultural Income Stabilization program of 2003, and has continued under Growing Forward 2.

Since 2003, the program has been revised twice in terms of coverage levels, premium rates and payment limits, in order to align with the objectives of the larger policy frameworks of promoting competitiveness and efficiency in the agricultural sector.
Although the premium rates remain high subsidized, between 2003 and 2013 participation in AgriStability has been declining steadily, despite no reduction in farmer’s risk exposure over that period. This trend raises questions about the necessity and efficiency of stabilization programs as a tool for risk management in the Canadian agricultural sector (Poon, 2013).

1.1 The Problem of Withdrawal from AgriStability

Over the last decade there has been a marked decrease in participation in agricultural income stabilization programs in Ontario, with participation in AgriStability by all types of farms declining from 73.4% to 56.5% between 2004 and 2009 (Poon, 2013). In the 2013 Farm Financial Survey, 53.8% of beef farmers in Ontario responded that the lack of participation in AgriStability was because farmers “Did not see a benefit,” as is shown in Figure 5; other responses include “Complicated process” and “Lack of information.” Additionally, delays in receiving program payments and changes to fundamental aspects of the program including to coverage levels and premiums have been mentioned as contributing causes of the phenomenon, however, these reasons have not been empirically validated in a farm-level multi-year framework (Poon, 2013).

![Figure 5. Reasons for Lack of Participation in AgriStability, Beef Farms, Total Farms and By Size, 2013](image-url)
The rate of withdrawal from AgriStability by Ontario beef farmers, as measured by enrollment in one period and program exit in the next period, increased from 2.0% in 2003 to 31.7% in 2013 (see Figure 6). Assuming the program is meeting its objectives of risk mitigation and income stabilization, and that producers’ risk exposure is not declining, then the level of participation by producers should remain high. Instead the data show an increase in the rate of exit, which raises questions about how farmers perceive the program and their motivation for using it.

Figure 6. Participation in AgriStability by Ontario Beef Farmers, 2003-2013
Source: OMAFRA, Ontario Farm Income Database, Authors Calculations.

The literature on the demand for a risk management products and the participation in government risk management programs in Canada is limited (Cabas et al., 2008; Poon, 2013; Uzea et al., 2014a). Cabas et al. (2008) and Poon (2013) both assess the factors that affect participation rates by modelling the decision of those who enter and exit separately. Cabas et al. (2008) found that the effect of premium rates for overall participation was not statistically significant, however when participation was modelled as separate entry
and exit decisions, an increase in the premium rate decreased the number of entries from the program, and increased the number of exits. Poon (2013) found that farms with a larger agricultural land base tend to participate continuously, farms that exit have lower net income and operating margin, and farms that participate every year trigger much higher payments than those that exit.

This thesis will contribute to the literature by investigating the factors that affect a farmer’s decision to withdraw from a government-sponsored insurance program using a farm-level multi-year framework. The study will also contribute to the literature by applying prospect theory, an approach based in behavioural economics, to explain the low demand for AgriStability. The research will be restricted to beef farmers in Ontario between 2003 and 2013 using data from the Ontario Farm Income Database. This time period is being used because 2003 was when the BRM suite of programs was introduced under the Agricultural Policy Framework.

Program payments that can be attributed to business risk management accounts for the largest share of total provincial government support to the Canadian agri-food sector, so the ability of the program to meet its outlined objectives is of interest to both the provincial and federal government (AAFC, 2015). The Ontario Ministry of Food, Agriculture and Rural Affairs (OMAFRA) is the administrative body responsible for delivering program payments in Ontario (AgriCorp is responsible for calculating payments), and policy analysts are in demand of research that helps to explain the trend of declining participation to aid in the development and design of future programs. The industry body Beef Farmers of Ontario (BFO) is also concerned with the decline in farmer participation in AgriStability, as they want to ensure that the sector is sufficiently
protected from potential income shocks, and that individual farmers are utilizing government insurance programs appropriately in order to effectively mitigate risk.

The study aims to provide insight into how farmers perceive and utilize government-funded risk management programs, in particular if BRM programs are being used by producers as a risk management tool or as an investment strategy for speculative earnings, and to determine the factors affecting the decision to withdraw from AgriStability. Results from the study will highlight those farm businesses that may be at high risk of withdrawing. If these farmers are the ones for which the BRM programs are meant to support, then the results can help in the design of a program to help those producers manage risk and enhance the competitiveness of the sector. Finally, the results generate implications for the rationale and efficiency of this type of government insurance program in terms of which producers it is meant to target and which producers it is actually reaching.

1.2 Purpose and Objectives

The purpose of this thesis is to identify and estimate the factors affecting the decision to withdraw from AgriStability by beef farmers in Ontario between 2003 and 2013, in order to provide insight into how farmers use and perceive the program. The analysis will use an approach based in behavioural economics that builds off of expected utility theory to focus on how farmers react to financial gains compared to losses, and how these welfare changes affect the participation decision. The research will inform future policy research regarding the role of government in providing agricultural risk management programs, and contribute to future design of this type of program so that the objectives of the program align more closely with producer expectations.
The specific objectives of this thesis are:

1. To provide an overview of the Ontario beef sector, including sector trends and challenges, and the nature of risk management in the beef sector.

2. To provide an overview of risk and agriculture, including sources of risk in agriculture, a history of risk management policy in Canada, and an overview of the AgriStability program.

3. To develop a conceptual framework that uses prospect theory and a reference-dependence framework to describe how changes in net income and returns from AgriStability affect the decision to withdraw from AgriStability.

4. To develop an empirical framework to estimate the factors affecting the decision to withdraw from AgriStability.

5. To estimate and explain the factors contributing to the decision to withdraw from AgriStability.

6. To assess the impact of the findings on program design, by using the results to outline policy implications.

1.4 Thesis Outline

The chapters of this thesis will be presented as follows: Chapter Two will provide an overview of the Ontario beef sector and Chapter Three will discuss risk in agriculture and risk management policy in Canadian agriculture. Chapter Four will develop a conceptual framework that describes the withdrawal decision from AgriStability using prospect theory. Chapter Five outlines the data and variables used in the analysis, and Chapter Six presents the empirical model used to answer the economic research question.
In Chapter Seven the results will be presented and discussed, and policy implications will be presented, and Chapter Eight will summarize the research results, and provide research limitations and recommendations for future research.
CHAPTER 2: The Ontario Beef and Cattle Sector

2.0 Chapter Introduction

The purpose of this chapter is to provide an overview of the beef and cattle sector in Ontario. The overview will include industry trends, farm characteristics, sector challenges and opportunities, and a discussion of risk in cattle and calf production. The sector is considered to be relatively heterogeneous and is subject to a substantial amount of risk; farmers operate on thin profit margins and experience high variability in returns. Beef and cattle producers do not have access to production insurance like field crop producers, meaning AgriStability is the main government support program they can access. These characteristics make the beef and cattle sector suitable for examining the problem of producer withdrawal from AgriStability.

2.1 Industry Trends and Farm Characteristics

The Ontario beef sector remains an important economic driver for the provincial economy, contributing approximately 8% of total Agri-food sector GDP between 2007 and 2011. The beef industry accounted for 13.7% of farms in Ontario in 2001, down from 22.5% in 2001, with the absolute number of farm operators declining from 13,000 in 2003 to 10,000 in 2013 (Statistics Canada, CANSIM Table 002-0038). The majority of this decline was in the lower sales classes (0 - $10,000 and $10,000 - $50,000). Farms in sales classes above $100,000 experienced a slower decline in their numbers, so farms with larger revenues now represent a larger fraction of beef farms in Ontario. Generally, the 20-80 rule holds for beef farms in Ontario; roughly 20% of all farms generate 80% of total revenue for the sector.
Farmers are categorized as cow-calf operations, feedlot operations, or other types of operations (OMAFRA, 2013). Cow-calf operations, or beef cattle farms, are responsible for the breeding and rearing of each new generation of young stock, raising animals to between 500 and 600 lbs. before selling them to feedlots and account for 86.5% of beef farms in Ontario according to the Ontario Farm Income Database (OFID). Feedlots, or cattle feeder farms, finish animals to be sold for slaughter. This operation type is characterized by high volume, high turnover and thin profit margins. Feedlots make up 9.8% of all beef farm types in the OFID. Other operation types account for the remaining 3.7% of beef farms and include dairy heifers, other livestock, and mixed operations.

The consolidation of beef farms to fewer, larger operations has been coupled with a gradual decline in the number of most types of cattle on farms in Ontario. The largest inventory of bulls, cows, calves and beef heifers for breeding was last seen in the mid-1990’s, but the largest decline has been in the population of beef cows and calves which has steadily declined by 60% and 66% respectively between 1996 and 2011. Based on 2012 inventories, Ontario accounts for 7.5% of the national beef cow population, after Alberta, Saskatchewan and Manitoba, with an average of 66 head per farm (BFO, 2016). The number of cattle slaughtered in Ontario tends to mirror the rest of the country, with relatively level slaughter numbers of 660,000 per year since 1990, with the exception of a spike in 2003 of 100,000 head. The number of calves slaughtered in Ontario has declined by 33% between 1986 and 2011.

International exports of cattle by Ontario producers have been relatively variable between 2000 and 2011. In the years leading up to the BSE crisis, over 200,000 head of
cattle were being sent to international markets each year. After the crisis, which halted all exports between mid 2003 and mid 2005, it took three years for cattle exports to return to pre-BSE levels. Then exports were reduced again between 2008 and 2011, with an average of 120,000 head sent to international markets each year.

The beef industry in Ontario has experienced significant market highs and lows over the last decade. At the beginning of the 2000s, the prices for slaughter cattle and calves rose and by 2001 had reached their highest values in 15 years. The fortunes of beef farms in Ontario quickly changed in 2003 when the discovery of BSE in a cow in Alberta caused Canadian trading partners to ban all imports of beef from Canada. Although the import bans were relatively short lived the fallout from the incident lasted several years. Prices have rebounded recently but the wide swings in prices are assumed to have affected the financial welfare of beef producers. Additionally, it is important to note that when beef farmers are hedging, the cash prices is generally not as highly correlated with the futures prices compared to other sectors like crop production. For example, a study by Ai (2012) found that when Ontario and Alberta feedlot operators used futures contracts for live and feeder cattle, the risk reduction from using the US-based futures was lower than 30%.

2.2 Sector Challenges and Opportunities

Market uncertainties have provided some level of financial instability for Ontario beef farmers over the past decade, however a few larger challenges have contributed to the extent of producers’ income risk. According to OFID, between 2003 and 2010, average per farm earnings before interest and tax for Ontario beef farmers was only positive in 2005, 2008, and 2010. This negative net income measure reflects the financial
strain faced by the sector over the last decade. From 2006 onward, the least profitable farms had average net losses of $35,500 per year. In contrast, the top performing farms have positive profits that stayed above $60,000 between 2005 and 2010.

The outbreak of Bovine Spongiform Encephalopathy (BSE) in 2003 resulted in a halt to all Canadian beef exports. Many producers experienced large income losses as the value of their breeding herds and the demand for beef dropped suddenly and rapidly (Brewin et al., 2009). Since 2003, Canadian beef producers have slowly regained their global market share, despite a general decline in domestic demand, continued competition from other exporting nations, and limited foreign market access (Cranfield, 2012).

More recently, producers face technical trade risk in the form of Country-of-Origin-Labeling (COOL) legislation in the United States. The increased costs Canadian producers will incur to access the US market could have a similar border-closing effect as BSE (Brewin et al., 2009). COOL is a major competitiveness challenge, however, there may also be an opportunity to increase demand for Ontario corn fed beef. Similarly, the EU decided to change their standards for beef imports such that no animal that was produced with hormones would be brought into the trade area. The effect of this trade negotiation was that if farmers wanted to keep market opportunities open to the EU they would have to change their production practices, thereby increasing costs and competing with low cost of production, hormone-free producers in South America (National Farmers Union, 2014).

Consumer preferences are another source of risk for a primary producer. In much of the developed world including the US, which is Canada’s largest export market, the
demand for beef is growing slowly or declining (FCC Ag Economics, 2015). In Canada, beef consumption declined by 28% between 1984 and 2013, however, the OECD-FOA projects that over the next decade there will be a 4% growth in consumption due to a sustained or increasing willingness-to-pay for beef. The cause of the recent decline in consumption has been attributed to Canada’s aging population, immigration patterns that change food patterns, health-related concerns, and the role of relative prices as a driver of consumption (FCC Ag Economics, 2015). Despite downward trends in beef consumption in the domestic and U.S. markets, the world export market is expected to grow by 20% by 2023, with most of the growth originating in emerging economies. Therefore, diversification of Canadian markets, including to China and Japan, will be important to maintaining the competitiveness of the Ontario beef sector (FCC Ag Economics, 2015).

Challenges of the past decade aside, the Ontario beef sector is well positioned to grow its share of the world export market, especially as the middle class in emerging markets demand more protein products (FCC Ag Economics, 2015). In 2014, five of the top ten importers of Canadian beef were Asian countries included in these trade deals, where the value of Canadian imports is relatively high. For example, in 2012 beef exports sold in the US at $3.33/kg, and in Japan it was priced at $5.08/kg. If Ontario producers can are able to manage risk effectively and make necessary investments to sustain or grow inventory, they will be poised to remain competitive in global markets.

2.3 Risk Management in the Beef Sector

Due to the biological lags associated with beef production, risk is particularly difficult to predict and plan for. Producers are able to manage some level of risk at the farm level, including enterprise diversification and marketing contracts, however for
those that are beyond their control, risk management programs are available. The benefits of these programs are that they provide stability to the industry and allow farmers to make long-term investments. Business risk management programs can also help establish young producers in the industry (BFO, 2016).

There are two government risk management programs that aid beef and cattle producers in stabilizing farm income. Under the Business Risk Management pillars of Growing Forward I and Growing Forward II, AgriStability is the main income support program that farmers can participate in for a relatively small fee. The second program is the Risk Management Program (RMP), which came into effect in Ontario in 2011 and acts as a complement to AgriStability. The specifics of the program for the livestock sector were developed in consultation with various industry representatives in order to ensure that the program provides farmers with the tools they need to sustain their operations. For the purposes of this study, participation in RMP is not taken into account because up until 2013, when the study period ends, participation in RMP was dependent on participation in AgriStability, so there is no concern over substitution effects.

The Crop Insurance Act was amended in 2014 to include all agricultural products, including beef cattle (BFO, 2016). The gross margin for beef farmers can be substantially impacted by unpredictable production risks related to weather, feed production and animal health, so the change to the Act creates an opportunity to take advantage of yield-based insurance and decrease the financial effects of these risks. By giving beef producers access to the protection that crop producers receive under AgriInsurance, another program under the BRM pillar, some equity issues across different sectors were addressed (BFO, 2016).
2.4 Chapter Summary

Despite challenges of the early 2000’s, the financial performance of beef farms in Ontario has improved somewhat as prices rebounded from the low periods after the BSE outbreak. Structural changes to the sector have included consolidation of fewer, larger farms, making the sector generally more heterogeneous. These farms seem to be better able to cope with risk, as has been shown through positive net income since 2004, despite the persistence of thin profit margins. However, financial welfare of the farm does differ drastically depending on its size, and the smaller, alternative farm types seem to be less profitable and in decline. As the sector moves forward there will be increased market opportunities, especially as global demand for beef products is set to increase, but competitiveness and efficiency gains will only be achieved through effective risk management.
CHAPTER 3: Risk and Agriculture

3.0 Chapter Introduction

The purpose of this chapter is to provide a discussion of risk and agriculture. An understanding of risk and risk management in agriculture is necessary in order to develop a conceptual framework and testable hypotheses. The chapter will start with a description of risk and uncertainty, outline the major sources of risk in agricultural production as well as responses to those risks, and discuss the rationale for government intervention. The next section of the chapter is a brief discussion of the history of risk management policy in Canadian agriculture up to 2003. The chapter ends with an overview of the current risk management programs in Canada, including a more detailed description of the AgriStability program and a simulated example of how the payment mechanism of AgriStability works for a representative beef farm.

