Efficiency and Financial Capital Constraints in Agricultural Marketing and Processing Co-operatives in Canada

by

Emily Anne Brennan

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ABSTRACT

EFFICIENCY AND FINANCIAL CAPITAL CONSTRAINTS IN AGRICULTURAL MARKETING AND PROCESSING CO-OPERATIVES IN CANADA

Emily Anne Brennan
University of Guelph, 2016

Advisor:
Professor Getu Hailu

This thesis examines the relationship between financial capital and efficiency in Canadian agricultural marketing and processing co-operatives, using a stochastic frontier approach. The effect of financial leverage was examined in terms of different types of debt in order to determine whether the source of debt matters. The findings of the study suggest that the relationship between total debt and efficiency is negative for the fruit and vegetable industry, but statistically insignificant for the dairy industry. When total debt is disaggregated and examined by source, the relationships between debt and production efficiency depends on the source of debt. Member debt and short-term debt were both found to have no statistically significant relationship with production efficiency, whereas co-operatives with more external debt were generally less cost and technically efficient. In addition, larger co-operatives are more technically and cost efficient.
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Look I made a hat, where there never was a hat- and it is all thanks to all of you!  

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Efficiency and Financial Capital Constraints in Agricultural Marketing and Processing
Co-operatives in Canada

Table of Contents

ABSTRACT .................................................................................................................................................. ii
ACKNOWLEDGEMENTS .......................................................................................................................... iii

Chapter 1: Introduction ................................................................................................................................. 1
  1.1 Motivation .............................................................................................................................................. 1
  1.2 Economic Problem ............................................................................................................................... 3
  1.3 Economic Research Problem .............................................................................................................. 4
  1.4 Purpose and Objectives ....................................................................................................................... 6
  1.5 Outline of Thesis .................................................................................................................................. 7

Chapter 2: Overview of the Canadian Co-operative Sector ............................................................................. 9
  2.1 Institutional Context .............................................................................................................................. 9
    2.1.1 Co-operative principles ................................................................................................................ 9
    2.1.2 Canadian Co-operatives Act ....................................................................................................... 10
    2.1.3 Industry Specific Regulation: Supply Management ...................................................................... 12
  2.2 Organizations Governing Canadian Co-operatives ............................................................................ 14
    2.2.1 Co-operatives Policy Unit (Innovation, Science and Economic Development Canada) ............ 14
    2.2.2 Co-operatives and Mutuals Canada ............................................................................................ 14
  2.3 Findings of the Special Committee on Co-operatives ....................................................................... 16
  2.4 Sector Description ............................................................................................................................... 17
    2.4.1 Types of co-operatives ................................................................................................................ 18
    2.4.2 Overview of Agricultural Co-operatives ...................................................................................... 20

Chapter 3: Review of Research on Economics of Organizations and Co-operatives .................................... 23
  3.1 Organizational Theory ........................................................................................................................ 23
  3.2 The Microeconomics of Co-operatives .............................................................................................. 25
    3.2.1 Co-operatives and market failures .............................................................................................. 25
    3.2.2 Co-operatives and the Financial Crisis ....................................................................................... 28
    3.2.3 Objectives of the Co-operative .................................................................................................. 29
    3.2.4 Decision-making process .......................................................................................................... 31
    3.2.5 Access to Capital ....................................................................................................................... 33
  3.3 Research on Efficiency in Co-operatives ............................................................................................ 35
    3.3.1 Comparisons with IOFs ............................................................................................................. 35
    3.3.2 Exogenous Factors that Impact Co-operative Efficiency ............................................................. 37
    3.3.3 Research Gap ............................................................................................................................ 41

Chapter 4: Conceptual Framework: Economics of Co-operatives; Types of Efficiency; and the Relationship between Capital and Efficiency .................................................................................. 43
  4.1 Types of Efficiency ............................................................................................................................. 43
  4.2 The Relationship between Capital and Efficiency ............................................................................ 46
  4.4 Theoretical Model .............................................................................................................................. 49
4.5 Chapter Summary..................................................................................................................51

  5.1 Approaches to Measuring Efficiency .............................................................................. 53
    5.1.1. Stochastic Frontier ................................................................................................. 53
    5.1.2 Data Envelopment Analysis ................................................................................... 56
    5.1.3 Evaluating the Impact of Environmental Factors on Efficiency ......................... 57
  5.2 Empirical Model ......................................................................................................... 58
    5.2.1 Production Frontier and Technical Efficiency ...................................................... 59
    5.2.2 Cost efficiency ..................................................................................................... 60
    5.2.3 Impact of environmental factors ......................................................................... 61
  5.3 Description of data sources ....................................................................................... 62
  5.4 Definition of key variables ....................................................................................... 63
    5.4.1 Data preparation .................................................................................................. 63
    5.4.2 Key variables ..................................................................................................... 64
  5.5 Chapter Summary ...................................................................................................... 67

Chapter 6: Results and Discussion ................................................................................. 68
  6.1 Descriptive Statistics ............................................................................................... 69
  6.2 Fruit and vegetable co-operatives ........................................................................... 70
    6.2.1 Production Frontier and Technical Efficiency .................................................... 70
      6.2.2 Cost frontier and cost efficiency ...................................................................... 77
  6.3 Dairy co-operatives .................................................................................................. 82
    6.3.1 Production frontiers and technical efficiency .................................................... 82
    6.3.2 Cost frontiers and cost efficiency ..................................................................... 87
  6.4 Chapter Summary ...................................................................................................... 92

Chapter 7: Summary, Conclusion and Policy Implications ........................................ 96
  7.1 Summary of purpose, methods and findings ............................................................ 96
  7.2 Implications ........................................................................................................... 97
  7.3 Conclusion .............................................................................................................. 99
  7.4 Limitations ............................................................................................................. 99
  7.5 Recommendations for future research .................................................................. 101

References ......................................................................................................................... 103

Appendix A: Deadweight loss from monopsony ............................................................. 113
Appendix B: Number of co-operatives by year and sector (excluding Quebec) .......... 114
Appendix C: Technical Efficiency Distribution by Number of Employees ............... 115
List of Figures

Figure 1: Distribution of Co-operatives in Canada by Province, 2010 ................................. 18
Figure 2: Deadweight Loss from Monopoly ........................................................................... 27
Figure 3: Types of efficiency .................................................................................................... 44
Figure 4: Estimated Models ...................................................................................................... 68
Figure 5: Distribution of Technical Efficiency Estimates for Fruit and Vegetable Co-operatives Outside the Province of Quebec (1984-2010) (modeled with Total Debt). 73
Figure 6: Distribution of Technical Efficiency Estimates for Fruit and Vegetable Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt). 73
Figure 7: Distribution of Technical Efficiency Estimates for Fruit and Vegetable Co-operatives Including the Province of Quebec (1984-2002) (modeled with Total Debt) .......................................................................................................................... 74
Figure 8: Distribution of Technical Efficiency Estimates for Fruit and Vegetable Co-operatives Including the Province of Quebec (1984-2002) (modeled by Type of Debt) .......................................................................................................................... 74
Figure 9: Distribution of Cost Efficiency Estimates for Fruit and Vegetable Co-operatives Outside the Province of Quebec (1984-2010) (modeled with Total Debt) ...................................................................................... 79
Figure 10: Distribution of Cost Efficiency Estimates for Fruit and Vegetable Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt) ...................................................................................... 79
Figure 11: Distribution of Cost Efficiency Estimates for Fruit and Vegetable Co-operatives Including the Province of Quebec (1984-2002) (modeled with Total Debt) ...................................................................................... 80
Figure 12: Distribution of Cost Efficiency Estimates for Fruit and Vegetable Co-operatives Including the Province of Quebec (1984-2002) (modeled by Type of Debt) ...................................................................................... 80
Figure 13: Distribution of Technical Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Total Debt) ...................................................................................... 84
Figure 14: Distribution of Technical Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt) ...................................................................................... 84
Figure 15: Distribution of Technical Efficiency Estimates for Dairy Co-operatives Including the Province of Quebec (1984-2002) (modeled by Total Debt) ...................................................................................... 85
Figure 16: Distribution of Technical Efficiency Estimates for Dairy Co-operatives Including the Province of Quebec (1984-2002) (modeled by Type of Debt) ...................................................................................... 85
Figure 17: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Total Debt) ...................................................................................... 89
Figure 18: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt) ...................................................................................... 89
Figure 19: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Including the Province of Quebec (1984-2002) (modeled by Total Debt) ...................................................................................... 90
Figure 20: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Including the Province of Quebec (1984-2002) (modeled by Type of Debt) ...................................................................................... 90
Figure 21: Monopsony and Marketing Co-operatives .................................................................. 113
List of Tables
Table 1: Changes in the Number of and Membership in Agricultural Co-operatives, 2000-2010.......................................................................................................................... 21
Table 2: Changes in the Volume of Assets in Agricultural Co-operatives, 2000-2010........ 21
Table 3: Changes in the Volume of Business in Agricultural Co-operatives, 2000-2010...... 22
Table 4: Descriptive Statistics (mean) for Agricultural Marketing Co-operatives by Sector and data sub-set ................................................................................................................ 69
Table 5: Production Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratio ........................................................................................................ 72
Table 6: Fruit and Vegetable Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Technical Efficiency .................................................................................................. 76
Table 7: Fruit and Vegetable Cost Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratios ................................................................................. 78
Table 8: Fruit and Vegetable Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Cost Efficiency ........................................................................................................ 81
Table 9: Dairy Production Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratios ........................................................................................................ 83
Table 10: Dairy Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Technical Efficiency ............................................................................................................. 86
Table 11: Dairy Cost Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratios .............................................................................................................. 88
Table 12: Dairy Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Cost Efficiency ...................................................................................................................... 91
Table 13: Mean efficiency and marginal effects estimates for all models.......................... 94
Table 14: Average Technical Efficiency by Number of Employees (all years, without province of Quebec)..................................................................................................................... 115
Chapter 1: Introduction

1.1 Motivation

Co-operatives are businesses whose operations follow an internationally recognized set of principles. In Canada, co-operatives are present in virtually all sectors, including agriculture, housing, education, retail, banking, and insurance. As of 2010, there were about 7,865 incorporated non-financial co-operatives in Canada, with 7.4 million members. These co-operatives generated $33.9 billion in revenue, and 87,900 full or part time jobs (Industry Canada, 2015). In 2010, agriculture and resource co-operatives generated the third highest amount of revenue ($5.5 billion, or about 16% of total sector revenues), after manufacturing, for which most business was actually generated by dairy processing co-operatives (18%), and wholesale and retail (59%).

Co-operatives are considered to offer a variety of advantages both to their members and to their communities. For example, co-operatives help to address market failures by improving market access for members, bringing prices closer to perfect competition prices (acting as competitive yardsticks), reducing asymmetric information, and lowering transaction costs (e.g., Diaz-Hermelo, Gray and Smith, 2001; Hansmann, 1996; House of Commons Special Committee on Co-operatives, 2012). Co-operatives can improve the economic circumstances of their members by improving the prices paid for members’ products or the prices paid for inputs purchased by members; reducing transaction costs; or providing training on agricultural practices (e.g., Casselman, 1952). In the agricultural sector, co-operatives help members access markets to

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2 These figures refer only to those co-operatives that responded to the Survey of Non-Financial Co-operatives in 2010, not all incorporated co-operatives.
buy inputs (supply co-operatives), sell outputs (marketing and processing co-operatives), or otherwise support agricultural activities (support to agriculture co-operatives).

Though co-operatives provide a number of benefits to their communities, there are some potential challenges identified in the academic literature, such as a complicated decision making process, and problems accessing capital to finance investment (Ferrier and Porter, 1991; Fulton and Laycock, 1990). These challenges can influence the efficiency with which the co-operative provides service to its members. This thesis attempts to shed light on the influence of financial capital constraints on the technical and cost efficiency of agricultural co-operatives, in response to concerns over access to capital, expressed by many organizations (e.g., House of Commons Special Committee on Co-operatives, 2012, and ICA, 2015).

There is ambiguity in the research examining the relationship between capital and efficiency. For example, some studies note that the agency cost of debt, which increases with higher levels of debt, can negatively influence efficiency (Jensen and Mackling, 1976), while others find an ambiguous relationship between efficiency and levels of debt due to the potential for both increased investment (which positively influences efficiency), but decreased effort from employees (which will decrease efficiency) (Brander and Spencer, 1989), or a positive relationship due to a tendency to use inputs more efficiently when debt is higher (Kim and Maksimovic, 1990).

A few studies empirically examine the role of capital in co-operatives and investor owned firms (IOFs). For example, Hailu, Jeffrey and Goddard (2007a) examine the relationship between debt and cost efficiency of Canadian agricultural co-operatives, and find that the debt to asset and debt to equity ratios are both negatively correlated to cost efficiency. In the case of
IOFs, Chavas and Aliber (1993) examine the relationship between the debt to asset ratio and efficiency, and find that it has no significant effect in the short run on the overall efficiency, and has a positive effect on technical and allocative efficiency in the intermediate and long term. In addition, Weill (2003) examines the relationship between debt to equity ratio and cost efficiency in IOFs in seven countries, and finds a positive relationship in five, a negative relationship in one, and no significant relationship in the last country. Overall, the findings of these studies are mixed and inconclusive regarding the relationship between debt ratios and efficiency in co-operatives. The uncertainty about the effects of the relationship between indebtedness and economic efficiency supports the need for further research.

This thesis examines the relationship between financial capital constraints and technical and cost efficiency of Canadian agricultural co-operatives. This study is important because of the continuing interest in capital constraints in co-operatives, which is embodied in the creation of programs such as the Canadian Co-operative Investment Fund (being developed by Co-operatives and Mutuals Canada). The study is further motivated by the lack of agreement about the relationship between capital and efficiency in the literature, and the study will add evidence to the literature using most recent firm level data.

1.2 Economic Problem

Despite its importance in dealing with market failure, the agricultural co-operative sector in Canada has been challenged by economic, political, and social changes, such as the 2008 recession, the changing value of the Canadian dollar, and the negotiation of new trade agreements, all of which can exacerbate existing problems, or create new ones (e.g., Diaz-Hermelo, Gray and Smith, 2001; Hailu, 2005; Hailu, Jeffrey and Goddard, 2007a). As these
changes bring into question the long-term viability of co-operatives, improvement in the efficiency of agricultural co-operatives may be crucial for co-operatives to continue serving their purpose well into the future (Ariyarantne et al., 2000). Before setting out to improve efficiency, however, it is first important to establish an understanding of the heterogeneity in efficiency across firms and the factors that influence efficiency, which can be done by conducting empirical efficiency studies. Insights into the relative efficiency of firms, the extent of efficiency of individual firms, and the influence of different factors on efficiency gleaned by these studies can be of value to managers, directors, members, and policy makers in the co-operative business sector.

1.3 Economic Research Problem

The efficiency of co-operatives has been widely discussed in economic literature. The existing work largely falls into two categories. The first compares the performance of co-operatives with IOFs (e.g. Porter and Scully, 1987). The second examines specific environmental factors that are related to (in)efficiency (e.g., Ariyarantne et al., 2000; Esho, 1997; Hailu, Jeffrey and Goddard 2007a and 2007b).

However, the efficiency of co-operatives in Canada has scarcely been studied, though Canada has a strong tradition of co-operative enterprises. The empirical research that has addressed this issue is limited to Hailu’s (2005) Ph.D. dissertation *Principal-Agent Problems and Capital Constraints in Canadian Agribusiness Supply and Marketing Co-operatives*, and publications associated with this work (e.g., Hailu, Jeffrey and Goddard, 2007a). Hailu (2005) uses data covering years up to 2001, and therefore does not include possible effects of structural changes in the economic environment on the co-operative sector since then, including the wave
of demutualization of several large agricultural co-operatives in the early 2000s, including Lilydale in 2005, and the Saskatchewan Wheat Pool in 2004 (Industry Canada, 2015). That study also only examined cost efficiency in these co-operatives. The present study uses data from 1984 to 2010 to examine both cost and technical efficiency in marketing and processing co-operatives.

This thesis has two main purposes: (1) to measure both technical and cost efficiency in Canadian agricultural marketing and processing co-operatives, focusing on the fruit and vegetable and dairy sectors; and (2) to examine the effect of financial leverage by type of debt (member debt, short-term debt, and long-term external debt). Fruit and vegetable co-operatives were chosen since the most observations were available for this sector. The dairy sector was selected both for its size, and because it is a supply managed sector. The specific research questions are:

1. What levels of technical and cost efficiency are present in Canadian agricultural marketing and processing co-operatives?

2. Does financial capital structure influence the technical and cost efficiency Canadian agricultural marketing and processing co-operatives?

3. Does the relationship between technical and cost efficiency and capital constraints differ by the type of debt?

In the context of this research, financial capital constraints is used to capture the effect of challenges in obtaining different type (e.g., debt from different sources) and relative amount (as measured by debt to asset ratio) of financial capital. In the co-operative context, the research principally focuses on problems accessing both sufficient amounts of capital overall (both debt
and equity), and challenges in diversifying the type of capital used to incorporate more equity rather than depending on debt. Based on the data available, this study focuses on the construction of the capital used in the co-op, including debt (from long-term external debt, short-term debt, debt from members, or all sources) relative to total assets. The term capital constraint is used to be consistent with the literature on co-operatives, which generally examines co-operative capital rather than sources of financing (see, for example, ICA, 2015). Consistency with the subject literature rather than broader economic literature was chosen since this study has concrete implications for the co-operative sector, rather than solely academic use.

By focusing on the impact of capital constraints, this study can help support initiatives in Canada (and abroad), such as the mounting of the Canadian Co-operative Investment Fund, being developed by Co-operatives and Mutuals Canada (CMC), and other provincial programs like the Régime d’Investissement Co-opérative in Quebec (Co-operatives and Mutuals Canada, 2015b; House of Commons Special Committee on Co-operatives 2012). Because size was found to be of statistical significance, programs promoting access to capital are important to allow for co-operatives to capture the benefits of expansion for efficiency. However, the empirical findings also suggest that programs targeting debt from members rather than external debt may be more effective at improving efficiency in co-operatives.

1.4 Purpose and Objectives

The purpose of this study is to examine the relationship between technical and cost efficiency and financial capital constraints in agricultural marketing and processing co-operatives in Canada. The objectives are to:
1) Measure technical and cost efficiency in Canadian agricultural marketing and processing co-operatives using a stochastic frontier modeling approach;

2) Estimate the influence of capital constraints on technical and cost efficiency of co-operatives;

3) Examine whether the type of debt considered changes the observed influence of capital constraints on technical and cost efficiency in co-operatives

and

4) Draw policy implications for effective targeting of programs to support agricultural co-operatives

1.5 Outline of Thesis

The remainder of this thesis is divided into six chapters. Chapter 2 presents an overview of the co-operative sector in Canada. Chapter 3 presents a review of literature on co-operatives, the microeconomics of co-operatives and literature examining efficiency of co-operatives, and the role of capital (in both co-operatives and IOFs) and other environmental factors in efficiency, which builds on the overview presented in the economic research problem to clearly establish the gap in existing research. Chapter 4 presents the conceptual framework, including types of efficiency, and theories about the relationship between capital and efficiency. Chapter 5 builds on this theoretical base to present the empirical model, including a description of data sources, key variables, and the model that will be used to evaluate cost efficiency and its relationship to capital constraints. Chapter 6 presents the findings of the study. Finally, Chapter 7 provides a
summary of the study, policy implications, a broad conclusion, and a discussion of limitations and recommendations for future research.
Chapter 2: Overview of the Canadian Co-operative Sector

This chapter presents an overview of the co-operative sector in Canada. First, it provides an overview of the basic legal framework for co-operatives (the Canadian Co-operatives Act, and supply management). It then provides an overview of the governance of co-operatives, both within the government and within the sector. It then describes the main findings of the House of Commons Special Committee on Co-operatives, as an introduction to the sector itself. The final sub-section provides an overview of the geographic distribution, distribution by type, and of some of the major trends in the Canadian co-op sector.

2.1 Institutional Context

This section provides an overview of the main laws and regulations governing co-operatives in Canada.

2.1.1 Co-operative principles

At their most basic, co-operatives (in Canada and globally) are businesses that are owned and run by their members. Their operation is governed by a set of international principles (the ‘co-operative principles’):

1. Co-operatives have membership that is open to any person willing to accept the responsibilities of membership;

2. They are democratically controlled by their members, either directly or by a board of directors elected by members. This is often referred to as the principle of one member, one vote;

3. Members contribute to and control the capital of the co-operative;
4. Co-operatives operate in an autonomous and independent way;

5. Co-operatives provide education, training and information to their members, managers, and employees;

6. Co-operatives are encouraged to co-operate with other co-operatives; and

7. Co-operatives should show concern for their community (ICA, n.d.).

These principles were first developed by the International Co-operative Alliance (ICA) in 1937, and were revised in 1966 and in 1995 (MacPherson, 2012). They are the basis of the international co-operative movement, although they need to be adapted to specific country and sector circumstances (MacPherson, 2012). These principles are what differentiate the operation of co-operatives from that of IOFs.