3.1 Uncertainty and Risk in Agriculture

Uncertainty and risk are important features of agricultural production, because some fundamental level of uncertainty – that is the inability to forecast outcomes with absolute accuracy – is present in all managerial and production decisions (Gardner & Rausser, 2002). For example, a beef farmer does not know precisely what the future price of feed or slaughter cattle will be, and will make production decisions based on a personal belief or perception about the occurrence of the various outcomes. This subjective probability distribution contains $n$ possible outcomes denoted $X_1, X_2, \ldots, X_n$ with a subjective probability $P(X_i)$ for $i = 1, 2, \ldots, n$. These subjective probabilities or beliefs can change with exposure and experience (McConnell & Dillon, 1997).
Uncertainty is always present in decision-making, however it does not necessarily lead to a risky situation. Risk is uncertainty that affects the welfare of an individual or enterprise in the form of an adversity or loss; in other words ‘uncertainty that matters’ (Harwood et al., 1999). The challenge for farmers is to quantify the frequency and probability of potential risks and develop effective strategies for mitigating the harmful effects of such occurrences (Miller et al., 2004).

3.1.2 Sources of Risk in Agricultural Production

Risk in the agricultural sector is distinct because it includes not only the expected market risk that all businesses are susceptible to, but production and regulatory risk as well (Antón et al., 2011). Market risk derives from uncertainty about movements in market indicators including foreign currencies, commodity and input prices, and interest rates. For example, a large appreciation or depreciation of the US-Canadian exchange rate dollar can have substantial impacts on certain agricultural sectors due to Canada’s position as a small price-taking nation that is highly reliant on the US export market.

Production risk affects the quality and quantity of output, for example weather and disease events, and is generally less predictable than production risk in other sectors (Gardner & Rausser, 2002). Agricultural production is particularly challenging in terms of planning for uncertainty due to the biological process associated with cultivating crops and raising livestock. The market price of the final output is unknown at the time initial production decisions are made, and this uncertainty can lead to a misallocation of resources.

In addition to market and production risk, producers face income risk from other sources. These include (i) changing consumer demands or social preferences, for example
animal welfare concerns or health concerns, (ii) technology uncertainty, for example in
the form of the evolution of production techniques or patenting that limits individual
producers from accessing the best information and technology, and (iii) the effect
government policy or institutional risk such as environmental legislation, regional trade
agreements, or changes to support programs (Gardner & Rausser, 2002).

3.1.3 Responses to Risk in Agricultural Production

While risk is defined as uncertainty in outcomes that impact financial welfare,
risk management can be defined as choosing between alternatives to reduce the effects of
risk (Harwood et al., 1999). Generally, the producer’s objective is to reduce variation in
household income and avoid large income losses (OECD, 2000). Given this objective,
risk management involves evaluating the tradeoffs between changes in risk and expected
returns, among other variables. Strategic management could include reducing risk within
the farms operations, transferring risk to outside the farm, or any other strategy that
improves the farm’s capacity to bear risk (Harwood et al., 2000).

It is nearly impossible to avoid risk entirely, so instead farmers find the
combination of available risk management options in order to bear a wide range of
outcomes. According to (Miller et al., 2004) the general methods for managing risk fall
into four categories: (1) avoidance, which involves structuring the business so that certain
types of risk are nonexistent; (2) reduction, which is the process of lowering risks
associated with the farm business; (3) assumption/retention, which is the process of
accepting certain risks with the assumption that it will enhance overall profitability; and
(4) transfer, which involves transferring the risk to another party, usually for a fee, such
as with crop or hail insurance (Miller et al., 2004). This last method will be focused on in
this analysis, given that the research problem involves the decision to remain enrolled in AgriStability or exit the program.

At the household level specific examples of tools and mechanisms that farmers use to manage competing risks include including enterprise diversification, commodity or revenue insurance, vertical integration, and production or marketing contracting; hedging and futures markets are also commonly used by farmers to manage production or market uncertainty in the beef sector (Miller et al., 2004). Additional strategies to manage risk include changing production practices and partaking in off-farm employment (Chen & Meilke, 1996). It is evident that risk management is complex and often includes the strategic use of multiple methods in order to be effective.

3.1.4 Government Intervention in Agricultural Risk Markets

No matter how effective an individual is at managing income risk at the farm level, the unpredictability of frequency and scale of income losses has prompted government support for the sector in most OECD countries, including Canada. Farmers face significant and potentially catastrophic risks, and possess limited opportunities to use insurance to avoid them (Stiglitz, 1987). The circumstantial attributes of risk in agricultural justify more frequent government intervention compared to other sectors, along with the general belief in society that farmers face more risk than other groups in society (Chen & Meilke, 1996). Historically, low and unstable farm incomes were the stated rationale for government intervention in Canada, with the rationale for public provision of income transfers to struggling farmers based on efficiency and equity grounds.
Additionally, international agricultural markets are flexible in terms of changes in commodity (volatile commodity markets) and input prices, but domestic factor markets (i.e., land and labour) are relatively rigid, and there is often price stickiness in non-agricultural markets. The consequence of these market characteristics is that agricultural prices are highly variable, and annual farm income can vary to a large extent (OECD, 2000). It is these income fluctuations that prompt governments to develop policies and programs that offset large losses and reduce the adverse effects of income variability.

According to Ruttan (1966) ‘the rationale for public intervention in agricultural commodity markets is, and will continue to be... to lend stability to an industry which technological and economic forces should render chronically unstable in the absence of such intervention’ (p.1113). This statement continues to hold in the 21st century political environment, as government intervention in agriculture markets is standard practice in both developed and developing countries. Support to the sector remains high since it is considered a primary role of the government to create the conditions for a sound business environment, including stable macroeconomic conditions to base production and investment decisions on (OECD, 2000). Specific intervention can manifest in the form of subsidies to farmers, stabilizing prices, imposing import tariffs and quotas, and providing credit below market rates, among others (Stiglitz, 1987).

There are two justifications for government intervention that relate most closely to agricultural risk markets. The first is incomplete markets in insurance futures. Incompleteness of private insurance and rural credit markets means that farmers cannot get the insurance required to protect against large price or production risks. Market risks faced by farmers tend to be large, unpredictable, and highly correlated across wide
geographical areas. These characteristics make pooling difficult and cause private insurance companies to charge far higher premiums than farmers would be willing to pay in order to remain actuarially sound (Stiglitz, 1987).

The second rationale for intervention is income distribution. Governments are concerned with the distribution of income generated by free markets that often favours large farms that are able to create economies of scale and more readily access credit. In this context, government intervention serves to reduce risks faced by farmers and redistribute income to farmers who need it most. Other market failures such as imperfect information, public goods, increasing returns and externalities also support the rationale for intervention in the agricultural sector (Stiglitz, 1987).

If the government were to not be involved in agricultural risk management, the potential welfare problems would have spillover effects on other rural households and businesses, including negative effects on employment opportunities. Low farm output also reduces turnover for agricultural retailers and food processors, and can affect income and employment outcomes of non-farm businesses (Varangis et al., 2002). Therefore, intervention in agricultural insurance markets not only supports individual farm welfare, but rural and regional economic environments more broadly.

3.2 History of Risk Management Policy in Canadian Agriculture

There has been a long history of government intervention in support of the agricultural sector in Canada, with income stabilization as a central feature of agricultural policy (Anton et al., 2011). However, specific program objectives have changed over time, from initial programs being price-based and commodity-specific, to program payment triggers based on net cash flow for a basket of crops, to commodity-specific
revenue-based insurance programs. Since 1991 programs have been voluntary and payment triggers are based on individual margins that measure whole farm profitability by covering most commodities (Rude & Ker, 2013).

The Agricultural Stabilization Act (ASA) was passed in 1958 as a response to low commodity prices. Under the ASA, insurance payments were coupled to production (Poon & Weersink, 2014). The program and was entirely government funded, meaning participation was not an issue as producers bore no cost from enrollment (Schmitz, 2008). The Crop Insurance Act was introduced in (1959). The next major policy shift occurred in 1976, when the Western Grain Stabilization Act (WGSA) was passed to aid prairie farmers stabilize income under production constraints instituted by the Canadian Wheat Board. The WGSA aimed to stabilize aggregate net cash flow, rather than commodity prices, and payments were decoupled from production. Producers were required to contribute to the program in conjunction with government funding (Poon & Weersink, 2014).

With the introduction of the National Tripartite Stabilization Program (NTSP) in 1986, funding of the programs was shared between producers and both the provincial and federal governments (Poon & Weersink, 2014). The introduction of NTSP cued the beginning of reduced support by shifting more of the cost of market and production risk on to producers. Despite the changing policy environment, overall support to the sector remained high, to the point where U.S. producers were pressuring their government to institute countervailing duties (Schmitz, 2008). International political and trade pressures caused further changes to the characteristics of income support policies in Canada to comply with WTO rulings. It was now a WTO requirement that support be decoupled
from production, and so another shift away from commodity price support began in 1991.

The first whole-farm income support programs were introduced under the Farm Income Protection Act (FIPA), which replaced the ASA, WGSA, and the Crop Insurance Act (Schmitz, 2008). The four programs that emerged under FIPA were the Gross Revenue Insurance Program (GRIP) (which was deemed too expensive and was dismantled almost immediately), the Net Income Stabilization Account (NISA), the Agricultural Income Disaster Assistance (AIDA) and the Canadian Farm Income Program (CFIP). These programs required a substantial amount of administrative support, both in the form of data and manpower, in order to determine the level of support each farm enterprise would receive (Poon & Weersink, 2014). FIPA served as the basis for all farm programs that have been implemented since, further solidifying income stabilization as a key objective in agricultural policy in Canada (Antón et al., 2011).

3.3 Current Risk Management Programs Overview

The Canadian Agricultural Income Stabilization (CAIS) program was established in 2003 under the Agricultural Policy Framework to replace the previous safety net programs that were available under FIPA. The objective of CAIS was to protect farmers from both small and large income drops by insuring an individual farmer’s reference margin, which was based on a historical average. In 2007, the Auditor General of Canada reviewed the CAIS program found that (i) it was very complex, (ii) it focused on preventing overpayments to producers and relied on producers to question incorrect figures (iii) it lacked transparency in terms of the consistency between program delivery and objectives, and (iv) there were conflicts of interest where program administrators who processed the applications were also working as private consultants to help
producers complete their CAIS applications (Schmitz, 2008).

The current motivation of agricultural policy in Canada under the Growing Forward 1 (GF1) and Growing Forward 2 (GF2) frameworks is to promote competitiveness and efficiency in the agricultural sector. However, the objective of stabilizing income remains embedded within the policy with a maintained focus on producers and their income variation (Poon & Weersink, 2014). The goal of stabilization programs under GF1 and GF2 is to reduce farm income risk under the assumption that all sources of risk (i.e., market, production, policy, etc.) contribute to farm income risk (Anton et al., 2011).

The four programs under the Business Risk Management (BRM) pillar of GF1 and GF2 are AgriInvest, AgriStability, AgriInsurance, and AgriRecovery. The joint effect of these four programs is that risk of all types and sizes can be targeted, and the income risks that farmers face can, for the most part, be alleviated. Figure 7 demonstrates the different risk-layers that the programs cover, and where some programs overlap in terms of risk coverage.

![Figure 7. Depiction of BRM Programs and Layers of Risk](source: Antón et al., 2011.)
The shift in policy objectives from individual well-being of the farmer to the competitiveness of the agricultural sector as a whole has changed the focus of risk management to the entire farm enterprise instead of solely price stabilization, by introducing payments based on the reference margin of individual farms (Poon & Weersink, 2014). The current challenge for policy makers is to ensure that the programs are working effectively as risk management tools that target income risk, rather than mere income support programs, and provide producers’ incentives to develop alternative risk management strategies, rather than relying on government insurance programs alone (Anton et al., Report, 2011).

3.3.1 AgriStability Overview

This section will provide a description of the mechanism of AgriStability, including its purpose, and examples of how program margins and payments are calculated. The Growing Forward 2: AgriStability Program Handbook published by Agriculture and Agri-Food Canada (AAFC, 2013) is used as a reference for the summary. The section will end with a description of how the program has changed since it was first introduced in 2003.

The key objectives of Growing Forward 2 are to bolster the productivity, profitability, and competitiveness of the agricultural industry. The purpose of AgriStability is to help individuals farmers meet this objective by stabilizing whole farm income and protecting them against large income losses that may arise from low commodity prices, rising input prices, or production losses. The steps that a producer must take to enroll in AgriStability occur on an annual basis. Farmers receive an enrollment notice each year, which also serves as their opportunity to end participation in
the program. If they choose to participate, an Administrative Cost Share (ASC) fee of $55 is paid along with program fees. Program fees are based on the Contribution Reference Margin (CRM), which is the Reference Margin from the previous year including changes for structural adjustments and whole farm combining. The Reference Margin is a calculation of the average of the previous five years Program Margin (explained below), excluding the highest and lowest performing years. The maximum program fee is 0.45% of your CRM multiplied by the 70% support level. For example, if a farmer wanted to insure a CRM of $100,000 their annual program fee would be:

\[ 100,000 \times 0.45 = 450 \times 0.7 = 315 + 55 \text{ ACS} = 370 \]

After the program fees are paid, farmers submit financial statements that are used to calculate the Program Year Margin (PYM). The PYM is for the year you are enrolled in AgriStability, based on the calendar year in which your fiscal year ends. The Margin is calculated by subtracting total allowable expenses from total allowable income. Adjustments are made for changes in inventory, purchased inputs, and accounts payable and receivable in order to ensure that the farm’s financial income situation is represented as accurately as possible. The following is an example of a calculation of a PYM:

Table 1. Example of the Calculation of a Program Year Margin

<table>
<thead>
<tr>
<th>Allowable Income</th>
<th>Allowable Expenses</th>
<th>Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>$350,000</td>
<td>$280,000</td>
<td>$70,000</td>
</tr>
<tr>
<td>+ Net increase (decrease) in purchased inputs</td>
<td>$2,000</td>
<td></td>
</tr>
<tr>
<td>+ Net increase (decrease) in accounts receivable and deferred income</td>
<td>($12,000)</td>
<td></td>
</tr>
<tr>
<td>+ Net increase (decrease) in accounts payable</td>
<td>$9,000</td>
<td></td>
</tr>
<tr>
<td>+ Net increase (decrease) in crop inventory</td>
<td>($2,000)</td>
<td></td>
</tr>
<tr>
<td>+ Net increase (decrease) in livestock inventory</td>
<td>($7,500)</td>
<td></td>
</tr>
<tr>
<td><strong>Program Year Margin</strong></td>
<td><strong>$59,500</strong></td>
<td></td>
</tr>
</tbody>
</table>
Allowable income does not include any Business Risk Management or Disaster payments. Some non-allowable expenses include land rental, machinery, equipment and buildings, salaries for family members, and administrative expenses. By specifying allowable income and expenses, the margin is constructed to reflect only revenues and expenses that directly relate to agricultural production in order to reduce incentives to engage in moral hazard activities, that way a farmer cannot include additional expenses that decrease the program year margin in order to position themself to receive a claim. Such activities could trigger payments by creating or shifting income and expenses over time (Rude & Ker, 2013).

Negative margins – that is when allowable expenses exceed allowable income – are also protected under AgriStability. Farmers are compensated for up to 70% of the portion of the margin decline that is below zero. For example, if a farmer’s allowable income was $100,000 and allowable expenses were $160,000, their negative margin benefit would be $60,000 x 0.7 = $42,000 in compensation. A payment is triggered in AgriStability when the Program Year Margin declines more than 30% below the Reference Margin. Government funds cover 70% of a producer’s margin decline, with a maximum payment cap of $3 million.

Since the earliest version of AgriStability (then called CAIS) was introduced in 2003, the program has undergone structural changes in terms of the threshold that triggers payments and the fees that farmers pay to be enrolled (Poon & Weersink, 2014). Under CAIS, farmers could choose a maximum, medium, or minimum protection, and different payments were triggered depending on the margin decline. For example, for the first 15%
of the margin decline, the program covered 50% of the decline, for the next 15% of the margin decline, the program covered 70% of the decline, and for the rest of the decline the program covered 80% of the decline (Poon, 2013).