### 2.1.2 Canadian Co-operatives Act

In Canada, to be officially considered as a co-operative, the organization must be legally incorporated at the federal, provincial or territorial level (Industry Canada, 2015). The following section provides an overview of some key provisions from the Canadian Co-operatives Act (the Act), last modified in December of 2012. The Act governs non-financial co-operatives with operations in more than one province or territory. Co-operatives with operations in only one province or territory are governed by the corresponding provincial or territorial act.

The basis for co-operatives laid out in the Act is similar to the co-op principles as specified by the ICA, including open membership, democratic member participation, member economic
participation, and education of members, officers and the community. It also includes some specifications, such as interest on loans from members and dividends on member shares must be specified in the articles of the co-op; and how the co-op can use its surpluses.

Part eight of the Act specifically deals with the capital structure of co-operatives. It specifies that the co-op can have loans from members. These loans do not necessarily have to be repaid with interest. It also indicates that membership shares, which grant the holder equal rights to other members, can only be issued to members. However, pending approval from the co-op’s board of directors, these shares can be sold directly to potential members if they meet the requirements for membership.

Part eight also allows for the issuance of investment shares. The Act itself does not restrict whether these can be issued to non-members, how many can be issued, or if different classes can be issued; it is the responsibility of the co-op to determine these characteristics in their articles. In addition, any issuance of shares has to be agreed to by membership. However, the Act restricts the voting rights that these shares can carry. Investment shareholders carry the right to vote on dissolving the co-op or on major changes in operation (e.g., demutualization). The Act also allows for debt obligations or securities to be issued (Justice Canada, 1998).

In summary, the Canada Co-operatives Act reflects the principles put forth by the ICA. However, it is somewhat less restrictive in that it allows for the issuance of investment shares to non-members, which may carry voting rights for a restricted set of possible issues. It allows for the additional capitalization tools of debt obligations and securities.
2.1.3 Industry Specific Regulation: Supply Management

In addition to sector wide regulations, some types of co-operatives also are subject to industry specific regulations. In Canada, the dairy, poultry, turkey and egg industries are governed by a system of supply management. The national structures for these products were put in place during the 1970s and 1980s (1972 for milk, 1973 for eggs, 1974 for turkey, 1978 for chicken, and in the 1980s for hatching eggs) (Barichello, Cranfield and Meilke, 2007; Hailu et al., 2004). The system was established in an effort to stabilize the prices received by farmers (Barichello, Cranfield and Meilke, 2007; Muirhead, 2014). Though the details differ by commodity, the basis is the same: prices are generally determined by a formula taking into account the cost of production plus some return with the goal of providing a fair return to producers; the quantity supplied to the market will be determined based on consumer demand at the price determined by the formula; and there are border measures in place to restrict less imports of commodities (that may be less expensive) from other countries (Barichello, Cranfield and Meilke, 2007; Doyon, 2011; Findlay and Gres, 2012; Muirhead, 2014). The price and the quantity are both set by either provincial (eggs, turkey, chicken) or national boards (dairy) (Larue and Lambert, 2012).

The quota system was put in place to restrict the volume supplied by producers. This is necessary since, because the actual price offered to producers is above the perfect competition price, the volume producers are willing to supply to the market is greater than what consumers would actually demand. This attributes a value to the right to produce at this price (quota) (Barichello, Cranfield and Meilke, 2007; Muirhead, 2014). In the case of dairy, the value of per cow annual production quota reached $25,000 in January of 2014 (Muirhead, 2014). However, in
the face of negotiations for free trade agreements like the Trans-Pacific Partnership, the future of the supply management system is uncertain (Barichello, Cranfield and Meilke, 2007). Some countries were opposing Canada’s inclusion in the agreement unless supply management is removed (Larue and Lambert, 2012; Muirhead, 2014).

Supply management could have a variety of implications for co-operatives. Hailu et al. (2004) found that supply management could decrease the agency cost of debt, which arises from an incompatibility between the goals of owners (members) and managers. Furthermore, supply management may help prevent shirking by managers. Since supply management controls the amount of raw material available, the level of output can also be seen to be effectively restricted, thus decreasing the need for monitoring (Hailu et al., 2004).

Nevertheless, for both co-operatives and IOFs, supply management reduces the ability to adjust output to minimize costs (or to maximize profit) (Doyon, 2011; Hailu, 2005). It has also been cited as a barrier to achieving economies of scale, which reduces the overall competitiveness of the Canadian dairy industry (Doyo, 2011; Findlay and Gres, 2012). The high cost of quota acts as a barrier to entry for new farmers (Findlay and Gres, 2012; Larue and Lambert, 2012). Supply management also leads to consumers paying a higher price (Findlay and Gres, 2012). Furthermore, if the demand at a given price is inaccurately predicted, this can lead to surpluses in the system, which have to be repurchased by the marketing board to maintain the price (Larue and Lambert, 2012). In addition, supply management may decrease the incentive for members to contribute capital to their co-operatives since, even without their co-op, they have a guaranteed market at a guaranteed minimum price for their products (Ernst and Young, 2002).
2.2 Organizations Governing Canadian Co-operatives

2.2.1 Co-operatives Policy Unit (Innovation, Science and Economic Development Canada)

The Co-operatives Policy Unit is responsible for the co-ordination of federal level activities impacting non-financial co-operatives across the country, including the administration of the Canada Co-operatives Act (House of Commons Special Committee on Co-operatives, 2012; Industry Canada, 2015). The Secretariat is also responsible for the Annual Survey of Canadian Co-operatives. In 2010, the survey response rate was 65%, a decrease from 70% the previous year. For some co-operatives, data was estimated based on previous information if the co-op is still in operation (Industry Canada, 2015). The data for this study was provided by Innovation, Science and Economic Development Canada (ISED)\(^3\), based on this survey.

This unit was developed within ISED in response to a recommendation of the report of the Special Committee on Co-operatives to transfer responsibility for co-operatives from Agriculture and Agri-food Canada to ISED. It was preceded by the Rural and Co-operatives Secretariat of Agriculture and Agri-food Canada (Industry Canada, 2015).

2.2.2 Co-operatives and Mutuals Canada

Co-operatives and Mutuals Canada (CMC) is the national apex organization that represents co-operatives, mutuals, sector federations, and provincial co-operative associations. CMC was founded on April 1, 2014, bringing together the Canadian Co-operative Association and the Conseil canadien de la coopération et de la mutualité, thereby uniting Anglophone and Francophone co-operatives in one organization. As such, it represents most of the co-operatives in Canada (CMC, 2015a). The strategic plan of the organization is aligned with the International

\(^3\) Innovation, Science and Economic Development Canada was formerly named Industry Canada.
Co-operative Alliance *Blueprint for a co-operative decade*, which includes a section on capital (see ICA, 2013). CMC, for its part, wants to “create a world-class environment for co-operatives and mutuals to grow and thrive” (CMC, 2015a, p. 5). CMC’s primary initiative in this area is the development of the Canadian Co-operative Investment Fund, in order to address limited access to capital that co-operatives are currently faced with, without impacting democratic member participation by providing loans and subordinated debt to co-operatives in order to support their development and expansion (CMC, 2015a and 2015b). The Fund is supported by other co-operatives and mutuals, which are provided with financial returns on their investments. As of January 2016, it is currently waiting for approval from the Ontario Securities Commission, and is expected to receive applications for loans in the summer of 2016 (Donovan, 2016).

CMC is also engaged with the federal government to increase government interest in co-operatives. They have a government affairs committee, which has submitted formal requests to the federal government to support the Canadian Co-operative Investment Fund, and to help develop a national co-operative development strategy. However, neither of these requests was mentioned in Budget 2015. CMC also works with the federal government through the All-Party Caucus on Co-operatives, and more directly with ISEDC to support the implementation of recommendations in the *Status of Co-operatives in Canada* report (CMC, 2015a).

Finally, CMC liaises with co-operatives in other countries as the only Canadian member of the International Co-operative Alliance (ICA). The ICA is an international apex organization made up of 283 organizations in 94 countries, representing over 1 billion people (CMC, 2015a). The ICA is the organization that has set out the co-op principles, as outlined in section 2.1.1.
2.3 Findings of the Special Committee on Co-operatives

The report of the House of Commons Special Committee on Co-operatives, *Status of Co-operatives in Canada*, was published in 2012. This report examined the nature of co-operatives, some of the benefits of co-operation, and the challenges faced by co-operatives, based on testimony given by stakeholders engaged in the sector. The report notes that co-operatives have traditionally been prominent in agriculture and finance, and are now involved in many other sectors. In the Canadian context, co-operatives have played important roles, particularly in official language minority communities (French communities outside Quebec, and English communities within Quebec), and in Quebec overall. Co-operatives also play an important role in First Nations’ communities.

One of the key points in the report was the lack of capital in Canada for co-operative development. The principal federal government program, the Co-operative Development Initiative, which provided advisory services, research and knowledge development helping co-operatives startup operations has not been renewed from its 2003-2013 term. This program had helped create over 300 co-operatives. The stakeholders participating in the consultations for the report criticized this decision. Though there remain some programs intended to support small and medium enterprises, which are available to co-operatives, co-operatives are generally not aware of these programs. Stakeholders also were critical restrictions on the eligibility of investment in co-operatives for RRSPs (registered retirement savings plans), including ineligibility of shares for members owning more than 10% of co-operatives, which excludes small co-operatives. The limited availability of programs contributed to the problem of co-op capitalization, which is a fundamental issue for co-operatives.
However, there are some provincial programs in place. For example, in Quebec, the Régime d’Investissement Co-opératif provides tax credits to those investing in registered co-operatives. Several stakeholders encouraged a federal initiative similar to this program. In addition, Nova Scotia has a community investment program that provides tax credits for investment in community projects, co-operatives or private business projects, and is RRSP eligible.

Overall, co-operatives play an important role in Canada, supporting various minority communities. However, just as co-operatives around the world do, Canadian co-operatives face problems raising capital to support their operations and investment. Though there are no federal government programs specifically targeted to co-operatives, some provinces have programs that representatives of the sector suggest expanding to a national scale.

2.4 Sector Description

Co-operatives are present across Canada. Some provinces have much higher representation of co-operatives (Ontario, Quebec, Saskatchewan) than others (Manitoba, Nova Scotia). Figure 1 shows the number of non-financial co-operatives incorporated in each province (co-operatives that operate in more than one province are counted in the province where their headquarters are located).
2.4.1 Types of co-operatives

There are three primary traditional types of co-operatives. The first is the producer co-operative. These co-operatives purchase products from their members, and will then re-sell them, either as a raw commodity or after some processing. The second type is the consumer co-operative. Consumer co-operatives provide their members with some goods or services (which can include credit). The other primary type of co-op is the worker co-op, which is owned by its employees (CMC, n.d.). Worker co-operatives are generally not considered in the agricultural context.
Producer and consumer co-operatives are the most common types in agriculture, often known as marketing and processing co-operatives, and supply co-operatives respectively. In this sector, there is a third type of co-op that provides services to members, referred to as ‘support to agriculture’, including activities like storage, machinery sharing, or grazing. These can be considered consumer co-operatives, since the farmers are consuming the services provided by the co-op (Industry Canada, 2015).

More recently, a new type of co-operative, the New Generation Co-operative (NGC), has emerged to counterbalance some of the problems faced by co-operatives, particularly capital constraints (Hendrikse and Veerman, 2001; ICA, 2015; Iliopoulos, 2003; Kramper, 2012). Though NGCs maintain what is often considered the key feature of the co-op, democratic member control, they differ from traditional co-operatives in many ways (NZMAF, 2005). NGCs typically have restricted (or closed) membership, while traditional co-operatives have open membership (principle 1) (NZMAF, 2005; Zamagni, 2012). By closing membership, short-term free riding can be reduced (Cotterill, 1987). In addition, a large capital investment is generally required to become a member, which can help to overcome problems of raising equity (NZMAF, 2005; Zamagni, 2012). Members of producer NGCs typically have delivery contracts that dictate their rights and obligations for the quality and quantity of good they are to sell to the co-op. This is often proportionate to their investment in the co-op (or their number of shares) (Zamagni, 2012). However, the membership shares are generally tradeable (with their associated delivery rights and obligations) between members or to prospective members, at variable prices (Iliopoulos, 2003; NZMAF, 2005; Zamagni, 2012). Since shares are tradeable, members may be more inclined to think longer term, which may help to solve the horizon problem, discussed in Chapter 3 (Iliopoulos, 2003).
2.4.2 Overview of Agricultural Co-operatives

This research focuses on agricultural co-operatives. The following section groups co-operatives into their traditional categories\(^4\). There have been some changes within this sector in the last decade. The major trends are summarized in Tables 1 to 3, below.

Table 1 shows that the number of co-operatives in all categories has decreased. This is reflective of a trend of demutualization, or conversion away from the co-operative business model, that has been observed in co-operatives globally. In Canada, the first demutualization was in 1999, in the insurance sector (Battilani and Schroter, 2012). More recently, there have been several major demutualizations in the agricultural sector, including Agricore Co-operative (which managed Dairyworld Foods) in 2001; the Saskatchewan Wheat Pool in 2004; and Lilydale in 2005, due to, in part, a generally high debt levels (Fulton and Girard, 2015; Hailu, 2005; Industry Canada, 2015).

Table 1 also shows that the total membership in agricultural co-operatives has decreased, which may reflect the decreasing number of farms in Canada across all revenue classes but the largest (over $500,000 per year) (Statistics Canada, 2015). However, while the membership of marketing and processing co-operatives and support to agriculture co-operatives has decreased, the membership of supply co-operatives has actually increased over the same period.

\(^4\) This is due to the information available in our data set. Innovation, Science and Economic Development Canada breaks down its data by activity, which can be broadly grouped into the traditional categories (marketing and processing, supply, and support to agriculture). There is no information on specifics of governance that would indicate whether a co-op is operating as an NGC.
Table 1: Changes in the Number of and Membership in Agricultural Co-operatives, 2000-2010

<table>
<thead>
<tr>
<th>Type of Co-op</th>
<th>Number of co-operatives</th>
<th>2000</th>
<th>2010</th>
<th>Percent Change</th>
<th>Membership</th>
<th>2000</th>
<th>2010</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing and Processing</td>
<td>212</td>
<td>204,989</td>
<td>55,578</td>
<td>-72.89%</td>
<td>212</td>
<td>146</td>
<td></td>
<td>-31.13%</td>
</tr>
<tr>
<td>Supply</td>
<td>231</td>
<td>289,113</td>
<td>361,552</td>
<td>25.06%</td>
<td>231</td>
<td>135</td>
<td></td>
<td>-41.56%</td>
</tr>
<tr>
<td>Support to Agriculture</td>
<td>532</td>
<td>64,125</td>
<td>50,086</td>
<td>-21.89%</td>
<td>532</td>
<td>338</td>
<td></td>
<td>-36.47%</td>
</tr>
<tr>
<td>Total</td>
<td>975</td>
<td>558,227</td>
<td>467,216</td>
<td>-16.30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author’s own calculation.

Table 2 shows a decrease in the volume of assets among agricultural co-operatives overall. The volume of assets for marketing and processing co-operatives is also decreasing. In contrast, the volume of assets has increased for supply co-operatives, potentially due to the increase in members, which allows for the potential of greater investments in assets with a large membership base, since the members generally provide the bulk of the financing in co-operatives. However, the assets in support to agriculture co-operatives have more than doubled over the period, despite a decrease in both the number of, and the membership in these co-operatives. This trend would require additional investigation, which is outside the scope of this research.

Table 2: Changes in the Volume of Assets in Agricultural Co-operatives, 2000-2010

<table>
<thead>
<tr>
<th>Type of Co-op</th>
<th>Volume of Assets</th>
<th>2000 (2010$)</th>
<th>2010</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing and Processing</td>
<td></td>
<td>5,978,788,502.75</td>
<td>2,431,168,608.00</td>
<td>-59.34%</td>
</tr>
<tr>
<td>Supply</td>
<td></td>
<td>1,439,062,686.86</td>
<td>1,998,377,819.00</td>
<td>38.87%</td>
</tr>
<tr>
<td>Support to Agriculture</td>
<td></td>
<td>509,305,311.50</td>
<td>1,740,580,161.00</td>
<td>241.76%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7,927,156,501.11</td>
<td>6,170,126,588.00</td>
<td>-22.16%</td>
</tr>
</tbody>
</table>

Source: Author’s own calculation, Bank of Canada, n.d.
Table 3 shows that the overall volume of business (total revenues) across all categories of agricultural co-operatives is declining, and specifically in marketing and processing co-operatives, with a small increase in the case of supply co-operatives and a very large increase for support to agriculture co-operatives. While this increase in assets and revenues of support co-operatives is interesting, it is not the focus of this paper.

**Table 3: Changes in the Volume of Business in Agricultural Co-operatives, 2000-2010**

<table>
<thead>
<tr>
<th>Type of Co-op</th>
<th>Volume of Business (Total Revenue)</th>
<th>2000 (2010$)</th>
<th>2010</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing and Processing</td>
<td></td>
<td>18,357,530,707.02</td>
<td>6,036,394,430.00</td>
<td>-67.12%</td>
</tr>
<tr>
<td>Supply</td>
<td></td>
<td>4,111,335,735.78</td>
<td>4,938,867,153.00</td>
<td>20.13%</td>
</tr>
<tr>
<td>Support to Agriculture</td>
<td></td>
<td>141,436,329.27</td>
<td>4,214,035,560.00</td>
<td>2878.89%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>22,610,329,772.07</td>
<td>15,189,297,143.00</td>
<td>-32.82%</td>
</tr>
</tbody>
</table>

Source: Author’s own calculation, Bank of Canada, n.d.
Chapter 3: Review of Research on Economics of Organizations and Co-operatives

This chapter examines two types of literature. It first reviews existing literature on the economics of organizations in general, and of co-operatives specifically to illustrate why firms develop, and why co-operatives, as specific type of firm, organize and what advantages they provide. It then deals specifically with literature on the efficiency of co-operatives. These studies can largely be grouped into two categories: comparative studies of efficiency in co-operatives and IOFs, and studies identifying environmental factors affecting efficiency. The empirical and theoretical approaches to compare co-op and IOF efficiency are considered separately, then studies on environmental factors that influence efficiency are presented: capital in both co-operatives and IOFs, and other factors in the case of co-operatives. These studies are reviewed in order to identify gaps in the literature to support the motivation for this study.

3.1 Organizational Theory

This section provides an overview of some of the key theoretical perspectives on why firms emerge. Some authors argue the ownership of the firm is strategically used to overcome some transaction costs, since market contracting can be expensive when market imperfections exist. The different types of firms that emerge respond to different types of market imperfections (Borzaga and Tortia, forthcoming; Hansmann 1988, 1996; Williamson, 1973). The firm is also seen in terms of improving the efficiency of contracting (Borzaga and Tortia, forthcoming; Coase, 1937; Alchian and Demsetz, 1972). In this way, Coase (1937) argues that with the development of the firm, the number of contracts can be reduced, which can help save on coordination and negotiation costs. Alchian and Demsetz (1972) add that the type of contract used can reduce other inefficiencies within the firm. For example, a profit sharing firm can help
to reduce shirking, particularly if it is a small firm, since employees directly benefit from their increased effort. In contrast, a corporation may be a more appropriate structure in the case of a larger firm, since decision-making can be undertaken more effectively with a small group of decision makers (Alchian and Demsetz, 1972).

Borzaga and Tortia (forthcoming) expand on this perspective. They propose that IOFs are developed because of failure in capital markets, consistent with Hansmann (1988). In addition, Borzaga and Tortia (forthcoming) note that co-operatives are the most efficient form in cases where monopolies or monopsonies exist within the market.