Under Growing Forward, the AgriInvest program replaced coverage of the top 15% of the margin decline, and the medium and minimum coverage levels were eliminated. Program fees were set at $4.50 per $1000 of Reference Margin protected with a maximum coverage of 70% of the reference margin. When Growing Forward 2 came into effect that reduced the program payment trigger from 85% below the Reference Margin to 70%. Poon (2013) provides an example of payments under the three different programs as shown in Table 2. It is evident that level of support has been declining since 2003, which may be one explanation for the declining participation.

Table 2. Program payout scenarios under CAIS, AgriStability, and AgriStability under Growing Forward 2, given reference margin of $100,000 and a year margin of $10,000.

<table>
<thead>
<tr>
<th>Coverage</th>
<th>CAIS</th>
<th>AgriStability</th>
<th>AgriStability Under Growing Forward 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1 $100,000 to $85,000</td>
<td>50% $7,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tier 2 $85,000 to $70,000</td>
<td>70% $10,500</td>
<td>70% $10,500</td>
<td></td>
</tr>
<tr>
<td>Tier 3 $70,000 to $0</td>
<td>80% $56,000</td>
<td>80% $56,000</td>
<td>70% $49,000</td>
</tr>
<tr>
<td>Tier 1 + Tier 2 + Tier 3</td>
<td>$74,000</td>
<td>$66,500</td>
<td>$49,000</td>
</tr>
<tr>
<td>CAIS Payment Cap $100,000 to $0</td>
<td>70% $70,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Margin $0 to $-10,000</td>
<td>60% $6,000</td>
<td>60% $6,000</td>
<td>70% $7,000</td>
</tr>
<tr>
<td>Total Payment with Negative Margin Coverage</td>
<td>$76,000</td>
<td>$72,500</td>
<td>$56,000</td>
</tr>
<tr>
<td>AgriStability – Payment Cap $100,000 to $-10,000</td>
<td>70% $77,000</td>
<td>$77,000</td>
<td>$77,000</td>
</tr>
<tr>
<td>Total Payment</td>
<td>$76,000</td>
<td>$72,500</td>
<td>$56,000</td>
</tr>
</tbody>
</table>

Other suggestions for the declining participation include the complexity of filing for a payment, the lag in the timing of payments, and an apparent bias against sectors that experience consistent adverse market conditions (Poon, 2013). The next section briefly explores the effectiveness of AgriStability as an income stabilization tool. This review will provide initial insight into how farmers are using the program. If various elements of the program, including the delay in payments, are reducing the effectiveness of the program in meeting its outlined objectives, this could lead farmers to use the program as an income support mechanism, rather than as a risk management tool. In turn, if the farmers are not receiving income support and do not need it as a risk management tool, this would induce withdrawal from the program (Anton et al., 2011).

3.3.2 An Example of the AgriStability Mechanism

The following is an example of how the AgriStability works to smooth farm income over time, by triggering a payment when the program year margin falls below 70% of the five-year Olympic reference margin. The simulation compares the final wealth of a producer who is participating consistently in AgriStability to the final wealth of a farmer who is not participating in the program.

Table 3 provides financial and program data for a small representative beef farm over a five-year period. In the top part of the table, average net income is calculated for the farmer not participating in AgriStability by differencing total income and expenses for each year. Average net-income for this farmer across the five-year period is negative $25,000. Comparatively, the bottom part of the table presents average net income if the same farmer had been enrolled in AgriStability for the same five years; inventory adjustments, the program fee, and program payments are included in the net income.
calculation for each year. The six-year average net income for the farm who was participating in AgriStability is $17,080.

Table 3. Example of Returns to AgriStability

<table>
<thead>
<tr>
<th>Not Participating in AgriStability</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>5-year Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>180,000</td>
<td>100,000</td>
<td>130,000</td>
<td>145,000</td>
<td>140,000</td>
<td></td>
</tr>
<tr>
<td>(Expenses)</td>
<td>175,000</td>
<td>170,000</td>
<td>180,000</td>
<td>105,000</td>
<td>90,000</td>
<td></td>
</tr>
<tr>
<td>Net Farm Income</td>
<td>5,000</td>
<td>-70,000</td>
<td>-50,000</td>
<td>40,000</td>
<td>50,000</td>
<td>-5,000</td>
</tr>
<tr>
<td>Participating in AgriStability</td>
<td>Allowable Income</td>
<td>180,000</td>
<td>100,000</td>
<td>130,000</td>
<td>145,000</td>
<td>140,000</td>
</tr>
<tr>
<td></td>
<td>(Allowable Expenses)</td>
<td>175,000</td>
<td>170,000</td>
<td>180,000</td>
<td>105,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Inventory Adjustment</td>
<td>-700</td>
<td>8,700</td>
<td>6,250</td>
<td>-5,000</td>
<td>-3,500</td>
<td>-2,500</td>
</tr>
<tr>
<td>(Program Fee)</td>
<td>170</td>
<td>145</td>
<td>150</td>
<td>130</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Payment</td>
<td>0</td>
<td>0</td>
<td>10,000</td>
<td>1,200</td>
<td>5,800</td>
<td></td>
</tr>
<tr>
<td>Net Farm Income</td>
<td>4,130</td>
<td>-61,445</td>
<td>-33,900</td>
<td>36,070</td>
<td>72,225</td>
<td>3,416</td>
</tr>
</tbody>
</table>

These data are rough calculations based on the design of AgriStability and a hypothetical reference margin using values from the Ontario Farm Income Database (which will be discussed in further detail in Chapter 5). The cost of program participation is relatively low, around $450 to cover $100,000 worth of contribution reference margin, much lower than the actuarially fair price of insurance if it were available in a private insurance market. This simulation does not address the issue of complexity of filing for a claim, the timing of payments, or the auditing processes, which do factor into the cost of participation. If the farmer is using the program as a risk management tool, the perceived probability of experiencing a loss must be extremely low in order for them to withdraw, given the monetary cost of participation is so low. Risk management behaviour would be observed as a consistent participation strategy as farmers hedge against losses for a relatively small fee.
3.3.3 The Effectiveness of Government Risk Management Programs

As the primary purpose of agricultural BRM programs is intended to be the stabilization of farm income, it is important to consider whether the existing policy framework in Canada has met this objective. Additionally, between 2007 and 2009 AgriStability has accounted for an average of 23% of total agricultural spending by the federal government and 16% by the provincial government. Over the same period, Business Risk Management (BRM) programs accounted for, on average, 84% and 66% of total federal and provincial spending on agriculture, respectively (Rude & Ker, 2013). With such continued high levels of support for the sector, it is important to consider the effectiveness of BRM programs – that is, the ability of the programs to deliver on government objectives and benefit farmers by smoothing net income over time.

A few studies have investigated the effectiveness of AgriStability at mitigating risk. From Uzea et al. (2014b), Figure 8 depicts average business risk, measured by standard deviation, of beef farms in Canada between 2006 and 2011 for both program participants and nonparticipants. The Figure shows that Business Risk Management (BRM) programs are effective at smoothing net income and decreasing farm income risks across all revenue classes, especially smaller farms. The business risk is likely to vary across revenue categories due to the ability of larger enterprises to leverage debt, and because smaller farms generally experience higher variability in net income. The same paper also investigates whether BRM programs have unintended consequences in the form of failing to reduce farm risk due to risk balancing behaviour. They find that BRM programs overall have no significant impact on the probability that farmers will take on
more financial risk, however, participation in CAIS/AgriStability does increase the likelihood that they will take on more debt than they otherwise would.

Figure 8. Average Business Risk (s.d. measure) for Beef Farms, by Size Category, 2006-2011
Source: Uzea et al., 2014.

Kimura & Antón (2011) also find that characteristics of AgriStability, such as delays in payments and declining coverage levels, decreases its effectiveness as a risk management tool because of how it interacts and affects farmers’ private risk management strategies. However, they do not estimate the extent to which various factors influence a farmer’s decision to remain in a program or exit. While there is clear evidence that BRM programs decrease farm income instability, further empirical analysis is necessary to determine whether there are other factors influencing program effectiveness and subsequently the observed increased rates of withdrawal by farmers.

3.4 Chapter Summary

Academics, policy makers, industry bodies, and farmers themselves have extensively explored the uncertainty associated with agricultural production, and have developed risk management mechanisms and tools to help mitigate the harmful effects of these risks. There has been a history of government intervention in agricultural risk
markets in most OECD countries, Canada included, often in the form of insurance of income support programs. AgriStability is the current program offered to producers, which provides a payment when income falls below a certain historical reference margin. The example provided shows how the mechanism of the program works and how a producer should have a higher average net income over time if they are enrolled in the program and experience large income fluctuations. This example contradicts the observed phenomena of declining participation in AgriStability.
CHAPTER 4: Conceptual Framework

4.0 Chapter Introduction

A farmer’s choice to participate in AgriStability is subject to uncertainty because changes in risk and expected returns, including the expected returns from insurance use, are unknown to the farmer. The most common way to model decision-making involving risk is using an expected utility framework, whereby the utility that would result from each outcome is multiplied by the probability of that outcome occurring and then summed over all possible outcomes (Varian, 3rd Ed, 1998). The purpose of this chapter is to develop a conceptual framework that can be used to test the effects of explanatory variables on the decision to withdrawal from AgriStability. The first section will explore how expected utility theory has been used previously to model insurance adoption and risk management decisions in agriculture.

The second section of the chapter will describe an alternative theory of decision-making under uncertainty called prospect theory, which is a descriptive model of probabilistic choice based in behavioural economics that proposes individuals evaluate gains and losses rather than final expected outcome. Prospect theory has been empirically applied in circumstances where observed phenomena are inconsistent with the axioms of expected utility theory. The section will cover relevant applications of prospect theory and its theoretical underpinnings. The third section will frame the problem of withdrawal from AgriStability in the context of prospect theory and develop hypotheses to be tested using the empirical model outlined in Chapter 5.
4.1 The Expected Utility Framework

4.1.1 Previous Literature

Expected utility is commonly used as the theoretical framework by which determinants of insurance adoption are examined. The studies that have used this framework (i.e. Cabas et al (2008), Sherrick et al (2004), Coble et al (1996), Goodwin and Smith (1995), Goodwin (1993)) assume that producers maximize their expected utility of profits subject to any constraint that affects the distribution of profits, including characteristics of their marketing and production environment and risk attitudes. Some of the variables that have been found to influence participation are the cost of participation (i.e. premium rates), expected returns from insurance, farmer characteristics (i.e. off-farm income, farm size, education), variability of indemnity payments, historical yield, level of diversification and current participation status.

Early studies find that as the cost of premiums increase, the demand for insurance decreases (Nieuwoudt et al. (1985), Goodwin (1993)), while other studies found farmers’ insurance decision was not sensitive to the level of premiums (i.e. Smith & Baquet (1996), Garrido and Zilberman (2007), Enjolras and Sentis (2011). In Cabas et al. (2008) the authors found that the effect of premium rates for overall participation was not statistically significant, however when participation was modelled as separate entry and exit decisions, an increase in the premium rate decreased the number of entries from the program, and increased the number of exits.

Larger farms were found to be more likely to insure (i.e. Goodwin (1993), Mishra & Goodwin (2003), Sherrick et al. (2004), Enjolras and Sentis (2011), Poon (2013), Lefebvre et al. (2014), Uzea et al. (2014)), with one explanation for this result being that the availability of human resources to administer the program and submit claims and the
size of claims make insurance purchases worthwhile for larger farms. However, in Figure 3.2 it was clear that small farms may experience higher variance in net income, so it is possible that the smaller revenue categories may exhibit higher demand for insurance. Farms with a higher level of enterprise diversification decreased insurance demand (Nieuwoudt *et al.* (1985), Coble *et al.* (1996), Pennings *et al.* (2008)), while the higher the expected rate of return from insurance, the higher the demand for insurance (Nieuwoudt *et al.* (1985); Smith and Baquet (1996)). Variance of indemnity negatively affects participation in Coble *et al.* 1996, whereas Garrido and Zilberman (2007) found the more dispersed the indemnities are in both amount and frequency, the greater the insurance participation. Uzea et al (2014) found that historical income volatility has no effect on participation.

Finger & Lehmann (2012) found that off-farm income had no significant affect on participation, and Velandia *et al.* (2009) found that only off-farm income greater than $50,000 had a negative and significant effect on crop insurance use. Nieuwoudt *et al.* (1985) found that the receipt of ad hoc payments from the government decreased insurance use, while conversely Mishra & Goodwin (2003) found that those farms that received government payments were more likely to adopt insurance.

Regional differences are included in some studies to explain variation in participation rates (Coble *et al.* (1996), Lefebvre *et al.* (2014)). As farms in areas with the highest risk exposure and the highest perception of risk (as measured by a higher number of declared climate events that reduce production) are more likely to insure. Finally, current participation status has modelled as what is termed the “loyalty effect,” with the consistent finding that when a farmer is enrolled in an insurance program they are more
likely to insure in the next period regardless of premiums or past claims (Enjolras and Sentis (2011), Uzea et al. (2014a)).

4.1.2 Expected Utility Theory

Expected utility is part of consumer choice theory that describes behaviour under uncertainty (Varian, 3rd Ed, 1998). Consider a lottery \((x_1, p_1; \ldots; x_n, p_n)\) which yields outcome \(x_i\) with probability \(p_i\) where \(p_1 + p_2 + \cdots + p_n = 1\). Under expected utility theory, an individual evaluates the lottery by the expected utility of its outcomes:

\[
\sum_{i=1}^{n} p_i U(x_i) \tag{4.1}
\]

where and \(U(.)\) is an increasing and concave utility function. We also assume a perfectly competitive market and that producers are price takers. Following Coble et al. (1996), the discrete insurance participation choice can be more explicitly defined for the problem of withdrawal from AgriStability by considering a producer who maximizes their expected utility of profits for the case of withdrawal \((EU_W)\) and for the case of continued participation \((EU_P)\). The withdrawal or non-participation case is expressed as:

\[
EU_W(\pi_t) = \int_{\theta_{\text{min}}}^{\theta_{\text{max}}} U[\pi_t(\theta)] g(\theta) d\theta \tag{4.2}
\]

where \(\pi_t\) is profit calculated by \((PQ - C)\), \(\theta\) are the unknown states of nature, and \(g(\theta)\) is the probability density function. The participation case is expressed as:
\[
EU_p(\pi_t) = \int_{\theta_{min}}^{\theta^*} U[\pi_t(\theta) + P(\theta) - F]g(\theta)d\theta
+ \int_{\theta_{min}}^{\theta_{max}} v[\pi_t(\theta) - F]g(\theta)d\theta \quad (4.3)
\]

where \(P(\theta)\) is the indemnity or program payment received, \(F\) is the premium or program fee paid, and \(\theta^*\) is the state of nature implicitly defined by the change in program year margin required to trigger a payment, as defined below in (4.4). Note that both the payment function and the current years’ net income \(\pi_t\) are random variables dependent on unknown states of nature \(\theta\). The payment function \(P(\theta)\) for an individual producer based on the structure of the AgriStability program:

\[P(\theta) = \delta 0.7[PYM(\theta)_t - PYM_{t-1}] \quad (4.4)\]

where

\[\delta = \begin{cases} 
1 & \text{if } PYM_t - PYM_{t-1} > 0.7RM_t \\
0 & \text{if } PYM_t - PYM_{t-1} < 0.7RM_t 
\end{cases}\]

and \(PYM_i\) is the program margin in year \(i\), and \(\delta\) indicates if a program payment is made. The payment is equal to 70% of this change, and a payment will be paid (\(\delta = 1\)) if the change in the program year margin is greater than 70% of the five-year reference margin.

By evaluating the expected utility of withdrawing from AgriStability compared to the expected utility of remaining enrolled, the decision to remain enrolled results if \(EU_{P_t} - EU_{W_t} > 0\) and the producer will withdraw if \(EU_{P_t} - EU_{W_t} < 0\).

### 4.2 An Alternative Model of Choice Under Uncertainty

With developments in behavioural economics, descriptive models have begun to surface which provide an alternative perspective on how economic agents make decisions
compared to behaviour under normative economic models, like the expected utility model. Rabbin (1998) provides a general discussion on how we cannot assume that each individual rationally maximizes their stable and coherent preferences, and the expected utility function $U(x)$ must be modified in order to make it more realistic based on what psychological research indicates regarding human choice.