Some authors examine what conditions are required for efficient firms. Hansmann (1988) proposes that the most efficient organization will assign ownership rights in such a way that transaction costs for all patrons (owners and non-owners), including the costs of ownership (like monitoring and risk bearing), and other costs (such as market power and asymmetric information) are all minimized. Similarly, Jensen and Meckling (1976) argue that the efficient firm will be organized in a way that will minimize agency costs, including costs associated with equity and debt. They note that there can be problems if the owner (or the principle) delegates some decision-making authority to another actor, like a manager (the agent). This type of problem is generally called the ‘principle-agent problem’. This is essentially a case of mismatched incentives, where the agent may not act in the interest of the principle, since they have different interests and will act in such a way to maximize their own utility. However, the principal may be able to establish some incentives for the agent to incentivize the agent to act in the interest of the principal, though these will carry costs (agency costs) (Jensen and Meckling, 1976). Similar costs can arise in cases where stocks are sold, since stockholders will bring in additional interests (Jensen and Meckling, 1976). In contrast, when a firm is wholly owned and
managed by one (or few) actor(s), the owner(s) can then simply work to maximize their own utility, although this will limit the types of capital that can be accessed by the firm (for example, since they will not be able to sell shares while maintaining total control) (Jensen and Meckling, 1976).

While the articles examined above look at firms as one or a small number of relatively homogeneous groups, Ostrom (2005) cautions that firms are built of a set of components that rarely exist in the same combination. Therefore, as with all simplified models, we should be cautious in not falsely extending the explanatory power of a given model by over-simplifying. However, the level of detail appropriate may not be clear in all cases.

3.2 The Microeconomics of Co-operatives

Many different aspects of co-operatives have been considered in the literature. The following section provides an overview of some of the key areas considered: the role of co-operatives in the reduction of market failures, building on the more general theory of the firm; and some of the specificities of co-operatives, like their objectives, decision making processes, and access to capital.

3.2.1 Co-operatives and market failures

Co-operatives are often considered to contribute to the reduction of market failures, as are firms in classic organizational theory, described above (Hailu, 2005; House of Commons Special Committee on Co-operatives, 2012; Kramper, 2012; Lerman and Parliament, 1990). The broadest of the mechanisms employed in co-operatives is the improvement of market access for members. In agriculture, this may either refer connecting farmers to the market for inputs (supply
Co-operatives), or to the market for output (marketing and processing co-operatives) (Diaz-Hermelo, Gray and Smith, 2001; USDA, 2012). Co-operatives can also improve the prices farmers face by either offering inputs at a lower price, or purchasing outputs for a higher price (Casselman, 1952). In addition, some authors have noted that co-operatives can also act to drive the economy towards more efficient outcomes by working towards prices that reflect a market in perfect competition, by acting as a ‘competitive yardstick’, or by ending monopolies, the benefits of which are illustrated in figure 2 (Baarda, 2006; Bateman et al., 1983; Cotterill, 1987; Enke, 1945; Smith, 1983).

Figure 2 provides a comparison of the prices and quantity that result in a monopoly and in a perfect competition. From classical economic theory, we know that the social optimum will occur where price (from market demand) is equal to marginal cost (for producing the last unit), at point A, or where the quantity supplied is equal to the quantity demanded, giving price $P_c$ and quantity $Q_c$. However, a monopolist firm generally prefers to produce a quantity that will maximize profit, where marginal cost is equal to marginal revenue (point B). This leads to a suboptimal quantity of the product being produced ($Q_m < Q_c$). Since a smaller quantity is being produced, it can be sold at a higher price, based on the demand function. This price will be higher than the optimal price ($P_m > P_c$). The loss in social welfare (the deadweight loss)$^5$, from the divergence from perfect competition (or the socially optimal point) is given by the shaded triangle in Figure 2, which shows the changes in pricing by a single firm if they are acting as a monopolist.

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$^5$ A similar situation will occur in monopsonist situations, where there are few purchasers. For example, in the agricultural processing sector, there are relatively few processing firms for farmers to sell their raw goods to. The mechanism through which the co-operative improves market outcomes in this situation is almost identical to the monopoly case.
monopolist, or if they are facing perfect competition (the case of the supply co-operative). The monopsonist and marketing co-operative case is depicted in Appendix A.

![Figure 2: Deadweight Loss from Monopoly](image)

Though co-operatives can act as profit maximizers, they can also fill a variety of different roles (Enke, 1945). For example, if the co-op makes pricing decisions to maximize the welfare of their members, this may lead to other actors in the economy pricing similarly, driving the price towards the perfect competition price, thus reducing or eliminating deadweight loss, and leading to an overall socially optimum outcome (for both members and others in the community), since social welfare is maximized (Borzaga and Tortia, forthcoming; Enke, 1945; Hailu, 2005).

In addition, co-operatives can help reduce asymmetric information, such as information about the quality of the product (Casselman, 1952; Hansmann, 1996; Ortmann and King, 2007;
Sexton and Iskow, 1993). They also help lower transaction costs, such as contracting costs, by reducing the number of actors involved in market processes (Huang et al., 2013; Sexton and Iskow, 1993; USDA, 2012).

### 3.2.2 Co-operatives and the Financial Crisis

Other benefits that can result from co-operatives are illustrated in their resilience during the 2008 financial crisis (Birchall and Ketilson, 2009; Delbono and Reggiani, 2013; House of Commons Special Committee on Co-operatives, 2012). For example, it has been noted that, in Europe, no credit unions (co-operative banks) failed, while the same cannot be said of non-co-operative banks (Sanchez Bajo and Roelants, 2011). In Canada, there was actually an increase in the assets and membership of credit unions during 2008 (Brichall and Ketilson, 2009).

This resilience comes from the nature of the co-operative enterprise. Since they are controlled by members, major decisions have to be debated and agreed upon by members. This decreases the likelihood of taking risky borrowing decisions (e.g. borrowing to finance risky projects), since the risk would be borne by members themselves (Sanchez Bajo and Roelants, 2011). In addition, since co-op banks operate for the benefit of their members, not just for profit, they are less likely to offer subprime loans or similar types of debt instruments (Birchall and Ketilson, 2009). There may also be some level of moral restraint within the co-op, since they are lending out members’ money (Birchall and Ketilson, 2009). Furthermore, members may have more patience with the effects of market fluctuations on the co-op (such as decreases in profit) than shareholders in IOFs, which can lead to greater stability (House of Commons Special Committee on Co-operatives, 2012).
Furthermore, due to challenges in accessing capital quickly, co-operatives often maintain a larger stock of capital (generally from retained patronage refunds), which can act as a buffer during economic shocks (Birchall and Ketilson, 2009; Delbono and Reggiani, 2013; House of Commons Special Committee on Co-operatives, 2012). In contrast, IOFs generally pay out dividends to stockholders, and may have less equity built up in case of economic distress (Delbono and Reggiani, 2013).

There were also fewer layoffs in co-operatives and in IOFs globally during the financial crisis (Borzaga and Tortia, forthcoming; Delbono and Reggiani, 2013). More generally, jobs in co-operatives tend to be more stable and to last longer (Sanchez Bajo and Roelants, 2011).

However, the financial crisis had some negative impacts on co-operatives, including constraining their ability to access external capital, and thus to finance projects like expansion, exacerbating the existing problem for co-operatives (Deloitte, 2012).

### 3.2.3 Objectives of the Co-operative

While IOFs are generally considered to act as profit maximizers, this is not necessarily the case with co-operatives. While co-operatives may aim to maximize profit, there are a variety of other potential objectives noted in the literature: the maximization of member or of social welfare; minimization of costs paid by or maximization of price paid to members; generation of new membership; maximization of output; or maximization of patronage refunds (per unit) (Bateman et al., 1983; Cotterill, 1987; Fulton and Giannakas, 2001; Hailu, 2005; NZMAF, 2005; Parliament, Lerman and Fulton, 1990; Smith, 1983; Soboh, Lansink and Van Dijk, 2012). In cases where co-operatives aim to maximize profit, it can be either the profit of the co-op itself, or the joint profit of the member farms and the co-op (Bateman et al., 1983). It is also important to
note that the welfare of members is found as the sum of the profit of the co-op (since this is returned to the member as a patronage refund) and producer surplus in the case of the marketing co-op, or consumer surplus in the case of supply co-operatives (Bateman et al., 1983; Cotterill, 1987; Hailu, 2005).

While co-operatives can choose to set an operational objective (with the agreement of their membership), their ability to achieve this objective is highly dependent on the personal objectives of members (Evans and Guthrie, 2002). For example, the amount members choose to supply to the co-op, or to purchase from the co-op will depend on their behavioural objectives. It will also be impacted by the price offered by the co-op relative to the costs of production and to the price in the wider market. Generally, the price considered in decisions by members will include both the price paid out and the patronage refund. Members will tend to move in and out of the co-op until the unit price offered, in the case of the marketing co-op, is equal to the cost at farm level (Hailu, 2005). In this way, the patronage refund can also play an important role in levels of member participation (Cotterill, 1987).

The number of members will also impact the supply of raw goods available to the co-op (or the potential consumption of goods in the case of supply co-operatives) (Cotterill, 1987). For this reason, co-operatives may try to optimize their membership to ensure an optimal supply level to meet their broader objectives (like profit maximization, which occurs where supply intersects net average revenue at the net average marginal product maximum). Furthermore, with increased membership, the co-op can internalize more of the external free-riding effects (Cotterill, 1987). However, this can prove difficult with the principle of open membership (Bateman et al., 1983; Cotterill, 1987; Hailu, 2005; Smith, 1983).
In addition, farms (or other types of members) retain their autonomy though they are members of the co-op. That is, the co-op does not dictate how its member farms are operated, so they do not control the quality or quantity of goods produced, or the cost at which these goods are produced (USDA, 2012). This can potentially lead to instability for the co-op, or at least complicate planning. However, this problem is resolved in NGCs, with the use of delivery contracts that dictate quality and quantity of goods to be delivered to the co-op.

The variety of objectives the co-op may choose to pursue arises since the benefits of ownership (profit) accrue to the patrons of the organization, rather than to someone who solely fills the role of owner. This provides for multiple channels for owner-patrons to benefit from their relationship with the co-op. For this reason, studies of co-operatives generally have to impose a behavioural assumption in order to evaluate efficiency (commonly cost minimization or profit maximization) (Ariyarantne et al., 2000; Hollas and Stansell, 1988).

3.2.4 Decision-making process

Since the co-op principles require open membership, co-operatives often have a heterogeneous member base with different objectives, which can complicate decision-making (Fulton and Giannakas, 2001). In addition, since members are engaged in the decision-making process (i.e., democratic control by members), the business knowledge of members can be important to the functioning of the co-op (Fanning and O’Mahony, 1983). Members may have low managerial capacity or specific business knowledge. As such, they may not always make the optimal business decisions (Chevallier, 2011). Democratic member control can also pose challenges in setting precise objectives and in meeting these objectives at low costs because of the slow decision-making processing inherent in the democratic system, the heterogeneity of
membership, and the diversity of possible behavioural objectives for the co-op and for individual members (Chevallier, 2011; Fulton and Giannakas, 2001).