Rabbin (1998) includes research that suggests an individual’s preferences can be determined by changes in outcomes relative to a reference point, rather than absolute levels of an outcome, as is the assumption in expected utility theory. More specifically, individuals tend to be more sensitive to losses in wealth than to gains. Rabbin (1998) discusses how the principle of loss aversion can be applied to economic research, however Khaneman and Tversky (1979) presented the initial theory in their seminal paper ‘Prospect Theory: An Analysis of Decision Under Risk.’ In the paper, the authors develop an alternative approach to expected utility theory by demonstrating the common and systematic violation of the axioms of expected utility theory through a series of hypothetical choice problems. These violations include (i) that the overall utility of a gamble is the expected utility of its outcomes, (ii) the domain of the utility function is final states, and (iii) that the utility function is concave (Khaneman & Tversky, 1979).

### 4.3 Overview of Prospect Theory

Economic agents display different behavioural characteristics under prospect theory than they do under expected utility theory (Freund & Ozden, 2008). Expected utility theory as an application of choices between lotteries is based on the three main tenants, which people are assumed to adhere to: (i) the overall utility of a prospect is the expected utility of its outcomes, (ii) the domain of the utility function is final states,
which includes an individual’s asset position, and (iii) risk aversion is assumed meaning the utility function is concave and that an individual person prefers a certain prospect $x$ to any risky prospect with expected value $x$ (Tversky & Kahneman, 1979).

The core principle of prospect theory is reference dependence, meaning individuals evaluate a decision based on losses or gains from a reference point or initial endowment, rather than the prospect’s effect on final wealth (Eckles & Wise, 2011). In other words, welfare is not only dependent on current state, but also in the change in states (Freund and Ozden, 2008). Two other key principles of prospect theory are diminishing sensitivity and loss aversion. Diminishing sensitivity implies that the marginal value of gains and losses decrease with their size, so an individual reacts more strongly to smaller gains and losses than to larger ones (Frend & Ozden, 2008). Loss aversion assumes that losses have a larger effect on welfare than corresponding gains.

The final component of prospect theory is probability weighting, which captures individuals’ preference for overweighting low probability events and underweighting high probability events.

Figure 9 depicts a hypothetical value function proposed by Tversky and Kahneman (1979), which resembles the expected utility function of a risk-averse consumer in the upper right quadrant. Losses and gains in wealth are depicted on the horizontal axis, and a value, or utility, is assigned to each gain or loss on the vertical axis. The kink of the value function at the reference point (the origin) creates an S-shaped value function that is concave in gains – indicating individuals are risk-averse in the domain of gains – and convex in losses – indicating individuals are risk-seeking in the
domain of losses. The function is also steeper for losses than for gains which captures the principle of loss aversion.


By expanding on equation (4.1), DellaVigna (2007) propose that individuals who exhibit prospect theory preferences evaluate the lottery \((x, p; y, 1 - p)\) as \(w(p)v(x - r) + w(1 - p)v(y - r)\), where \(v\) is value function which is defined over differences from the reference point \(r\), and \(w(p)\) is a probability weighting function where that overweights small probabilities and underweights large probabilities. The two key principles of prospect theory that are relevant to this analysis are (i) that individuals evaluate changes to income relative to a reference point, rather than final wealth, and (ii) that individuals value losses more heavily than gains. Given this simplification and the parameters outlined above, individuals will maximize:

\[
\sum_{i=1}^{n} p_i v(x_i | r) \tag{4.5}
\]

where the value function is defined as:
\[ v(x_i | r) = \begin{cases} 
  x - r & \text{if } x \geq r \\
  \lambda(x - r) & \text{if } x < r 
\end{cases} \]

and \( \lambda \) is a measure of loss aversion that is \( > 1 \). Research by Tversky and Khaneman (1992) indicate that this loss aversion measure is approximately equal to 2.25, or that losses are weighted roughly twice as heavily as gains.

### 4.4 Relevant Applications of Prospect Theory

Given that prospect theory was first introduced in 1979, there is relatively limited research that applies prospect theory to real-world choice settings. Barberis (2013) provides a comprehensive review and assessment of prospect theory in economics. He cites one of the main reasons for prospect theory not moving expansively beyond experimental settings is that it is difficult to determine exactly how to apply the theory, especially the challenge of accurately defining both the reference point and what constitutes a gain or loss\(^2\). Finance and insurance are the most common areas of research where prospect theory has been applied, likely because risk attitudes play a central role in the decision-making process and evidence from the finance and insurance disciplines indicate that behavioural factors influence financial decisions (Hwang, 2015). The following discussion will focus on prospect theory as it has been applied to insurance demand, since this area of research is most closely aligned with the problem of withdrawal from AgriStability.

There is a growing area of research that examines how differences in preferences and psychology affect insurance decisions (Eckles and Wise, 2011). In expected utility theory, risk-averse agents should fully insure against unfavourable events if the provided

\(^2\) Other applications of prospect theory are limited, but can be found in the industrial organization, contract choice, labour supply, trade theory, consumption choice and the endowment effect literature.
insurance is actuarially fair (Hwang, 2015). This means in the case of participation in AgriStability, under an expected utility framework the observed participation levels should be high and consistent. The phenomenon of low insurance demand has prompted some research that applies prospect theory as an alternative descriptive model of choice under uncertainty.

The prospect theory principle of loss aversion is the main focus of most insurance studies, which propose that the demand for insurance may be more closely related to loss aversion than risk aversion, as is generally assumed based on the concavity of the Bernoulli utility function (Hwang, 2015). The reason that loss aversion decreases the demand for insurance is because individuals may regard insurance as a risky investment that can cause losses, rather than solely as a protection measure (Hwang, 2015).

Eckles and Wise (2011) use prospect theory to explain why there is a lack of demand to insure high-loss, small probability events, and a high demand to insure small losses. Their hypothesis is that individuals will take action to avoid losses and maximize gains and choose insurance coverage to minimize the experience of a loss, should one occur. In the context of insurance decisions, because loss aversion indicates that individuals weigh losses more heavily than gains, they are willing to take on additional risk to avoid feeling a loss.

4.5 Applying Prospect Theory to the Problem of Withdrawal from AgriStability

For the purpose of this analysis the principles of reference dependence and loss aversion will be incorporated into a model of choice under uncertainty that is used to determine how prospect theory preferences affect the decision to withdraw from AgriStability. Like in (4.2) and (4.3), consider a producer who is participating \((P)\) in
AgriStability and faces income risk, and maximizes expected utility of net income ($\pi$).

The principles of reference dependence and loss aversion are also incorporated so that expected utility includes $f(\pi_t, \pi_{t-1})$ which includes the reference point of previous years’ income $\pi_{t-1}$, which in turn includes the parameter $b$ that captures loss aversion.

The value function that a producer maximizes for the case of withdrawal from AgriStability is defined as:

$$
EU_W(\pi_t | \pi_{t-1}) = \int_{\theta_{min}}^{\theta_{max}} u[\pi_t(\theta) + f(\pi_t(\theta) - \pi_{t-1})] g(\theta) d\theta 
$$

where

$$
f(\pi_t(\theta) - \pi_{t-1}) = \begin{cases} 
a(\pi_t - \pi_{t-1}) & \text{if } \pi_t \geq \pi_{t-1} \\
b(\pi_t - \pi_{t-1}) & \text{if } \pi_t < \pi_{t-1} \end{cases}
$$

and $|b| > a > 0 > b$. So $b$ is the measure of loss aversion which is scales utility from losses as greater than gains. The expected utility equation for the case of continued enrollment is expressed as:

$$
EV_P(\pi_t | \pi_{t-1}) = \int_{\theta_{min}}^{\theta^*} v[\pi_t(\theta) + f(\pi_t(\theta) - \pi_{t-1}) + P(\theta) - F] g(\theta) d\theta 
$$

$$
+ \int_{\theta_{min}}^{\theta_{max}} v[\pi_t(\theta) + f(\pi_t(\theta) - \pi_{t-1}) - bF] g(\theta) d\theta
$$

(4.7)

where again,

$$
f(\pi_t(\theta) - \pi_{t-1}) = \begin{cases} 
a(\pi_t - \pi_{t-1}) & \text{if } \pi_t \geq \pi_{t-1} \\
b(\pi_t - \pi_{t-1}) & \text{if } \pi_t < \pi_{t-1} \end{cases}
$$

and like in (4.3), $P(\theta)$ is the payment function, $F$ is the program fee, $g(\theta)$ is the probability density, and $\theta^*$ is the state of nature defined by (4.4).

The producer will remain enrolled in AgriStability as long as $EU_P - EU_W > 0$.

Variables that decrease $EU_P$ or increase $EU_W$, have an effect in increasing the likelihood
of withdraw from AgriStability and the opposite is true for variables which increase \( EU_p \) or decrease \( EU_w \). The next section will explore each variable and develop hypotheses for the effect they will have on the withdrawal decision; each variable and its expected effect on withdrawal is summarized at the end of the chapter in Table 4.

### 4.5.1 Deriving Testable Hypotheses

#### Previous Year’s Net Income

As the historical net income increases, the change in the program year margin will also increase, meaning producers will be more likely to receive a program payment. This increased likelihood of a program payment will increased the expected value of remaining in the program, and therefore decrease the likelihood of withdrawal. In formal terms using (4.6), an increase in \( \pi_{t-1} \) will cause \( EU_w \) to decrease since the \( f(\pi_t(\theta) - \pi_{t-1}) \) term will be smaller. This would indicate the producer is more likely to stay enrolled based on the expression \( EU_p - EU_w > 0 \).

However, an increase in \( \pi_{t-1} \) will also cause \( EU_p \) to decrease, so the participation decision will be based on whether or not program payment \( P(\theta) \) is received, and if \( P(\theta) > F \). If results show an increase the probability of withdrawal, this could be due to the farmers subjective belief that they are in a relatively protected financial position, and therefore do not see a need for further insurance under AgriStability.

#### Positive and Negative Change in Net Income from Previous Year

Under prospect theory, the key principle of sensitivity to losses compared to gains is tested by calculating variables of the relatively change in income from the previous year. Expressed algebraically, if \( (\pi_t(\theta) - \pi_{t-1}) \) is positive, that is \( \pi_t(\theta) \geq \pi_{t-1} \) then
$EU_W$ will increase, and $EU_W$ will decrease if $\pi_t(\theta) < \pi_{t-1}$ and the producer experiences a loss. This would result in the producer being more likely to exit the program if they experience a gain in net income, and remain enrolled if they experience a loss.

The changes in net income will have similar effects on $EU_P$ which results in the opposite participation effect based on $EU_P - EU_W > 0$ (i.e., gain in net income will cause $EU_P$ to increase which increases likelihood of participation; loss in net income will cause $EU_P$ to decrease which increases likelihood of withdrawal). However, a loss in net income increases likelihood of a program payment which may cause $EU_P$ to increase which would result in an increase in likelihood of continued participation. The expected sign of the gain and loss variables are therefore ambiguous, with the sign on the loss variable depending on whether the loss is large enough to trigger a payment.

_Previous Year’s AgriStability Payment_

Based on the equation (4.7) the larger the AgriStability program payment $P(\theta)$, the higher the expected utility from enrollment, which means the producer is less likely to withdraw from the program, giving an expected negative sign on the variable.

_No AgriStability Payment in Previous Year or Previous Two Years_

Brown et al. (2008) find that individuals view insurance as an investment and evaluate the expected gains or losses associated with purchasing a policy, or in our case choosing to enroll in AgriStability. Hwang (2015) echoes this theory, explaining how insurance can be viewed as a risky gamble rather than as a wealth protection measure. In the context of AgriStability, producers who are participating will lose the program fee if
is not triggered (i.e., if the program year margin does not fall below the historical reference margin), perhaps viewing the insurance program itself as a risk. Further, Hwang (2015) asserts that prospect theory individuals ignore diversification effects, meaning they evaluate the insurance decision in isolation for existing risks, instead focusing on the insurance policy’s own value.

Therefore, no payment in the previous year is expected to increase the likelihood of withdraw, because the second term of (4.7) \(+ \int_{\theta_{\text{max}}}^{\theta_{\text{min}}} u[\pi_t(\theta) + f(\pi_t(\theta) - \pi_{t-1}) - bF]g(\theta)d\theta\) will be used to calculate the \(EU_p\) which will be smaller than if the producer were not enrolled, as defined in 4.6. This means \(EU_p - EU_w < 0\) and the producer is more likely to withdraw.

Other Control Variables:

Enterprise Diversity: Sector concentration and Herfindahl Index

Based on previous literature, the more concentrated a sector is, the higher the demand is for risk management strategies, so we expect that the higher the concentration the operation is in the beef sector, the less likely the producer will be to withdraw from AgriStability. Conversely, the herfindahl index as a measure of crop diversity (in this case is generated as a measure of enterprise diversity) has the opposite effect, as the more diverse streams of revenue the less likely the demand for insurance, therefore the more likely withdrawal from AgriStability will be. However, given that AgriStability is a whole-farm revenue program the effects of these two production characteristics may be ambiguous.
**Operation Type**

We expect that larger operations, generally feedlot operations, will be more likely to withdraw from AgriStability based on their ability to leverage debt. However, feedlots operate on very thin margins, so may be more likely to demand insurance in the case of an unpredictable year. The fluctuations in yearly margins also means that farmers may experience a cycle of payments with more certainty than other types of operations with more predictable net income, such as the cow-calf sector.

**Ad hoc Payments**

We expect that ad hoc payments from other government programs will increase the likelihood of withdrawal, since producers may not have to rely as much on the AgriStability payments for income support. If this is the case, it would be evidence that ad hoc programs have crowding-out effects on AgriStability. If the opposite effect is found, it may be the case that producers may not feel the program fee as a loss, since they still received some indemnity payment from the government, even if not from AgriStability. In algebraic terms, the adhoc payment would enter both into (4.6) and (4.7) as a positive term and increase both $EU_w$ and $EU_p$.

**Policy Change in 2008**

We expect that after 2008 when the Growing Forward 2 policy framework was introduced, producers are more likely to withdraw from AgriStability. Changes to the program make it less likely for a decrease in the program year margin to trigger a payment, therefore decreasing the expected value of enrollment. This could also be
framed in terms of $F$ as it enters into the first term of (4.7). The larger this value the lower the $EU_p$ which increases the likelihood of withdrawal.

Table 4. Summary of Explanatory Variables, with Description and Expected Sign

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Description</th>
<th>Expected Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program margin$_{t-1}$</td>
<td>The previous year’s program year margin on which AgriStability payments are based</td>
<td>-</td>
</tr>
<tr>
<td>Program margin increase</td>
<td>Positive change in the program year margin between previous year and the decision year</td>
<td>-/+</td>
</tr>
<tr>
<td>Program margin decrease</td>
<td>Negative change in the program year margin between previous year and the decision year</td>
<td>-/+</td>
</tr>
<tr>
<td>AgriStability payments$_{t-2}$</td>
<td>Most recent program payment from AgriStability</td>
<td>-</td>
</tr>
<tr>
<td>% no payment in t-2</td>
<td>=1 if received a payment from AgriStability in t-2</td>
<td>-/+</td>
</tr>
<tr>
<td></td>
<td>=0 if otherwise</td>
<td></td>
</tr>
<tr>
<td>% no payment in t-3</td>
<td>=1 if received a payment from AgriStability in t-3</td>
<td>-/+</td>
</tr>
<tr>
<td></td>
<td>=0 if otherwise</td>
<td></td>
</tr>
<tr>
<td>Sector concentration$_{t-1}$</td>
<td>% revenue derived from specified sector</td>
<td>-</td>
</tr>
<tr>
<td>Herfindahl index$_{t-1}$</td>
<td>Index of enterprise diversity</td>
<td>+</td>
</tr>
<tr>
<td>Operation Type: Feedlot</td>
<td>=1 if operation is a feed lot</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>=0 if operation is a cow-calf operation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=0 if operation is other type of operation</td>
<td></td>
</tr>
<tr>
<td>Operation Type: Other</td>
<td>=1 if operation is a cow-calf operation</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>=0 if operation is a feed lot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=0 if operation is other type of operation</td>
<td></td>
</tr>
<tr>
<td>Ad hoc payment from beef program$_{t-1}$</td>
<td>Payments received from ad hoc programs specific to beef farmers in the decision year</td>
<td>-/+</td>
</tr>
<tr>
<td>Ad hoc payment from other program$_{t-1}$</td>
<td>Payments received from all other ad hoc programs in the decision year</td>
<td>-/+</td>
</tr>
<tr>
<td>Policy Change in 2008</td>
<td>=1 if year is 2008 to 2013</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>=0 if year is 2003 to 2007</td>
<td></td>
</tr>
</tbody>
</table>

4.6 Chapter Summary

The purpose of this chapter was to outline how expected utility frameworks has used to examine determinants of insurance adoption and demand for insurance, along with relevant findings of those studies. Given the drawbacks of the standard expected
utility model in terms of its ability to reflect observed human behaviour of choice under uncertainty, prospect theory is discussed as an alternative model of decision-making that incorporates risk. The final section of the chapter develops a conceptual model of withdrawal from AgriStability using the prospect theory preferences of reference dependence and loss aversion, and outlines the hypotheses to be tested in Chapter 6.
CHAPTER 5: Data and Variable Description

5.0 Chapter Introduction

The purpose of this chapter is to describe the data used in this analysis and the specifics of how each variable is generated. The unique nature of the Ontario Farm Income Database is outlined, particularly as it relates to the research question of determinants of withdrawal from AgriStability. The second section of the chapter describes each variable that is used in the analysis individually, including how each variable is generated. The chapter ends with a presentation of the summary statistics of the explanatory variables.