There is a delicate balance that must be struck in the decision making process to consider both the needs of the co-op as an organization, and of members in each of their roles. For example, Fulton and Giannakas (2001) note that if the members view the co-op as acting in a way that is not aimed at maximizing their utility, they may decrease their commitment to the co-op. To add further complexity, members may also judge the co-op’s performance based on other (non-financial, and often non-quantifiable) services provided by the co-op (Cotterill, 1987; Fulton and Giannakas, 2001; Hardesty and Slagia, 2004; Kramper, 2012; Parliament, Lerman and Fulton, 1990). These services, while potentially important to members, can impact efficiency.

In addition, co-operatives are faced with portfolio problems. This refers to the challenge in making decisions that reflect difference in risk preferences of members in their two roles as both owners and patrons (e.g., Chevallier, 2011; Iliopoulos, 2003; NZMAF, 2005). This can further complicate the process of decision making within the co-op. Additionally, control problems (or principal agent problems) can arise because of a divergence between the interests of owners and managers (Fulton and Laycock, 1990; Hailu, 2005; NZMAF, 2005; Porter and Scully, 1987). Similarly, influence cost problems may arise because of a difference between the interests of members (Evans and Guthrie, 2002; Hart and Moore, 1998; NZMAF, 2005). The complexity of the decision-making process in co-operatives can contribute to inefficiency (Ferrier and Porter, 1991; NZMAF, 2005).
3.2.5 Access to Capital

The ability to raise financial capital has been identified as a key challenge facing co-operatives (Baarda, 2006; Fanning and O’Mahony, 1983; Fulton and Laycock, 1990; Hailu, Jeffrey, and Goddard, 2007b; Hart and Moore, 1998; Idda, Furesi and Madau, 2004; ICA, 2013). This can present challenges for operations since, as Hansmann (1996) has stated, co-operatives need some flexibility in their capital to allow for efficient operation. A review of the relationship between capital and efficiency can be found in Chapter 4.

Co-operatives are limited in the ways they can raise capital by the co-op principles (primarily democratic member control and member economic control) (Ernst and Young, 2002; Fanning and O’Mahony, 1983; ICA, 2015). For this reason, co-operatives generally raise the majority of their capital either from members (by direct contributions or through retained earnings), or by borrowing (Hansmann, 1996). However, they may face challenges in raising all of the required capital from the members, either due to unwillingness or inability to contribute large sums (Casselman, 1952; Diaz-Hermelo, Gray and Smith, 2001; Ernst and Young, 2002; Hardesty and Salgia, 2004; Iliopoulos, 2003; Sexton and Iskow, 1993).

Co-operatives may also be faced with external and internal free-rider problems, which may decrease the willingness of members to contribute capital to their co-operative. External free-rider problems arise when benefits from the co-op accrue to non-members (for example, in the case of the competitive yardstick effect) (Iliopoulos, 2003; NZMAF, 2005; Ortmann and King, 2007). If members view non-members as gaining specific benefits from the co-op, they may become less engaged in the co-op. This may also impact the ability of the co-op to recruit new members.
members. In addition, co-operatives may suffer from internal free-riding, which arises because all members share the same benefits, but new members often pay a lower cost for membership, since older members had to cover the initial start up costs for the organization (Chevallier, 2011; Iliopoulos, 2003; NZMAF, 2005; Salazar and Galve Gorriz, 2011).

Another commonly cited problem is the horizon problem. This arises because members only receive benefits of membership during their tenure, and are therefore less likely to make long term investments, which could lead to more efficient outcomes for the co-op in the future (e.g. Chevallier, 2011; Evans and Guthrie, 2002; Hailu, 2005; Idda, Furesi and Madau, 2004; Iliopoulos, 2003). This problem can be exacerbated in the case of intangible assets (like brand recognition, advertising) (Salazar and Galve Gorriz, 2011).

In addition, the equity raised from members is generally returned to the members when they terminate their membership (NZMAF, 2005). Since it is must be returned, it is often considered by external lenders to be debt, rather than equity. With a higher debt to equity ratio, a tool used by lenders to evaluate a risk of default, it may be more difficult for co-operatives to obtain a loan (Hansmann, 1996; House of Commons Special Committee on Co-operatives, 2012). This is relatively common because of a lack of understanding of the co-operative model among traditional lenders (House of Commons Special Committee on Co-operatives, 2012; ICA, 2015). Co-op lenders (i.e., credit unions) have a better understanding of the functioning of co-operatives, and may therefore be considered a more appropriate lender for co-operatives. However, credit unions are generally not able to meet the borrowing needs of large co-operatives (House of Commons Special Committee on Co-operatives, 2012). Despite the challenges in raising these types for funds, lines of credit and loans are expected to remain important sources of co-op funding into the future (Deloitte, 2012).
In the face of these challenges, there is an increasing trend of demutualization, in Canada and abroad (Battilani and Schroter, 2012; Chaddad and Cook, 2004; Hailu, 2005; Hendrikse and Veerman, 2001; House of Commons Special Committee on Co-operatives, 2012). That is, it is becoming more common for co-operatives to convert away from the co-op model, and towards the IOF model. Demutualization can be due to a number of environmental factors including decreasing commitment to the co-op model; changes in political attitudes towards co-operatives; lack of potential for growth, relating to capital constraints; and mismanagement (Battilani and Schroter, 2012; Chaddad and Cook, 2004; Fulton, 1995; Fulton and Girard, 2015; House of Commons Special Committee on Co-operatives, 2012).

3.3 Research on Efficiency in Co-operatives

All of the challenges faced by co-operatives create potential for inefficiency. This section presents existing literature in the area of efficiency in co-operatives, including comparisons of co-operatives and IOFs, and the impact of specific exogenous factors, including capital, on levels of efficiency.

3.3.1 Comparisons with IOFs

3.3.1.1 Theoretical Comparisons between IOFs and Co-operatives

Some studies have compared co-operatives and IOFs using a theoretical approach, with mixed results. These studies have found that co-operatives are more efficient than IOFs (Bontems and Fulton, 2009; Fulton, 1995). Other studies have found that the IOF organizational structure is better suited in certain cases, while in others co-operatives are found to be more efficient (Hansmann, 1988; Hart and Moore, 1998).
3.3.1.2 Empirical Comparisons with IOFs

A number of studies have empirically compared the efficiency of co-operatives and IOFs, without a clear consensus on which type of business is more efficient. Several find that IOFs are more efficient (Berry, 1994; Ferrier and Porter, 1991; Hollas and Stansell, 1989; Idda, Furesi and Madau, 2004; Porter and Scully, 1987; Soboh, Lansink and Van Dijk, 2012). In contrast, Parliament, Lerman and Fulton (1990) found that co-operatives are, in general, more efficient than IOFs. Other studies had mixed results. Lerman and Parliament (1990) found that co-operatives in the dairy industry are more efficient than IOFs, while, in the fruit and vegetable sector, IOFs are more efficient. Similarly, Akridge and Hertal (1992) found that in some circumstances co-operatives are more efficient, while in others IOFs are more efficient. Singh, Coelli and Fleming (2001) found different results when different methods were used: using stochastic frontier analysis, co-operatives are more cost efficient, but when using data envelopment analysis, IOFs appeared to be more cost efficient (more information on these approaches can be found in chapter 5).

In reviewing these studies, a geographical gap emerges. Studies used data from the United States (Akridge and Hertel, 1992; Berry, 1994; Ferrier and Porter, 1991; Hollas and Stansell, 1988; Lerman and Parliament, 1990; Porter and Scully, 1987), Europe (Idda, Furesi and Madau, 2004; Soboh, Lansink and Van Dijk, 2012), or India (Singh, Coelli and Fleming, 2001). There are no empirical studies comparing co-operatives and IOFs in Canada due to lack of comparable data for IOFs and co-operatives.
3.3.2 Exogenous Factors that Impact Co-operative Efficiency

This section provides a review studies that examine the effect of capital constraints (in co-operatives and in IOFs) and other environmental factors on efficiency. It also includes a comment on the geographic focus of these studies.

3.3.2.1 Capital in Co-operatives

A few studies have considered the effect of capital constraints in co-operatives, measured in different ways: equity to asset ratio, debt to asset ratio, or leverage (debt to equity ratio).

Ariyarantne et al. (2000) find that overall efficiency (technical, allocative, and scale) decreases with an increase in equity to asset ratio. Hailu (2005), and Hailu, Jeffrey and Goddard (2007a and 2007b) found that debt to asset ratio was negatively related to cost efficiency in both supply and marketing and processing co-operatives, and that debt to equity ratio was negatively related to cost efficiency in dairy marketing and processing co-operatives. Hailu, Goddard and Jeffrey (2005) found that, on average, in fruit and vegetable co-operatives, leverage and efficiency are negatively correlated. Similarly, Huang et al. (2013) found that leverage has a negative impact on pure technical efficiency, but has no impact on scale efficiency.

3.3.2.2 Capital in IOFs

The relationship between capital and efficiency has also been examined in the context of IOFs. Backman, Islam and Sumelius (2011) found that access to microfinance is positively related to technical efficiency in farms. Similarly, Haider, Ahmed and Mallick (2011) find that the number of years a firm accessed credit was positively related to technical efficiently. In
contrast, Alvarez and Crespi (2003) find that there was no significant relationship between access to credit and technical efficiency.

Faria, Fenn and Bruce (2005) have found that efficiency is improved with higher intensity of capital. In addition, Chemmanur, Krishnan, and Nanady (2011) found that firms that were supported through venture capital were more efficient than those that were financed in other ways.

Several authors have examined the relationship between the debt to asset ratio and efficiency. Some find that debt to asset ratio is positively related to efficiency (Alarcon, 2007). Another study looked at the relationship that runs in the other direction, and finds that more efficient firms have lower debt to asset ratios (Hadley, 2006). Still others find mixed results. Chavas and Aliber (1993) find that the short run debt to asset ratio has no significant effect on efficiency, whereas intermediate and long run ratios have positive effects on both technical and allocative efficiency.

Some studies examine the relationship between leverage and efficiency. Weill (2003) examines seven European countries, and finds a positive relationship between cost efficiency and leverage in five countries, a negative relationship in one, and no significant relationship in the seventh country. Other authors find a significant and positive relationship between leverage, measured as the debt to equity ratio, and efficiency (Margaritis and Psillaki, 2007; Mok et al., 2007).

These studies examined European countries (Alarcon, 2007; Faria, Fenn and Bruce, 2005; Hadley, 2006; Weill, 2003), the United States (Chavas and Aliber, 1993; Chemmanur, Krishnan, and Nandy, 2011); Chile (Alvarez and Crespi, 2003); and Bangladesh (Backman, Islam and
Summelius, 2011; Haider, Ahmed and Mallick, 2011). There were no studies found that empirically assess the relationship between capital and efficiency in IOFs, further supporting the need for more investigation in this area.

### 3.3.2.3 Other Environmental Factors

A variety of different environmental factors have been evaluated in relation to efficiency in co-operatives. One study examined the relationship between input and output prices and efficiency. Ariyarantne et al. (2006) found mixed results for the relationship between output prices and efficiency, but the prices for all inputs were positively correlated with efficiency (but labour and capital not statistically significant).

Others examined the relationship with size, and find a positive relationship between size and technical efficiency (Esho, 1997; Idda, Furesi and Madau, 2004), while Hailu, Jeffrey and Goddard (2007a and 2007b) find mixed results: for feed supply, and dairy and fruit vegetable processing co-operatives, size had a positive relationship with cost efficiency, while for petroleum supply and grain marketing co-operatives, the relationship was negative. Hailu, Goddard and Jeffrey (2005) find that size was quadratically related to cost efficiency in fruit and vegetable co-operatives. Huang et al. (2013) find that size had no significant impact on technical efficiency, a negative relationship with pure technical efficiency and a positive relationship with scale efficiency.

A number of other factors were also examined in the literature. Age of the co-op was found to have a positive relationship with technical efficiency (Idda, Furesi and Madau, 2004). Hendrikse and Veerman (2001) find that efficiency would be negatively affected by demand for differentiated products, and are more suitable with relatively low asset specificity. Huang et al.
(2013) found that the economic development in the area in which the co-op is located has a positive effect on technical, pure technical and scale efficiency. Salazar and Galve Gorriz (2011) found that the degree of vertical integration is positive correlated with efficiency.

Ariyarantne et al. (2000) examined a number of other financial variables. This study found that, with more sales or with better credit management (shorter collection period), there tended to be a higher level of technical efficiency. Allocative efficiency was found to decrease with diversification, to increase with total sales, to increase with better credit management, and to decrease with higher gross income to personnel ratio (labour productivity). Scale efficiency increases with an increase in total assets; increases with diversification; decreases with an increase in equity to asset ratio; and increases with better credit management. X-efficiency increases with size; increases with better credit management; but it is not statistically significantly related to diversification or specialization.

3.3.2.4 Geographic Distribution of Studies

Across the studies examining environmental factors affecting efficiency, a variety of countries have been considered: the United States (Ariyarantne et al., 2000; Ariyarantne et al., 2006); countries in Europe (Idda, Furesi and Madau, 2004; Salazar and Galve Gorriz, 2011); China (Huang et al., 2013); and New Zealand (Esho, 1997). However, only those studies emanating from Hailu’s (2005) Ph.D. dissertation *Principal-Agent Problems and Capital Constraints in Canadian Agribusiness Supply and Marketing Co-operatives* deal with efficiency of Canadian co-operatives (Hailu, Jeffrey and Goddard 2007a, 2007b; and Hailu, Goddard and Jeffrey, 2005). These papers use panel data from 1984-2001, from the Annual Survey of Canadian Co-operatives, the same data set that I use in this study, with the addition of data from
2002-2010. In addition, it focuses only on cost efficiency, and uses only one measure of debt (total debt) to define the debt to asset and debt to equity ratios. This study builds on Hailu’s (2005) findings, using a similar methodology applied to more recent data. In addition, it measures technical efficiency, and examines whether different types of debt influence efficiency differently.

3.3.3 Research Gap

In the studies reviewed, a distinct gap has emerged. In both the comparative studies and those examining environmental factors, there is a dearth of research on co-operatives in Canada. However, the data available cannot be used to address the gap in the comparative literature. Therefore, this study focuses on the exogenous factors that impact efficiency. There is some variation in the findings for the relationship between size and cost or technical efficiency, though several studies do find that positive co-operatives are more efficient (though negative, quadratic, and insignificant relationships were also found in single studies). In addition, there have been only a few studies that empirically evaluate the relationship between capital and efficiency in co-operatives. Though these studies are generally in agreement about the negative relationship between leverage and the debt to asset ratio and efficiency, the generalizability of these results is limited since it comes from so few studies. The impact of specific types of debt (e.g. long-term external vs. short-term) has also not been examined in the co-operative literature. In addition, since the IOF research is less clear, this would indicate that there is doubt regarding this relationship. This indicates that additional studies should be undertaken to examine if there is a more complex relationship between capital and efficiency in co-operatives that has not been revealed in the few studies so far undertaken.
In summary, this study seeks to address the gaps in the literature on capital and efficiency in co-operatives by evaluating the relationship between capital (as measured by the debt to asset ratio) and efficiency in the context of Canadian co-operatives.
Chapter 4: Conceptual Framework: Economics of Co-operatives; Types of Efficiency; and the Relationship between Capital and Efficiency

This chapter presents the theoretical basis of this analysis. Firstly, the primary types of efficiency are presented. Secondly, the relationship between capital and efficiency is discussed. Finally, a theoretical profit maximization problem is developed.

4.1 Types of Efficiency

This section will focus on cost efficiency, and its components: technical and allocative efficiency. Figure 3 provides a visual representation of these types of efficiency using an isoquant (Q), which shows the possible combinations of inputs ($x_1$ and $x_2$), for a given fixed level of output ($y$). The line P’P represents the ratio of relative prices of inputs $x_1$ and $x_2$. The isoquant and the area above it represent all possible combinations of inputs for producing $y$. This concept of efficiency is input oriented. Efficiency can also be considered in an output-oriented framework.
Figure 3: Types of efficiency

Source: Coelli et al. (2005, p. 52); Kumbhakar, Wang and Horncastle (2015); Farrell (1957).

Technical efficiency refers to a situation where no less input can be used to produce a given level of output. Alternately, it is where no more output can be produced using a given set of inputs (Farrell, 1957; Ferrier and Porter, 1991; Idda, Furesi and Madau, 2004; Porter and Scully, 1987). In Figure 3, point C represents a technically efficient point, as do all points on the isoquant Q, since the amount of one input cannot be reduced without increasing the amount of the other input required. Point D represents a technically inefficient point since C and D produce the same level of output (y), but from point D, you can produce the same output while reducing
both $x_1$ and $x_2$. The level of technical inefficiency can be measured by the ratio of the distance between points C and D to the distance between point D and the origin (Coelli et al., 2005).

Allocative efficiency occurs when the choice of inputs are chosen in a way that achieves the behavioural objectives of the producers (Hailu, Goddard and Jeffrey, 2005; Porter and Scully, 1987). If the producer seeks to minimize costs, points found along a line connecting point A and the origin would be considered as allocative efficient, since they represent points at which the ratio of inputs used minimizes the cost (corresponds to an optimum ratio of inputs, represented by P’P). In figure 3, point D is allocatively inefficient since its corresponding ratio of prices would be represented by a line tangent to point C, which is a departure from the optimum ratio (found at point B, or along P’P). The allocative inefficiency of point D is thus measured by the ratio of the distances between point B and C, and between point C and the origin.

Cost efficiency, which is composed of technical and allocative efficiency can be defined as “the ratio of the minimum (or efficient) cost of producing the output for the firm in question to the actual cost at given input prices and technology” (Hailu, Jeffrey, and Goddard, 2007b, p. 52), composed of cost and allocative efficiency. The cost efficient point can be found at point A in Figure 3. This point is both technically efficient, since it is found on the isoquant, and allocatively efficient, since the ratio of prices, P’P is tangent to the isoquant at this point. The cost inefficiency of point D is the product of its technical and allocative inefficiencies, and can therefore be measured by the ratio of distances OB and OD. To measure cost efficiency, as well as allocative efficiency (one of its components), a behavioural assumption, such as profit maximization or cost minimization is necessary (Hailu, Goddard and Jeffrey, 2005; Kumbhakar, Wang and Horcastle, 2015).
4.2 The Relationship between Capital and Efficiency

It is important to note that financial capital is composed of both debt and equity. The actual balance of capital and debt adopted by the co-op (or any firm) will depend on several factors, including interests rates and risk aversion. However, the need to balance the risk aversion of individual members can complicate this decision (Barton, Parcell and Featherstone, 1996; Jensen and Meckling, 1976). Generally, equity provides more certainty, since it acts as a buffer in instances of financial uncertainty (Barton, Parcell and Featherstone, 1996).

Several authors have examined the importance of the choice of capital structure to the firm. Modigliani and Miller (1958) look at the importance of capital structure in the market value of a firm. The key proposition in this paper is that the market value of the firm is independent of its capital structure, based on a model of stocks (equity) and bonds (debt). These authors argue that, though the cost of loans will increase as levels of debt rise, the overall cost of capital (from debt and equity) is independent of leverage, since arbitrage can be used by stock and bondholder to undo changes in leverage. Modigliani and Miller (1958) also note that in classical finance that the average cost of capital should fall with increasing leverage, within some moderate debt ratios, but may rise again at high levels of debt, creating a U-shaped cost of capital curve. However, in some examples tested by the authors, the cost of capital is found to be constant, which is consistent with their proposition. Based on their model, the actual choice of capital structure will be complicated, and depend on a variety of factors, including utility function of managers (Modigliani and Miller, 1958).

Fama (1978) adds two key observations to Modigliani and Miller (1958). Firstly, the wealth of the bond and stockholders is independent of the capital structure at time t since the security
holders will be indifferent to capital structure, given some rules restrict certain decisions of firms. Secondly, the changes in the capital structure of one firm can be offset by changes in another firm, leading to quantity of securities on the market to remain constant in the long term.

Brander and Spencer (1989) also look at capital structure, by examining output as a function of investment, debt and effort. They find that the effect of debt on output is ambiguous since it increases investment (which is positively correlated with output) but decreases effort (positively correlated with output). If output (with the same level of inputs) is decreased (increased), efficiency will also decrease (increase). As such, by Brander and Spencer’s (1989) reasoning, the relationship between capital structure and efficiency is unclear.