5.1 The Ontario Farm Income Database

The data for this analysis comes from the Ontario Farm Income Database (OFID), which is collected by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). The dataset includes data for all Ontario farmers who reported farming income as part of the Canadian Agricultural Income Stabilization (CAIS) program, which ended in 2007, or in the AgriInvest and AgriStability programs from 2007 onward. The dataset is primarily used for income tax purposes and to administer program payments, however, the program data on government payments and participation status offers a unique opportunity for an assessment of the demand for whole-farm revenue insurance programs that is not possible with traditional datasets on the farm sector.

The OFID consists of five parts: (1) non-financial characteristics of the operator; (2) income and expense data from tax files; (3) program payment data and participation status; (4) beginning and ending inventory data of commodities each year; and (5)
production data, including acreage and revenue. It is important to note that each observation is assumed to be an individual farm operator, rather than a farm entity.

The criteria used in the sample selection are (1) filed taxes between 2003 and 2013, (2) are beef farm operators, and (3) were participating in AgriStability in time $t - 1$. The number of farm operators in the sample is 6,917 and the number of operations or farm entities is 3,742. The ability of the OFID to link operators with their respective operations is another unique feature of the dataset, compared to larger datasets that only report findings at the operator level, for example the Census of Agriculture and the Taxation Data Program. This means the results obtained using the OFID may differ slightly because of the farm-level aggregations. For example, a partnership that would otherwise treat the farm as two entities and therefore put each in a lower revenue bracket, would be treated as one and categorized in the appropriate higher revenue class if using the OFID.

In order to be classified as a beef farm, at least 50% of total farm revenue must come from beef sales. Originally, the sample only contained those farms that fit this description, and where yearly data was missing the observation was treated as a withdrawal. However, it became clear that some farms were remaining in AgriStability, and simply changing sector classification. To fix this problem, the sample was specified again, retaining all observations for farms that were classified as a beef farm for at least one year in the eleven-year panel. A hypothetical example of a farm operator with this issue would look as follows:

Table 5. Inclusion of Farms that Switch-Sectors into the Sample.

<table>
<thead>
<tr>
<th>Original Sample</th>
<th>New Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Id</td>
<td>Year</td>
</tr>
</tbody>
</table>

55
In the original sample Farm 8030 appears to have withdrawn from AgriStability in 2005, 2006, and 2011. Beef farms make up 72.5% of all observations and field crops make up 20.3% of observations. Fifteen sector types make up the remaining 7.2% of observations, with a less than 2% share each. These sectors include dairy, mixed operations, and swine operations. Table 6 shows sector representation by year. During the high crop price periods of 2008 to 2012, there is a larger increase in field crop farms, indicating those farms previously classified as beef farms are receiving more than 50% of revenue from field crop production. The general trend is that the share of beef farms is declining and the share of field crop operations is increasing over the study period. Again, only those classified as beef operations were used in the sample for analysis.

Table 6. Percentage Sector Type by Year, 2003 - 2013.
Additionally, the beef farm operation can be decomposed further by type of operation. Cow-calf operations, or beef cattle farms, are responsible for the breeding and rearing of each new generation of young stock, raising animals to between 500 and 600 lbs. before selling them to feedlots. This type of farm makes up 86.5% of all beef farms. Feedlots, or cattle feeder farms, finish animals to be sold for slaughter. This operation type is characterized by high volume, high turnover and thin profit margins. Feedlots make up 9.8% of all beef farm types in the sample. Other operation types account for the remaining 3.7% of beef farms and include dairy heifers, other livestock, and mixed operations, but still receiving more than 50% of their revenue from beef production.

Again, we can break up the type of beef operation by year to gain more insight into industry trends (see Table 7). Although the percentage of cow-calf operations has been declining, it still remains by far the largest sector in terms of share of operation type. The percentage of total beef farms that are feedlots has been increasing steadily from 9.2% to 14.1%, while the other operation types hover between 3% and 4%.

Table 7. Percentage Beef Operation Type by Year, 2003 - 2013.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cow-Calf</th>
<th>Feed Lot</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>86.7%</td>
<td>9.2%</td>
<td>4.1%</td>
</tr>
<tr>
<td>2004</td>
<td>88.5%</td>
<td>7.4%</td>
<td>4.1%</td>
</tr>
<tr>
<td>2005</td>
<td>88.3%</td>
<td>8.5%</td>
<td>3.2%</td>
</tr>
<tr>
<td>2006</td>
<td>88.1%</td>
<td>8.6%</td>
<td>3.3%</td>
</tr>
<tr>
<td>2007</td>
<td>87.4%</td>
<td>9.3%</td>
<td>3.4%</td>
</tr>
<tr>
<td>2008</td>
<td>87.4%</td>
<td>8.8%</td>
<td>3.9%</td>
</tr>
</tbody>
</table>
The OFID dataset is an unbalanced panel, with year observations missing when the farmer did not file taxes. This creates problems for the generation of lagged variables. For all missing years, it is assumed that farmers are not enrolled in AgriStability, so the panel was expanded to a balanced panel in order to accommodate this problem. Each farm now has eleven years of observations, with missing data for all missing years. Continuing with the representative Farm 8030, the expanding and remerging of the dataset from an unbalanced to a balanced panel looks as follows:

Table 8. Creating a Balanced Panel.

<table>
<thead>
<tr>
<th>Unbalanced Panel</th>
<th>Balanced Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Id</td>
<td>Year</td>
</tr>
<tr>
<td>8030</td>
<td>2003</td>
</tr>
<tr>
<td>8030</td>
<td>2004</td>
</tr>
<tr>
<td>8030</td>
<td>2005</td>
</tr>
<tr>
<td>8030</td>
<td>2008</td>
</tr>
<tr>
<td>8030</td>
<td>2008</td>
</tr>
<tr>
<td>8030</td>
<td>2010</td>
</tr>
</tbody>
</table>
To further clean the data, an outlier variable is generated to account for those farms with revenue greater than $10 million. This cut-off was chosen based on advice from policy analysts at OMAFRA, who iterated that $10 million is a reasonable maximum revenue for a representative beef farm in Ontario. After outliers are accounted for, the number individual farms falls to 6,910, which omits seven farms or 86 individual observations. Table 9 shows the total number and percentage of farms by sales class from 2003 to 2013 for the full sample in OFID. In general there was a decrease in the total number of farms in the lowest two revenue class categories. Some of the decrease in those farms is due to attrition, and some is due to consolidation, which is reflected in the increased number of farms in the top revenue class. There is also growth in the $100,000 to $250,000 category.


<table>
<thead>
<tr>
<th>Year</th>
<th>&gt;0 &amp; &lt;10</th>
<th>&gt;10 &amp; &lt;100</th>
<th>&gt;100 &amp; &lt;250</th>
<th>&gt;250 &amp; &lt;500</th>
<th>&gt;500</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>1,181 (14.8%)</td>
<td>4,527 (56.8%)</td>
<td>1,245 (15.6%)</td>
<td>589 (7.4%)</td>
<td>433 (5.4%)</td>
<td>7975</td>
</tr>
<tr>
<td>2004</td>
<td>1,509 (18.7%)</td>
<td>4,560 (56.5%)</td>
<td>1,094 (13.6%)</td>
<td>553 (6.9%)</td>
<td>349 (4.3%)</td>
<td>8065</td>
</tr>
<tr>
<td>2005</td>
<td>1,330 (16.0%)</td>
<td>4,906 (58.9%)</td>
<td>1,109 (13.3%)</td>
<td>563 (6.8%)</td>
<td>419 (5.0%)</td>
<td>8327</td>
</tr>
<tr>
<td>2006</td>
<td>1,370 (16.9%)</td>
<td>4,647 (57.4%)</td>
<td>1,101 (13.6%)</td>
<td>559 (6.9%)</td>
<td>422 (5.2%)</td>
<td>8099</td>
</tr>
<tr>
<td>2007</td>
<td>1,581 (19.2%)</td>
<td>4,517 (54.9%)</td>
<td>1,109 (13.5%)</td>
<td>566 (6.9%)</td>
<td>458 (5.6%)</td>
<td>8231</td>
</tr>
<tr>
<td>2008</td>
<td>1,426 (17.9%)</td>
<td>4,322 (54.3%)</td>
<td>1,162 (14.6%)</td>
<td>546 (6.9%)</td>
<td>508 (6.4%)</td>
<td>7964</td>
</tr>
<tr>
<td>2009</td>
<td>1,524 (20.0%)</td>
<td>4,107 (53.2%)</td>
<td>1,088 (14.1%)</td>
<td>518 (6.7%)</td>
<td>469 (6.1%)</td>
<td>7706</td>
</tr>
<tr>
<td>2010</td>
<td>1,248 (17.4%)</td>
<td>3,770 (52.6%)</td>
<td>1,156 (16.1%)</td>
<td>506 (7.1%)</td>
<td>487 (6.8%)</td>
<td>7167</td>
</tr>
<tr>
<td>2011</td>
<td>1,146 (16.3%)</td>
<td>3,610 (51.4%)</td>
<td>1,190 (16.9%)</td>
<td>544 (7.7%)</td>
<td>537 (7.6%)</td>
<td>7027</td>
</tr>
<tr>
<td>2012</td>
<td>1,059 (16.1%)</td>
<td>3,229 (49.0%)</td>
<td>1,183 (18.0%)</td>
<td>556 (8.4%)</td>
<td>557 (8.5%)</td>
<td>6584</td>
</tr>
<tr>
<td>2013</td>
<td>1,007 (16.0%)</td>
<td>3,091 (49.2%)</td>
<td>1,116 (17.8%)</td>
<td>514 (8.2%)</td>
<td>557 (8.9%)</td>
<td>6285</td>
</tr>
</tbody>
</table>

Source: Ontario Farm Income Data Base internal calculations, OMAFRA.
5.2 Variable Definition

The variables discussed in Chapter 4 are outlined below, including a description of how each variable was constructed. The key variables of analysis are previous years’ net farm income or program year margin (Note: these two terms will be used interchangeably), the positive and negative changes in net income, and AgriStability payment variables. Additional control variables include sector concentration and the Herfindahl index of enterprise diversity, operation type, and other farm financial and production characteristics. The process for how each variable was generated will be provided, and summary statistics are reported and discussed at the end of the section.

5.2.1 Dependent Variable

Withdrawal from AgriStability

Withdraw is defined as the event whereby a producer enrolled in AgriStability in time \( t - 1 \) decides to exit the program at time \( t \), and is therefore conditional on enrollment up until time \( t \). In the OFID, participation in AgriStability is characterized as ‘FULL’, ‘NO’, or ‘PARTIAL’. To construct the withdrawal variable, first a dichotomous AgriStability participation variable is generated as follows:

\[
\text{participation}_t = 1 \text{ if status} = \text{FULL or PARTIAL} \\
\text{participation}_t = 0 \text{ if status} = \text{NO}
\]

Those farms that have a status of PARTIAL account for 1.35% of the sample so they have been grouped with FULL status and defined as participation = 1. From here the binary withdrawal variable is constructed as follows:

\[
\text{Withdrawal}_t = \begin{cases} 
1 \text{ if } \text{participation}_t = 0 \text{ or missing } | \text{participation}_{t-1} = 1 \\
0 \text{ if } \text{participation}_t = 1 | \text{participation}_{t-1} = 1
\end{cases}
\]
Farmers are remaining in the program consecutively for an average of 5 years, and 35% of farms participate in AgriStability continuously over all eleven years. Of those farmers that participate continuously, 48% belong to the operating revenue category of $10,000 to $100,000. In terms of exit behaviour, 90% of the farms only enter the program once, meaning they either exit permanently or are still enrolled in the program in 2013 when the sample ends. Only 9% drop out and re-enter at least once, 0.7% withdraw and re-enter twice, and 0.07% withdraw and re-enter three times. This means most farms have a consistent participation strategy in that they are not exiting and re-entering many times, and implies that a withdraw from AgriStability is likely a permanent exit.

Table 10 shows the percentage of producers participating in AgriStability in each year and revenue size category, with participation calculated by tabulating the percentage of observations where participation, $t = 1$. For example for the 0 to $10,000 sales class, 64.4% of farmers were participating in AgriStability in 2003, and the percentage declined to 14.4% by 2013, constituting the largest percentage change in participation across all revenue categories. The same general trend of declining participation is consistent across all income categories, although it is not always a monotonic decline. The largest absolute change is in the $10,000 to $100,000 category, from 3,023 farms in 2003 to 813 farms in 2013. For the largest income category the absolute number of farms does not change too drastically, however participation falls by 20% over the study period.

Table 10. Number (Percentage) of Producer Participating in AgriStability by Year and Revenue Size, 2003 - 2013.

<table>
<thead>
<tr>
<th>Revenue Sales Class ($ thousands)</th>
<th>Year</th>
<th>&gt;0 &amp; &lt;10</th>
<th>&gt;10 &amp; &lt;100</th>
<th>&gt;100 &amp; &lt;250</th>
<th>&gt;250 &amp; &lt;500</th>
<th>&gt;500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
<td>546 (64.4%)</td>
<td>3,023 (82.1%)</td>
<td>826 (92.9%)</td>
<td>440 (97.1%)</td>
<td>357 (96.5%)</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>622 (58.1%)</td>
<td>2,855 (80.0%)</td>
<td>683 (93.6%)</td>
<td>370 (96.9%)</td>
<td>262 (95.3%)</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>412 (48.3%)</td>
<td>3,072 (77.6%)</td>
<td>712 (90.7%)</td>
<td>399 (93.9%)</td>
<td>327 (96.2%)</td>
</tr>
</tbody>
</table>
Table 11 shows the percentage of withdrawal from AgriStability by year and revenue category size, calculated by tabulating the percentage of withdrawal, \( t = 1 \).

Remember, the withdrawal variable is constructed over a two year period, where participation \( t-1 = 1 \) and participation \( t = 0 \). The year 2003 is excluded from the sample because withdrawal is calculated using a lagged variable. Unlike the previous table, the absolute number of farms that are withdrawing from AgriStability in a given year does not change drastically over the eleven-year period. However, the percentage of farms withdrawing is increasing over time across all revenue sales classes. The top three classes all have a withdrawal rate increase of around 9% over the period, for example the over $500,000 category starts off with 1.9% of farms withdrawing in 2003, to 11.7% of farms withdrawing in 2013. The two lowest income categories experience larger rates of withdrawal, with the largest in the 0 to $10,000 category from 10.3% in 2003 to 28.6% in 2013 (a change of 18.3%).

Table 11. Number (Percentage) of Producers Withdrawing from AgriStability by Year and Revenue Size, 2003 - 2013.

<table>
<thead>
<tr>
<th>Year</th>
<th>&gt;0 &amp; &lt;10</th>
<th>&gt;10 &amp; &lt;100</th>
<th>&gt;100 &amp; &lt;250</th>
<th>&gt;250 &amp; &lt;500</th>
<th>&gt;500</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>68 (10.3%)</td>
<td>192 (6.4%)</td>
<td>15 (2.2%)</td>
<td>6 (1.6%)</td>
<td>5 (1.9%)</td>
</tr>
<tr>
<td>2005</td>
<td>33 (8.5%)</td>
<td>138 (4.6%)</td>
<td>22 (3.1%)</td>
<td>6 (1.6%)</td>
<td>3 (0.9%)</td>
</tr>
<tr>
<td>2006</td>
<td>59 (14.9%)</td>
<td>301 (10.8%)</td>
<td>40 (5.5%)</td>
<td>13 (3.2%)</td>
<td>8 (2.5%)</td>
</tr>
<tr>
<td>2007</td>
<td>70 (18.7%)</td>
<td>234 (10.1%)</td>
<td>25 (4.0%)</td>
<td>18 (5.0%)</td>
<td>12 (3.7%)</td>
</tr>
</tbody>
</table>
The reported statistics in Table 10 and Table 11 indicate the importance of conducting the regression analysis based on individual revenue categories, rather than solely on the aggregate level in order to properly provide inferences regarding the efficiency of the program, and the ability of the program to provide support to those who need it most.

5.2.2 Key Explanatory Variables

Based on the conceptual framework and hypotheses developed in Chapter 4, the key explanatory variables are chosen to test for the presence of prospect theory and to explore the determinants of withdrawal from AgriStability more generally. The analysis includes variables that are relevant to the distribution of profits and therefore relevant to the AgriStability participation decision.

Net Income (Program Year Margin)

In Chapter 2, the program year margin is defined as total allowable income less total allowable expenses. In the OFID, there is a measure for net income called EBITA that closely represents the year margin. EBITA stands for Earnings Before Interest, Tax, and Amortization and it is calculated subtracting non-operating revenue, total operating expenses, interest expenses, and capital and depreciation expenses from total operating revenue, and does not incorporate non-allowable income or non-allowable expenses.
According to Poon (2013), this variable gives a more accurate measure of farm financial performance and net income than total operating revenue less total operating expenses alone.

Since the participation decision being considered at time $t$, the farmer will use the program margin at time $t-1$ to make that decision. The historical program margin is represented in the model by the log of previous years’ net income, $\ln \text{program margin}_{t-1}$. The log form of net income is chosen to smooth the distribution. In taking the natural log, all negative net income observations are excluded from the analysis, which could impact the analysis by biasing the result in terms of those who are withdrawing including making it more frequent as a percentage of total withdrawals, as it is unlikely that those with negative net income would withdraw in the next period.

Gain and Loss Variables

For the gain and loss variables, the “previous” year is at time $t-2$ since the farmer is making his/her withdrawal decision at $t-1$. With this in mind, the program margin gain and loss variables are calculated as follows:

$$\text{Diff} = \text{program margin}_{t-1} - \text{program margin}_{t-2}$$

The gains are differentiated from the losses:

$$\text{Gain} = \begin{cases} \text{Diff} & \text{if Diff} > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\text{Loss} = \begin{cases} |\text{Diff}| & \text{if Diff} < 0 \\ 0 & \text{otherwise} \end{cases}$$

then, take the natural-log of the Gain and Loss variables, again to smooth the distribution.
AgriStability Program Payments

Besides gains and losses in the program year margin, changes in farmers’ financial position are also felt based on program receipts, so a number of variables to capture the effects of AgriStability payments are included in the analysis. The payment data included in the OFID is based on actual, calculated payments from OMAFRA rather than those reported by the operators. Payments are linked to the program year in which they are triggered, not the year the operator receives the funds. The timeline for when payments are triggered and received is important to consider: farmers in \( t - 1 \) who are currently enrolled in AgriStability and deciding whether or not to remain enrolled or withdraw in time \( t \) will not have received a program payment from that period (time \( t - 1 \)) even if a payment was triggered. Therefore, when estimating the effects of historical program payments, the payment the farmer received in \( t - 2 \), and the second most recent payment they received in \( t - 3 \) are used to generate the program payment variables. The period at \( t - 1 \) when the farmers are considering whether or not to continue participating in AgriStability will be referred to as the ‘decision period.’

The first variable is the log of payments that a farmer received in the previous year (time \( t - 2 \)), \( \ln \text{AgriStability payment}_{t-1} \). The other two variables that represent the effect of AgriStability payment receipts are dummies for whether farmers received a payment or not, or whether the farmer experienced a gain or loss in terms of expected returns from participation in AgriStability. The dummy for a payment in the previous year is constructed by lagging program payments by one year from decision period (\( t - 1 \)) and letting \( \text{no payment in } t - 2 = 1 \) if the farmer did not receive a payment in the previous year, and setting \( \text{no payment in } t - 2 = 0 \) if payment in the previous year was greater than 0.
Similarly, the dummy for a payment in the two years prior to the decision year, is no payment\textit{ in }t-3 = 1 \text{ if the farmer did not receive any payment two years ago, and no payment\textit{ in }t-3 = 0 \text{ if the payment in that year was greater than }0.\

\textit{5.2.3 Additional Control Variables}\

\textit{Enterprise Diversity}\

Variables used in the sensitivity analysis to check for robustness of results include measures for enterprise diversity, operation type, ad-hoc program payments and a structural break to account for policy changes. The two enterprise diversity variables are (i) the sector concentration, defined by the percentage of sales generated by that sector and is as $\in [0,1]$, and (ii) the Herfindahl index of diversity, which is also $\in [0,1]$ and was calculated by OMAFRA analysts specifically for the purposes of this study to reflect the diversity of the beef enterprise. The closer to 1 the index is, the more diversified the operation is in terms of production. Once-lagged \textit{sector concentration}_{t-1} and \textit{Herfindahl index}_{t-1} are used in the analysis to be consistent with the logic that the farm is using data from the previous year to make a decision regarding participation status (they are in the decision period of t-1).\

\textit{Type of Operation}\

As mentioned previously, there are three types of beef operations: beef cattle, cattle feeder, and other. Two dummy variables are constructed to estimate the difference in the probability of withdrawal compared to the most prevalent operation type, beef cattle or cow-calf operations. These variables are defined as follows:

\[ Feedlot = \begin{cases} 
1 & \text{if \ operation \ is \ a \ feedlot} \\
0 & \text{if otherwise} 
\end{cases} \]
\[
Other = \begin{cases} 
1 & \text{if operation is not a feedlot or cow – calf operation} \\
0 & \text{if otherwise}
\end{cases}
\]

Refer to Table 5.3 for a description of operation type by revenue size over time.

*Ad Hoc Government Program Payments*

The effect of ad hoc program payments are an important element of the analysis, since it is possible that government payments from other ad hoc programs that farmers are automatically enrolled in are crowding out the effect of AgriStability payments and increasing the likelihood of withdrawal. The ad hoc payment variable is generated in the same way as the AgriStability program payment variable. The only difference is that the log ad hoc program variable is created for the decision period and is once lagged rather than twice lagged, since the farmer will generally receive the payment in the same year it is triggered. Two ad hoc payment variables are estimated, one for ad hoc payments specific to beef production \(\ln \text{beef adhoc payment}_{t-1}\), and one for other ad hoc payments \(\ln \text{other adhoc payment}_{t-1}\).

*Structural Policy Break*

Finally, a structural break variable is generated to test whether withdrawal is more likely after 2008, when Growing Forward 2 was introduced. This dummy variable is created as follows:

\[
Break = \begin{cases} 
1 & \text{if year} = 2008 - 2013 \\
0 & \text{if year} = 2003 - 2007
\end{cases}
\]
As mentioned in Chapter 4, we expect that for the years 2008 – 2013 farms will be more likely to withdraw from AgriStability compared to the likelihood of withdraw during the years 2003 to 2007 under CAIS, due to structural changes to the program that increase the program fees and decrease the coverage level. Refer to Table 3.2 for a review of how the program changed with the introduction of each new policy framework.

5.3 Summary Statistics

The summary statistics for key explanatory variables are presented in Table 12. The program year margin for the lowest two income categories is negative, and increases across revenue categories from there. The average program margin in the previous year for those farms that are larger than $500, 000 is $60,780. On average producers are experiencing much larger increases in their program margin, $63, 450, than decreases in their margin, $20, 430. This trend persists over all revenue categories, with only the $100-$250k and >$500k categories being relatively closer in terms of average increases and decreases in program margin from the year previous to the decision year.

AgriStability payments are increasing across revenue categories as expected, since the reference margin depends on the program year margin, which is increasing over categories as well. Also, large farms tend to be feedlots, which are characterized by relatively thin margins. This could affect the reference margin and in turn the level of payments from AgriStability. Finally, a slightly higher proportion of farmers did not receive a payment in the previous year to the decision year in the lower revenue categories than the higher categories. The same trend is evident for the percentage of farmers not receiving a payment in the two years prior to the decision year.
Table 12. Summary Statistics by Revenue Size Category, by Mean (Standard Deviation)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
<th>0-$10k</th>
<th>$10-$100k</th>
<th>$100-$250k</th>
<th>$250-$500k</th>
<th>&gt;$500k</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Withdrawal</td>
<td>0.13</td>
<td>0.15</td>
<td>0.10</td>
<td>0.06</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.35)</td>
<td>(0.30)</td>
<td>(0.24)</td>
<td>(0.21)</td>
<td>(0.21)</td>
</tr>
<tr>
<td>Explanatory Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program margin_{t-1} ('000)</td>
<td>7.97</td>
<td>-3.07</td>
<td>-1.20</td>
<td>8.74</td>
<td>14.10</td>
<td>60.78</td>
</tr>
<tr>
<td></td>
<td>(179.45)</td>
<td>(18.76)</td>
<td>(31.81)</td>
<td>(58.04)</td>
<td>(81.28)</td>
<td>(551.92)</td>
</tr>
<tr>
<td>Program margin increase ('000)</td>
<td>63.45</td>
<td>162.47</td>
<td>45.26</td>
<td>23.44</td>
<td>123.97</td>
<td>104.59</td>
</tr>
<tr>
<td></td>
<td>(4266.08)</td>
<td>(7124.19)</td>
<td>(4658.07)</td>
<td>(230.31)</td>
<td>(4920.70)</td>
<td>(464.08)</td>
</tr>
<tr>
<td>Program margin decrease ('000)</td>
<td>20.43</td>
<td>4.30</td>
<td>7.81</td>
<td>18.20</td>
<td>28.47</td>
<td>99.75</td>
</tr>
<tr>
<td></td>
<td>(162.07)</td>
<td>(12.40)</td>
<td>(27.58)</td>
<td>(47.50)</td>
<td>(61.56)</td>
<td>(496.66)</td>
</tr>
<tr>
<td>% Program margin increase</td>
<td>0.51</td>
<td>0.49</td>
<td>0.50</td>
<td>0.51</td>
<td>0.52</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.50)</td>
<td>(0.50)</td>
<td>(0.50)</td>
<td>(0.50)</td>
<td>(0.50)</td>
</tr>
<tr>
<td>AgriStability payments_{t-2} ('000)</td>
<td>6.52</td>
<td>2.13</td>
<td>3.23</td>
<td>6.08</td>
<td>8.65</td>
<td>27.03</td>
</tr>
<tr>
<td></td>
<td>(35.32)</td>
<td>(4.37)</td>
<td>(8.26)</td>
<td>(19.63)</td>
<td>(23.95)</td>
<td>(102.51)</td>
</tr>
<tr>
<td>% No payment in t-2</td>
<td>0.57</td>
<td>0.50</td>
<td>0.54</td>
<td>0.62</td>
<td>0.63</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>(0.49)</td>
<td>(0.50)</td>
<td>(0.50)</td>
<td>(0.49)</td>
<td>(0.48)</td>
<td>(0.47)</td>
</tr>
<tr>
<td>% No payment in t-3</td>
<td>0.28</td>
<td>0.23</td>
<td>0.25</td>
<td>0.31</td>
<td>0.32</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>(0.45)</td>
<td>(0.42)</td>
<td>(0.43)</td>
<td>(0.46)</td>
<td>(0.47)</td>
<td>(0.49)</td>
</tr>
<tr>
<td>Sector concentration_{t-1}</td>
<td>0.872</td>
<td>0.925</td>
<td>0.880</td>
<td>0.848</td>
<td>0.837</td>
<td>0.864</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
<td>(0.14)</td>
<td>(0.16)</td>
<td>(0.16)</td>
<td>(0.16)</td>
<td>(0.15)</td>
</tr>
<tr>
<td>Herfindahl index_{t-1}</td>
<td>0.518</td>
<td>0.541</td>
<td>0.573</td>
<td>0.479</td>
<td>0.410</td>
<td>0.341</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.18)</td>
<td>(0.19)</td>
<td>(0.26)</td>
<td>(0.26)</td>
<td>(0.25)</td>
</tr>
<tr>
<td>Operation Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedlot</td>
<td>0.133</td>
<td>0.001</td>
<td>0.001</td>
<td>0.056</td>
<td>0.521</td>
<td>0.795</td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.23)</td>
<td>(0.50)</td>
<td>(0.40)</td>
</tr>
<tr>
<td>Other</td>
<td>0.036</td>
<td>0.076</td>
<td>0.022</td>
<td>0.026</td>
<td>0.047</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.27)</td>
<td>(0.15)</td>
<td>(0.16)</td>
<td>(0.21)</td>
<td>(0.29)</td>
</tr>
<tr>
<td>Adhoc payment from beef_{t-1} ('000)</td>
<td>2.460</td>
<td>0.190</td>
<td>0.590</td>
<td>1.830</td>
<td>3.210</td>
<td>14.610</td>
</tr>
<tr>
<td></td>
<td>(26.49)</td>
<td>(0.73)</td>
<td>(5.45)</td>
<td>(8.13)</td>
<td>(12.37)</td>
<td>(79.66)</td>
</tr>
<tr>
<td>Adhoc payment from other_{t-1} ('000)</td>
<td>5.020</td>
<td>0.550</td>
<td>1.490</td>
<td>3.990</td>
<td>6.910</td>
<td>27.280</td>
</tr>
<tr>
<td></td>
<td>(25.39)</td>
<td>(1.29)</td>
<td>(2.77)</td>
<td>(7.91)</td>
<td>(9.91)</td>
<td>(74.49)</td>
</tr>
</tbody>
</table>

The summary statistics for the supplementary control variables used in the sensitivity analysis are also presented by revenue size. Sector concentration ranges from
0.84 to 0.93 meaning that most farms are highly concentrated as beef farms. The Herfindahl index is slightly lower across revenue size categories, meaning from 0.31 to 0.57 of the beef farm operation is diversified among other revenue streams. Larger farms are less diversified, so it follows that 80% of beef farms operate as feedlots. Only 0.1% of farms in the smallest two revenue categories are feedlot operations and under 10% of the same farms are other operations, meaning the majority of small farms (in terms of revenue size) are cow-calf operations. The largest size farms are also receiving the largest ad hoc payments from beef, which may stem from disease events or widespread industry losses. These large farms also receiving substantially more ad hoc payments from other government programs than the other size categories.

5.4 Chapter Summary

The purpose of this chapter was to discuss the unique data contained in the OFID. The dataset provides an opportunity for exploration of the determinants of withdrawal from a government whole-farm revenue insurance program that is not possible with other agricultural datasets. Some of the key elements of the data were presented, as they pertain to Ontario beef farms and relevance to the research question. The second part of the chapter outlined the specific variables that are used in the empirical model in Chapter 5, with a description of how each variable was constructed. The chapter ended with a description of the summary statistics of the variables by revenue class.
CHAPTER 6: Empirical Methods

6.0 Introduction to Chapter

The purpose of this chapter is to develop the empirical model that will be used to test the principles of prospect theory on the decision to withdraw from AgriStability. The chapter begins with a description of the empirical models used in previous research on the determinants of insurance adoption and relevant findings. This overview is necessary in order to build an empirical model with appropriate assumptions and specifications. The second section of the chapter describes the logistic year-fixed effects model that is used to test the hypotheses developed in Chapter 4.

6.2 Empirical Model

Binary choice models specify the relationship between set of covariates influence the binary (0/1) dependent variable, and there are a number of models that can be used to model this discrete choice. The following section will outline the standard latent regression model, specify and justify the functional form that is used in the analysis, and outline the estimation method. The theory used to describe the empirical model is adapted from Greene, 7th Edition (2012).

The Latent Regression Model

The concept behind a latent regression model, is that a discrete choice reflects an underlying regression, and that the consumer makes a calculation based on expected utilities achieved by choosing one outcome over another. In the case of withdrawal from AgriStability, the producer considers the marginal benefit/marginal cost of remaining enrolled in AgriStability compared to withdrawing. From Chapter 4, we know a farmer
will withdraw when \( EV_p - EV_w < 0 \). The difference between the two, or the result of the net utility calculation, is modeled as an unobserved or latent variable \( y^* \), defined as:

\[
y^* = x' \beta + \varepsilon
\]

where \( x' \beta \) are all the observable elements of the difference in the two value functions, with \( x' \) alone being the vector of observable characteristics of the individual and \( \beta \) representing the marginal effects of each characteristic on \( y^* \), and \( \varepsilon \) is the difference between the random or unobservable elements of each value function.

Since it is only possible to observe the withdrawal decision, but not the underlying utility received from that decision, we observe withdrawal from AgriStability, where

\[
y = \begin{cases} 
1 & \text{if } y^* > 0 \\
0 & \text{if } y^* \leq 0 
\end{cases}
\]

To define the probability that a withdrawal will occur, or that \( y^* > 0 \) we need to make an assumption about the distribution of \( \varepsilon \). If we assume the distribution is symmetric, meaning we can apply either a normal or logistic distribution, the probability of withdrawal is:

\[
\text{Prob}(y^* > 0|x) = \text{Prob}(\varepsilon < x' \beta | x) = F(x' \beta)
\]

where \( F(x' \beta) \) is the cdf of the random variable \( \varepsilon \).

**Functional Form**

The linear probability model (LPM) is one option for modeling discrete choice. The model assumes a linear relationship between the dependent and independent variables and is estimated using an OLS regression. However, there are a number of challenges to using this approach. First the error term is heteroscedastic in how it depends
on $\beta$, and second $x' \beta$ cannot be constrained to the 0-1 interval, meaning the model produces probabilities that cannot be interpreted, and negative variances.

A more useful model is one that will produce estimates that are consistent with the underlying theory, therefore a model with any continuous probability distribution is appropriate. The normal distribution is used in many circumstances, which results in a probit model, however the logistic distribution is also regularly applied because of its mathematical convenience, and the resulting model is called the logit model. The logit model is defined as:

$$\text{Prob} (y = 1|x) = \frac{\exp (x' \beta)}{1 - \exp (x' \beta)} = \Lambda(x' \beta)$$

where $\Lambda$ is the logistic cumulative distribution function and has the familiar bell shape of symmetric distributions. The logit model will be used for this analysis, based on the assumption about the error terms being logistically distributed rather than normally distributed, in which case the probit model would be applied.

*Model Specification for Panel Data*

One of the advantages of using panel data is that it allows for control of individual variation across individual units of observation, termed heterogeneity. Incorporating the effect of heterogeneity, the model for a panel of data would be defined as:

$$y_{it}^* = x'_{it} + \epsilon_{it} + \alpha_i, \quad i = 1, \ldots, n; t = 1, \ldots, T_i$$

where $\alpha_{it}$ is the unobserved individual-specific heterogeneity and $y_{it} = 1$ if $y_{it}^* > 0$, and 0 otherwise. The inclusion of this $\alpha_i$ is necessary since it is difficult to model the assumption that $\epsilon_{it}$ and $\epsilon_{is}$ are correlated within a group, but not correlated across groups.
It is important to account for this unobserved heterogeneity \((\alpha_{it})\), otherwise estimators can be biased as the probability of \(y_{it} = 1\) may be correlated with previous time periods, \(y_{it-1}\) (Santeramo et al., 2016).

The pooled estimator is one possible functional form for panel data, however it ignores the effects of \(\alpha_{it}\) completely and fits the model using a cross-section specification of the latent regression model. To incorporate the effect of heterogeneity, either a random effects or fixed effects model can be used. The distinction between a random and fixed effects model is based on the relationship between \(x'_{it}\) and \(\alpha_i\). A random effects model is specified by the two being unrelated, so that the conditional distribution \(f(\alpha_i|x'_{it})\) is not dependent on \(x'_{it}\) and \(\alpha_i|x_{it} \sim N(0, \sigma^2_\alpha).\) On the other hand, a fixed effects model has an unrestricted distribution, so that \(x'_{it}\) and \(\alpha_i\) may be correlated.

The choice between a random and fixed effects model can be determined by using a Hausman test, however there are other reasons for choosing a fixed effects model without the test. Fixed effects models are used to measure the effect of time-variant explanatory variables within each panel, and removes effects of time-invariant characteristics so the net effect of the time-variant predictors on the outcome variable can be assessed. It is appropriate to use a random effects model if you have reason to believe that differences across entities have some influence on your dependent variable. The key insight is that if the unobserved variable does not change over time, then any changes in the dependent variable are due to influences other than these fixed characteristics. In the case of withdrawal from AgriStability, we use a logistic year-fixed effect model, fixing each panel by year and controlling for farm-level heterogeneity by clustering variance by farm panel id.
The model for the specific question of withdrawal from AgriStability using year-fixed effects is defined as follows:

\[ \text{Prob} (\text{Withdrawal} = 1|x) = f(\text{Program year margin variables, Program payment indicators, Farm characteristics}) \]

**Estimation**

A logistic model uses the method of maximum likelihood to model the probability of \( y_{it}^* > 0|x \). The observed variable \( y_{it} \) can take on a value of 0 and 1 with probability \( p_i \) and \( 1 - p_i \) respectively. The distribution of \( y_{it}^* \) for \( y_{it} = [0,1] \) is

\[ \text{Pr} \{ y_{it}^* = y_{it} \} = p_i^{y_{it}} (1 - p_i)^{1-y_{it}} \]

The log-likelihood function for a fixed-effects logit model is:

\[ \ln L = \sum_{i=1}^{n} \sum_{t=1}^{T_i} \ln P(y_{it}|\alpha_{it} + \chi_{it}\beta) \]

where the estimated coefficients are represented by \( \beta \). These coefficients are interpreted as the marginal effect, or change in probability, of going from one state to the other (i.e. from a state of participating to a state of not participating) based on a change in the control variable.

**6.3 Chapter Summary**

This chapter developed an empirical model that will be used to test the hypotheses outlined in Chapter 4. The rationale for using a fixed-effects logit model was described and the functional form was specified. Finally, the log-likelihood function for the model was defined.
CHAPTER 7: Results and Discussion

7.0 Chapter Introduction

The purpose of this chapter is to present the results of the year-fixed effects logit model presented in the previous chapter in order to explain the factors affecting withdrawal from AgriStability by beef producers in Ontario. The results of an expected utility model are reported first, with comparisons to a simplified prospect theory model with only the key explanatory variables. After the most robust base model is determined, additional covariates are added for explanatory power. Finally, the full model is decomposed across the five revenue categories. The chapter will include a discussion of the results as they are presented, and end with the major policy implications of the research findings.

7.1 Results and Discussion

A year-fixed effects logit model is used to regress key explanatory variables against the dependent variable of withdrawal from AgriStability. Year fixed effects are imposed using dummy variables, and to account for additional farm-level heterogeneity, variance is clustered within each farm panel to allow for standard errors to be correlated within a group, relaxing the assumption that observations within a panel are independent.

Table 13 reports the results of the base model estimation comparing the expected utility model, which leaves out the gain and loss variables, to the prospect theory models. For each model, McKelvey and Zavoina’s R-squared is used to determine goodness-of-fit. This pseudo R-squared is used for fixed effects logit models as it is considered the best measure to use according to Windmeiher (1995), compared to reporting the number of correctly predicted withdrawals equal to one, for example. McKelvey and Zavoina’s
measure is reported at the bottom of each regression table. While it is difficult to interpret the pseudo R-squared value independently, it is a useful computation when comparing two separate models, in which case the higher pseudo R-squared indicates which model is ‘better’ at predicting the outcome.

In Table 13, the estimated results are largely the same between the expected utility, EU and the prospect theory, PT(1) model, however PT(1) performs slightly better than EU with a McKelvey and Zavoina’s R-squared of 0.1088 compared to 0.1. In fact, PT (1) also performs better than PT (2) which include the variable of not receiving a program payment from AgriStability for two years in a row, and than PT(3) which provides an alternative way of modeling the prospect theory preferences; one variable that measures sensitivity to changes in net income (either positive or negative), and a dummy variable that compares sensitivity to a gain in net income relative to a loss (d = 1 if \( \pi_t - \pi_{t-1} \geq 0 \). However, since the difference in goodness-of-fit between PT(1) and PT(2) is so slight and the variable for not receiving a payment two years in a row is significant and positive, inferring that there are multi-year effects that influence a farmer’s decision to remain enrolled or withdraw from AgriStability.

The estimated coefficients of PT(2) are consistent with all other models estimated in Table 13. The higher last year’s program margin, the less likely the farmer will be to withdraw from AgriStability. This finding confirms the hypothesis developed in Chapter 4, and can be explained by how an increase in the program margin will affect the reference margin, and in turn affect the likelihood of a program payment in the next period (with the assumption that if a farmer expects a payment they will remain enrolled). The increased likelihood of a payment due to a higher program margin in the previous
year is evidence of the income effect, in which case the farmer is remaining enrolled in
the program for investment purposes, speculating that they will receive a payment.

Table 13. Estimated Regression Coefficients Explaining Withdrawal From AgriStability
using Expected Utility (EU) and Prospect Theory (PT) Frameworks.

<table>
<thead>
<tr>
<th>Model</th>
<th>EU</th>
<th>PT (1)</th>
<th>PT (2)</th>
<th>PT (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-1.804</td>
<td>-0.990</td>
<td>-0.981</td>
<td>-1.948</td>
</tr>
<tr>
<td></td>
<td>(0.25)***</td>
<td>(0.27)***</td>
<td>(0.28)***</td>
<td>(0.25)***</td>
</tr>
<tr>
<td>Ln program margin$_{t-1}$</td>
<td>-0.019</td>
<td>-0.0227</td>
<td>-0.0232</td>
<td>-0.0219</td>
</tr>
<tr>
<td></td>
<td>(0.01)***</td>
<td>(0.01)***</td>
<td>(0.01)***</td>
<td>(0.01)***</td>
</tr>
<tr>
<td>Ln program margin increase</td>
<td>-0.0943</td>
<td>-0.0943</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.02)***</td>
<td>(0.02)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln program margin decrease</td>
<td>-0.115</td>
<td>-0.115</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.02)***</td>
<td>(0.02)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln program margin difference</td>
<td></td>
<td></td>
<td>-0.0761</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.02)***</td>
<td></td>
</tr>
<tr>
<td>If program margin increased</td>
<td></td>
<td></td>
<td></td>
<td>0.895</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.21)***</td>
</tr>
<tr>
<td>Ln AgriStability payments$_{t-2}$</td>
<td>-0.270</td>
<td>-0.247</td>
<td>-0.247</td>
<td>-0.2610</td>
</tr>
<tr>
<td></td>
<td>(0.03)***</td>
<td>(0.03)***</td>
<td>(0.03)***</td>
<td>(0.03)***</td>
</tr>
<tr>
<td>If no payment in t-2</td>
<td>-1.737</td>
<td>-1.517</td>
<td>-1.567</td>
<td>-1.6460</td>
</tr>
<tr>
<td></td>
<td>(0.23)***</td>
<td>(0.24)***</td>
<td>(0.24)***</td>
<td>(0.23)***</td>
</tr>
<tr>
<td>If no payment in t-3</td>
<td></td>
<td></td>
<td></td>
<td>0.1120</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.06)*</td>
</tr>
<tr>
<td>McKelvey &amp; Zavoina's R²</td>
<td>0.1000</td>
<td>0.1088</td>
<td>0.1084</td>
<td>0.1030</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>28,390</td>
<td>28,390</td>
<td>28,390</td>
<td>28,390</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses *** is significant at the one percent level \( (p<0.01) \), ** is significant at the 5 per cent level \( (p<0.05) \), * is significant at the 10 percent level \( (p<0.1) \).

In terms of the effect of a decrease in the program margin, the larger the decrease
the less likely is the farmer will withdraw due to the need to protect against that loss and
the increased likelihood that the loss will trigger a payment. This finding is evidence that
the farmer is using AgriStability as a risk management tool. The larger a gain in net income will have a similar effect as described in the previous paragraph regarding the effect of previous years net income – the larger the change the more likely the producer is to receive a payment, so even if the farmer is in a relatively healthy financial position, they may be remaining enrolled in the program for speculative purposes, with the expectation of a program payment.

An F-test is conducted to determine if the loss and gain variables are statistically different. The results are as follows for the null hypothesis that the two coefficients are not statistically different:

\[ H_0: \ln \text{program margin increase} = \ln \text{program margin decrease} \]

\[ \text{chi2}(1) = 14.85 \text{ and Prob > chi2} = 0.0001 \]

meaning we reject the null hypothesis at the 1% level, meaning that producers are more sensitive to a loss than to a gain.

In model PT(2), all the payment variables have the expected sign, except the dummy variable for not receiving a payment in the previous year, which is negative and significant. The larger the payment received from AgriStability, the less likely the farmer is to withdraw, which could be evidence of investment motivation. A payment signals to farmers that the program is meeting their expectations in that it is providing returns, and therefore they will stay enrolled.

If the farmer did not receive a payment in the period previous to the decision year, they are less likely to withdraw; recall the decision year is \( t - 1 \) and the year previous to the decision year is \( t - 2 \). This finding is contrary to the hypothesis derived in Chapter 4, if we assume the producer is using the program for investment purposes. In this case the
farmer is likely using the program as a risk management tool, and not receiving a payment will decrease the likelihood of withdrawal as long as the change in the program year margin is larger than the program fee. A patience effect could also be at work, meaning the farmer is remaining enrolled because they expect a payment in time t or time t+1.

If the farmer did not receive a payment two years ago, their likelihood of withdrawal increases, which is consistent with the hypothesis developed in Chapter 4. The finding infers that producers are only patient for one year, but after two years of not receiving a payment the risk of withdrawal increases. As discussed in the conceptual framework chapter, program premiums can be felt as a loss, so experiencing this loss for two years consecutive years with no indemnity payments could trigger a withdrawal. This could be evidence that the program is being used for investment motivation rather than as a risk management tool.

For the remainder of the analysis, we use the key explanatory variables in model PT (2). When additional control variables are added to account for enterprise diversity, operation type, ad hoc payments from other government programs, and the structural policy break, we see consistent effects on the key variables from the base model, as is reported in Table 14. The magnitudes of the effects also remain consistent. The higher the sector concentration is, the more likely the farmer is to withdrawal, which is contrary to most literature, which shows that a farm which is concentrated in once sector (and therefore most of their revenue is concentrated in that sector) is more likely to seek risk management strategies such as insurance to cover that narrow revenue stream. This finding could be evidence of favourable conditions in the beef sector, making farmers
confident that market conditions will keep net income relatively stable, and therefore they are withdrawing due to lack of need for AgriStability.

An increase in the Herfindahl index for the enterprise, which should not be confused with the index for crop diversity specifically, decreases the risk of withdrawal. This could be evidence that the farmers are remaining in AgriStability for risk management purposes, since the literature shows that increased diversity should decrease the demand for insurance, so we expect that the higher the Herfindahl index, the higher the likelihood of withdrawal. A more diverse enterprise also increases the administrative costs associated with participating in AgriStability since each production stream must be accounted for separately. Additionally, the McKelvey and Zavoina’s R-squared for this model is lower than for the initial base model, as does the model (3) with both the sector concentration and Herfindahl index together, therefore the Herfindahl index is left out of the full model regression (6).

Table 14. Regression results of the effects of Farm Characteristics, Enterprise Diversity, Ad Hoc Payments, and Policy Changes.

<table>
<thead>
<tr>
<th>Models</th>
<th>DV = Prob (Withdrawal = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory Variables</td>
<td>PT (l) (1) (2) (3) (4) (5) (6)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.981 (-0.28)***</td>
</tr>
<tr>
<td>Ln log program margin&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.0232 (-0.01)***</td>
</tr>
<tr>
<td>Ln log program margin increase</td>
<td>-0.0943 (-0.02)**</td>
</tr>
<tr>
<td>Ln log program margin decrease</td>
<td>-0.1150 (-0.02)***</td>
</tr>
<tr>
<td>Ln AgriStability payment&lt;sub&gt;t-2&lt;/sub&gt;</td>
<td>-0.2470 (-0.03)***</td>
</tr>
<tr>
<td>If no payment in t-2</td>
<td>-1.5670 -1.5790 -1.7150 -1.6940 -1.4300 -1.3960 -1.296</td>
</tr>
</tbody>
</table>
Feedlot operators and other operators are less likely to withdraw compared to cow-calf operations. Although feedlot operations are generally larger, they operate on thin profit margins, which can make it difficult to smooth net income over time. A small change in the price of beef or the cost of a major input can have a large effect on the net income of the operation. On the other hand, cow-calf operations, which are responsible for generating the next generation of young stock, are better able to manage their farm operations.
Table 15. Regression Results for Full Model by Revenue Category

<table>
<thead>
<tr>
<th>Model</th>
<th>Revenue Sales Class ($ thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;0 &amp; &lt;10</td>
</tr>
<tr>
<td>Explanatory Variables</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.871</td>
</tr>
<tr>
<td></td>
<td>(0.97)</td>
</tr>
<tr>
<td>Ln program margin&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
</tr>
<tr>
<td>Ln program margin increase</td>
<td>-0.029</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>Ln program margin decrease</td>
<td>-0.050</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>Ln AgriStability payment&lt;sub&gt;t-2&lt;/sub&gt;</td>
<td>-0.181</td>
</tr>
<tr>
<td></td>
<td>(0.08)**</td>
</tr>
<tr>
<td>If no payment in t-2</td>
<td>-0.943</td>
</tr>
<tr>
<td></td>
<td>(0.65)</td>
</tr>
<tr>
<td>If no payment in t-3</td>
<td>0.152</td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
</tr>
<tr>
<td>Sector concentration&lt;sub&gt;t-1&lt;/sub&gt; (%)</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>(0.57)</td>
</tr>
<tr>
<td>Operation Type</td>
<td></td>
</tr>
<tr>
<td>Feedlot</td>
<td>19.13</td>
</tr>
<tr>
<td></td>
<td>(1.15)***</td>
</tr>
<tr>
<td>Other</td>
<td>-0.604</td>
</tr>
<tr>
<td></td>
<td>(0.41)</td>
</tr>
<tr>
<td>Ln beef adhoc payment&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.140*</td>
</tr>
<tr>
<td></td>
<td>(0.08)*</td>
</tr>
<tr>
<td>Ln other adhoc payment&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.038</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
</tr>
<tr>
<td>If year = 2008 - 2013</td>
<td>1.477</td>
</tr>
<tr>
<td></td>
<td>(0.53)***</td>
</tr>
<tr>
<td>Year FE</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>1,979</td>
</tr>
<tr>
<td>Number of frm_rnd</td>
<td>964</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses *** is significant at the one percent level (p<0.01), ** is significant at the 5 per cent level (p<0.05), * is significant at the 10 percent level (p<0.1).
Additionally, they are less affected by world feed prices because the majority of their animals feed in pastures. The other operation types are generally small in terms of revenue, so are likely enrolled to protect against income shocks. It is also possible that these are hobby farms that operate at a loss from year-to-year and are supplemented with off-farm income. Ad hoc program payments have a negative effect on the likelihood of withdrawal, but do not change the effect of AgriStability payments, indicating there is no crowding-out phenomenon happening. Because ad hoc payments are received in the decision year, this may mitigate some of the effects of a decrease in the program margin from the previous year. After 2008, the likelihood of withdrawal increases compared to the years prior to 2008, which implies that the policy changes of Growing Forward have some effect on farmers perceptions about the program and its ability to meet its objective of smoothing net income, or their expectation that they will receive a payment each year.

When model PT (2) is used to estimate the fixed-effects model separately by revenue size we find a number of interesting results. Previous year’s net income is not longer significant across any of the revenue categories, and changes sign for the $10,000 to $100,000 and $100,000 to $250,000 categories. The prospect theory variables are now only significant for the $100,000 to $250,000 and over $500,000 revenue classes, however their sign has changed so that the larger the gain or loss in net income, the more likely the producer is to withdrawal.

All revenue classes are sensitive to the size of the AgriStability payment at either the 5% and 1% significant level except the over $500,000, indicating that program payments play an important role in the participation decision. The variables that indicate whether or not a farm received a payment in the previous year or two years is only
statistically significant for the $10,000 to $100,000 and $100,000 to $250,000 categories. Only the $10,000 to $100,000 class has a positive and significant result on the dummy variable for not receiving a program payment for the previous two years. This could indicate that the $10,000 to $100,000 category is the most reliant on the program payments in for income stability, and may derive the most benefit in terms of income stabilization from utilizing the program.

For the additional explanatory variables, the majority of the estimated coefficients are not statistically significant. Only the two lowest revenue categories were sensitive to ad hoc government payments specific to beef, however all categories but the lowest one were sensitive to other ad hoc program payments. Again, this result highlights the influence of any kind of direct payment on the participation decision.

Finally, we estimate the marginal effects of a change in the explanatory variables on the dependent withdrawal variable, based on model (6) in Table 13 (see Table 16). The program payment variables have the largest effects of the key explanatory variables, with a 1% increase in the AgriStability payment associated with a 0.21% decrease in the likelihood of withdrawal. The receipt of no payment in the previous year decreases the likelihood of withdrawal by 1.3% and the receipt of no payment in the previous two years increase the likelihood of withdrawal by 0.11%.

Table 16. Marginal Effects of a Change in an Explanatory Variable on the Dependent Withdrawal Variable.

<table>
<thead>
<tr>
<th></th>
<th>Delta-method</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marginal Effect</td>
<td>Std. Err.</td>
<td>z</td>
<td>P&gt;</td>
</tr>
<tr>
<td>Ln program margin_{t-1}</td>
<td>-0.01</td>
<td>0.01</td>
<td>-1.20</td>
<td>0.23</td>
</tr>
<tr>
<td>Ln program margin increase</td>
<td>-0.03</td>
<td>0.02</td>
<td>-1.47</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
<td>z-Value</td>
<td>p-Value</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Ln program margin decrease</td>
<td>-0.04</td>
<td>0.02</td>
<td>-2.49</td>
<td>0.01</td>
</tr>
<tr>
<td>Ln AgriStability payment_{t-2}</td>
<td>-0.21</td>
<td>0.03</td>
<td>-7.40</td>
<td>0.00</td>
</tr>
<tr>
<td>If no payment in t-2</td>
<td>-1.30</td>
<td>0.24</td>
<td>-5.37</td>
<td>0.00</td>
</tr>
<tr>
<td>If no payment in t-3</td>
<td>0.11</td>
<td>0.06</td>
<td>1.73</td>
<td>0.08</td>
</tr>
<tr>
<td>Sector concentration_{t-1} (%)</td>
<td>0.48</td>
<td>0.18</td>
<td>2.72</td>
<td>0.01</td>
</tr>
<tr>
<td>Operation Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedlot</td>
<td>-0.63</td>
<td>0.11</td>
<td>-5.96</td>
<td>0.00</td>
</tr>
<tr>
<td>Other</td>
<td>-0.47</td>
<td>0.16</td>
<td>-2.92</td>
<td>0.00</td>
</tr>
<tr>
<td>Ln beef adhoc payment_{t-1}</td>
<td>-0.08</td>
<td>0.02</td>
<td>-4.18</td>
<td>0.00</td>
</tr>
<tr>
<td>Ln other adhoc payment_{t-1}</td>
<td>-0.12</td>
<td>0.01</td>
<td>-12.82</td>
<td>0.00</td>
</tr>
<tr>
<td>If year = 2008 - 2013</td>
<td>1.42</td>
<td>0.16</td>
<td>8.71</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The additional explanatory variables all have a negative effect of less than 0.5%, but the largest effect comes from the policy change of 2008 when Growing Forward 2 was introduced, increasing the likelihood of withdrawal after that time period by 1.42%.

### 7.2 Policy Implications and Recommendations

The results of this study provide some important policy implications in terms of Business Risk Management policy and more specifically program design, especially as the Growing Forward 3 policy framework, which will be introduced in 2018, is currently being negotiated. First, the results provide insight into why farmers are leaving or remaining enrolled in AgriStability, across revenue categories and farm types. All farmers except the highest revenue bracket are sensitive to program payments, which would be viewed as a gain under prospect theory rather than the loss incurred of the program fee if a payment is not received.

If the goal of the government is to have increased and sustained enrollment, payments could be structured so that a farmer received a payment at least every other year, which would act as a type of incentive to stay enrolled. The positive and significant sign on the structural break variable is clear evidence that changes to the program design
has contributed to the problem of increased withdrawal rates. Research that aims to understand how farmers insurance adoption behaviour changes as risk management policy and programs change is fundamental in order to provide farmers with risk management mechanisms that are both effective and meet larger government objectives.

Although most of the applications of prospect theory are descriptive models that use prospect theory to make sense of observed behaviour, prospect theory models can also be used in a prescriptive way, which is relevant for developing policy responses to a stated problem by encouraging individuals toward behaviours that are viewed as more desirable (Baberis, 2013). The underlying idea is that people will respond more enthusiastically to incentives that are framed as losses rather than gains, therefore there is an opportunity for government to communicate the objectives and of AgriStability in such a way to encourage sustained enrollment. The issue of alignment between farmers’ expectations about the program and the government’s objectives of the program must be addressed.

In the coming years, there will be increased pressure on the BRM programs and the fiscal capacity to fund these programs will become strained, especially since the average cost of the program increases as enrollment decreases. The risk of climate change and other environmental challenges are likely to increase the income risk associated with agricultural production and the size and frequency of indemnities which farmers receive. The programs must be designed in a way that encourages enrollment but does not let farmers put themselves in a position to make a claim and receive a payment if they are, in fact, financially stable. Such designs will require more careful consultation with producers and industry bodies. The BRM programs such as AgriStability will also be
increasingly competing with other risk management options, such as the Risk Management Program that AgriCorp delivers, in which participation is not longer conditional on enrollment in AgriStability.

7.3 Chapter Summary

This chapter presented the results of the empirical analysis, starting with a simple base model that compared the expected utility framework to prospect theory. The prospect theory model that included all program payment variables was used to estimate additional explanatory variables including enterprise diversity, operation type, and the influence of ad hoc program payments and the structural policy break of 2008. The full model was estimated across the five separate revenue categories and a discussion of each set of regression results was provided. The chapter ended with the policy implications of the research results, including recommendations on how the behavioural principles of prospect theory can influence program design.
CHAPTER 8: Conclusion

8.0 Summary of Research and Results

Agricultural production is inherently risky due to the many factors that affect financial returns and overall welfare. The purpose of this study was to investigate the phenomenon of declining participation in AgriStability by beef farmers in Ontario using an approach based in behavioural economics, since little is known about whether farmers are using AgriStability as a risk management tool or as an income support measure, and what factors are contributing to the decision to withdraw from AgriStability.

A year-fixed effects logistic model was used to estimate the factors affecting withdrawal from AgriStability for an eleven-year period spanning from 2003 to 2013. All key variables in the base model are negative and statistically significant in the base model, except the dummy indicator for not receiving a payment in the two previous years, which was positive and statistically significant. We found that producers are more sensitive to losses than to gains in terms of the effect of a gain or loss in net income from the previous year. Program payments are important to farmers, and the receipt of a payment will decrease the likelihood of withdrawal. The same result was found with the receipt of ad hoc payments from other government programs.

Other farm characteristics affect the participation decision, with farm sector concentration and the Herfindahl index of enterprise diversity producing unexpected results to the outlined hypotheses. Feed lot operations are more likely to withdraw than cow-calf operations, and the structural break in 2008 when Growing Forward 2 was introduced and changes to program design were made has a positive and significant effect on withdrawal from the program.
Across revenue classes, we find the lower classes are generally more sensitive to the size of the AgriStability payment, and the indicators for whether they received a payment at all. The largest revenue class is not sensitive to program payments at all, but the gains and losses in net income have a positive and significant effect on the withdrawal decision. Most revenue categories were also sensitive to an ad hoc payment from the government, which decreased the likelihood of withdrawal, highlighting the effect that direct indemnity payments have on insurance adoption and how this might be incorporating into risk management policy moving forward.

8.1 Research Limitations and Future Research

One of the challenges with explaining the factors affecting withdrawal from AgriStability is how to capture the cycle of program payments, since this is cited as one of the reasons farmers leave the program. In this research we gained some insight into how the most recent payment affects the withdrawal decision, but this fails to capture the unpredictability of when payments will arrive. There are a number of other variables that are missing from OFID that would increase the power of the model, including off-farm income and the program fee payments. These variables are important, because they affect how a gain or a loss is felt by the farmer. For example, if a small farm has a negative net income change of $80,000, but receive an off-farm income of $100,000 then the loss in net income is less likely to be felt as a loss at all. Other variables that indicate financial well-being and affect the distribution of profits, such as the debt-coverage ratio, would also be useful to include in the analysis.
In terms of prospect theory, there is difficulty surrounding how to define the reference point. The reference point that we chose for our analysis, the previous years’ program margin, assumes that this is the metric farmers are using to determine their changes in financial position, however, it is reasonable that they may be using a different financial measure that we are not aware of. This analysis also assumes that farmers are thinking in terms of annual gains and losses, since the OFID has information for each farm by year, whereas in reality farmers may be evaluating their gains and losses on a weekly or monthly basis.

There are also other behavioural models which would provide insight in the area of insurance adoption, including disappointment aversion which is yet another model of decision making under uncertainty. The theory shows that risk aversion implies disappointment aversion such that when a lottery results in a bad outcome (i.e. a farmer does not receive an AgriStability payment) the agent experiences some level of disappointment, which can worsen the disutility received from the bad outcome (Grant et al., 2000). Our analysis used payment indicators to gain some insight into patience effects, and alternative model could have used defined inter-temporal discount factor framework to model preferences for immediate gratification or self-control problems.

Future research would focus on adding some of the other variables mentioned above that affect the distribution of profits to the analysis. The research should focus more specifically on the role that indemnity patterns play in insurance adoption decisions, including frequency and variation, under the assumption that farmers primary reason for adopting insurance is to cover large and infrequent losses, and secondary reason is to get a return from their paid premiums.
Additionally, individual risk preferences are not accounted for in this analysis, but it would be useful to model risk preferences in terms of how they affect the participation decision. This analysis would focus more on risk aversion rather than loss aversion, as this study has done, and investigate the relationship between farmers’ insurance decisions and their expectations about revenue risk.

Finally, although this dynamic model takes into account state dependence and unobserved heterogeneity, the model does not focus on duration dependence, which has surfaced in econometric theory as another important factor of dynamic choice analysis. The idea is that the length of time the farmer has been enrolled in AgriStability will have an effect on the withdrawal decision, so the analysis would either include a duration variable as an explanatory variable, or the empirical model would change to a survival or duration model which incorporates duration dependence into estimation.
REFERENCES


AgriCorp. 2015. Risk Management Program, Cattle. Retrieved from:
http://www.agricorp.com/en-ca/Programs/RMP/Cattle/Pages/Overview.aspx

Agriculture and Agri-Food Canada (AAFC). 2015. An Overview of the Canadian Agriculture and Agri-Food System. Ottawa, Canada.


Farm Credit Canada (FCC) Ag Economics. 2015. The 2015 Beef Sector Report.


OMAFRA. 2013. Ontario Farm Income Database.


Statistics Canada. No date. *CANSIM Table 002-0027 Average total income of farm