Kim and Maksimovic (1990) look at the relationship between leverage (debt to equity ratio) and some firm decisions. For example, the equity holders in a more leveraged firm may underinvest, since they may view their investment as primarily benefitting debt holders. However, the tendency to use capital for inefficient ends decreases with leverage. In this way, debt may actually improve efficiency. This can, in contrast, be outweighed by choice of inputs. With debt, there can be a tendency to use inputs that can be more easily monitored or can serve as collateral, which leads to an inefficient choice of inputs. Overall, Kim and Maksimovic (1990) conclude that efficiency will decrease with higher levels of debt due to input misallocation.

In addition, when capital is constrained, it impedes the ability to make investments that are needed to foster growth of an organization, and allow it to stay competitive when market conditions or policy change (Chaddad and Cook, 2002; Chavas and Aliber, 1993; Hadley, 2006). The actual level of constraint depends on many factors, including the level of permanent equity, size, and credit risks (Chaddad and Cook, 2002).
In the case of co-operatives, there is often a higher reliance on debt, since they are limited in how they can raise equity, often only sourced from members (Borganza and Tortia, forthcoming; Parliament, Lerman and Fulton, 1990). However, they are also limited in their ability to borrow in many cases, often due to a limited amount of collateral, or a misunderstanding in financial institutions about the co-operative model (Chaddad and Cook, 2002; House of Commons Special Committee on Co-operatives, 2012). This can lead to higher costs of borrowing, since the bank perceives that they are taking on more risk (Li, Jacobs and Artz, 2014).

In addition, borrowing can impose different challenges on the co-op. It may increase the pressure on managers to improve performance. However, it can also decrease efficiency by increasing agency costs because of diverging interests between the lender, the co-op members, and the manager (Weill, 2003). There is therefore not a clear relationship between leverage and efficiency. The challenge of competing interests is also present in mixed capital source situations, since debt and equity holder may have different interest, which can create agency costs (Jensen and Meckling, 1976; Margaritis and Psillak, 2007; Mok et al., 2007). As previously stated, problems in promptly raising capital can make it more difficult to implement decisions, which are already challenging to arrive at with the democratic process that defines co-operatives (Chevallier, 2011).

Overall, though there is some disagreement in the literature over the importance of capital structure to the firm, both in terms of market value and efficiency, there are problems associated with leverage that may contribute to inefficiency, particularly in the case of co-operatives, since their unique structure compounds some of the problems in firms facing financial constraints, notably an inability to implement decisions, since their potential sources of financing are limited by the co-operative principles.


4.4 Theoretical Model

This section presents a theoretical model illustrating the relationship between capital and efficiency, through a constrained optimization problem.

Equation (1) articulates the problem at hand, namely a maximization of profit where the level of inputs (labour and capital) is constrained by the amount of financing available or by the cost of obtaining financing.\(^6\):

\[
\begin{align*}
\text{max } \pi &= p \cdot f(K, L) - w_K K - w_L L \\
s.t. \quad w_K K + w_L L &\leq F
\end{align*}
\]

where \( \pi \) is profit; \( p \) is the price of output; \( f(K, L) \) is the level of output, expressed as a function of two inputs \( K \), which is capital and \( L \), which is labour; \( w_L \) is the price per unit of labour; \( w_K \) is the price per unit of capital; \( F \) is the level of financing available to the firm.

The overall problem can be expressed in one equation (equation 2), following the method laid out in Varian (1992). The Lagrange equation for the constrained profit maximization problem is given by:

\[
L = p \cdot f(K, L) - w_K K - w_L L + \lambda [F - w_K K - w_L L]
\]

where variables carry the same meaning as in equation 1; and \( \lambda \) is the Lagrange multiplier, which effectively expresses the relationship between the constraint and the profit function, and can vary given the different costs associated with different types of debt.

\(^6\) This is a simplified model to illustrate the role of access to credit in the profit of the firm. In the specific case of co-operatives, member’s welfare maximization problem is sum profit maximization problem and member (consumer/producer) surplus (see section 3.2 for a discussion of the microeconomics of co-operatives).
In taking the derivative of equation 2, we arrive at the following first order conditions (equations 3-5)

The first order condition for profit maximization with respect to capital:

\[
\frac{\partial \pi}{\partial K} = p \cdot f'(K, L) - w_K - \lambda w_K = 0 \tag{3}
\]

The first order condition with respect to labour:

\[
\frac{\partial \pi}{\partial L} = p \cdot f'(K, L) - w_L - \lambda w_L = 0 \tag{4}
\]

The first order condition with respect to Lagrange multiplier (\(\lambda\)):

\[
\frac{\partial \pi}{\partial \lambda} = D - w_L L - w_K K = 0 \tag{5}
\]

By rearranging equation 3, we can see the impact of the constraint in accessing financial capital (equation 6).

The marginal cost of capital with capital constraint is given by:

\[
p f' (K, L) = w_K (1 + \lambda) \tag{6}
\]

where the right hand side represents the marginal cost of the level of capital that will be chosen for use by the firm.

Though the equation would suggest equality between marginal revenue and marginal cost, as would be expected in perfect equilibrium, in reality the constraint will prevent this optimal outcome from being reached. The inequality is the result of the increased marginal cost of capital that results from the increased price that results from the constraint (which reflects, for example, transaction costs, agency costs of debt, asymmetric information, and interest payments), which is
evident if this equation is compared to the unconstrained situation, where $\lambda=0$, as expressed in equation (7).

The marginal cost of capital or credit without constraints is given by:

$$pf'(K, L) = w_K$$

(7)

By comparing equations (6) and (7), we can see that the constraint will directly impact the amount of capital that will be used by the firm. Since, in the constrained case, $\lambda>0$, it follows that $w_K(1+\lambda)>w_K$. As the cost of capital goes up, the amount of capital that the firm is able to access will decrease, which moves the firm away from its optimal level of capital, and can thus constrain growth and the ability of the firm to adapt to changes in the market and policy environment, or to implement decisions. This may decrease the efficiency of the firm.

If, as this model suggests, there is an efficiency loss from capital constraints, then it should be the case that the relationship between debt and efficiency should be negative as suggested by Hailu, Goddard and Jeffrey (2005) and Huang et al. (2013). This relationship will be empirically evaluated using a stochastic frontier model.

4.5 Chapter Summary

This chapter introduced the theoretical foundations for the model in this paper. The first section presented an overview of the types of efficiency that will be key within the analysis. The next section looked at the relationship between capital and efficiency, to lay the groundwork for the theoretical model, presented in the last section. This model presents a mathematical basis for the relationship between capital and efficiency, which builds on the qualitative discussion in the
preceding sections. Taken together, these sections provide propositions about the potential outcomes of the empirical model, which will be developed in the next chapters.
Chapter 5- Empirical Model: Measuring Efficiency of Marketing and Processing Co-operatives and the Influence of Capital Constraints

This chapter provides an overview of the empirical model. The first section discusses the two primary approaches to measuring efficiency: stochastic frontier analysis and data envelopment analysis. The second section describes the model as it is used in the study. Finally, the data sources and key variables are described.

5.1 Approaches to Measuring Efficiency

The most commonly used methods for evaluating efficiency of firms are the stochastic frontier model and data envelopment analysis. Both approaches are widely applied in the analysis of efficiency of co-operatives (Hailu, 2005; Sexton and Iskow, 1993). The following section describes the relative advantages and disadvantages for each of these methods. It also describes some of the approaches taken to measure the impact of certain environmental factors on inefficiency.

5.1.1. Stochastic Frontier

The stochastic frontier (SF) model establishes some optimal frontier showing efficient production given a fixed level of technology (Aigner, Lovell and Schmidt, 1977, Meeusen and van Den Broeck, 1977). The unique feature of the stochastic frontier model is the use of a composed error term, meaning that error term measuring all deviations from the optimal frontier is separated into two parts: random error and inefficiency (Aigner, Lovell and Schmidt, 1977; Hailu, 2005; Kumbhakar and Lovell, 2000). The separation of the error into two parts is the primary advantage of the SF model, since it removes random error from the estimation of (in)efficiency, which helps to distinguish inefficiency from the effect of factors outside the firm’s
control (considered in the random error term) from what is within the firm’s control (in the inefficiency term) (Aigner, Lovell and Schmidt, 1977; Forsund, Lovell and Schmidt, 1980; Hjalmarsson, Kumbhakar and Heshmati, 1996; Schmidt and Sickles, 1984). It also reduces the impact of outliers (Idda, Furesi and Madau, 2004). For these reasons, the stochastic frontier is considered to estimate more accurate values than those generated using other methods (Aigner, Lovell and Schmidt, 1977; Forsund, Lovell and Schmidt, 1980; Hjalmarsson, Kumbhakar and Heshmati, 1996; Schmidt and Sickles, 1984). In addition, statistical tests can be conducted when using the SF model, which can also be considered advantageous over traditional data envelopment analysis (DEA) models (Singh, Coelli and Fleming, 2001).

The primary criticism of the SF model is that it requires a number of functional specifications, including the functional form for the production and cost functions used and distributions for random error and inefficiency terms (Huang et al., 2013; Ondrich and Ruggiero, 2001). If the empirical specifications deviate from reality, then the measurement of inefficiency may be inaccurate (Hailu, 2005). However, in cases where the frontier that is assumed to closely reflect the actual technology, SF models are preferred over traditional DEA, because of their ability to account for noise and random error with the separation of the error term, which also helps to account for outliers and measurement error, though recent developments in the DEA model are addressing some of its main challenges (Simar and Wilson, 2015). For example, by using bootstrapping techniques, statistical testing can be done, and by using order-\(m\) or order-\(\alpha\) estimators, the models are much less sensitive to outliers (Simar and Wilson, 2011).

5.1.1.1 Functional Forms

In the stochastic frontier model, the functional form for the frontier must be specified. The Translog or Cobb-Douglas functional forms are the most common functional forms used for
the SF model. The translog functional form is the more flexible of the two, since it allows for the
elasticity of substitution between inputs to take on any value (Berry, 1994; Esho, 1997; Hadley,
2006; Hailu, 2005, Nicholson and Snyder, 2005). It also allows for quadratic relationships
between the variables. For this reason, it might be a better approximation if the actual functional
form is unknown (Nicholson and Snyder, 2005). The Cobb-Douglas function form is a special
case of translog, where the elasticity of substitution between inputs is equal to one, and some
terms are omitted (Nicholson and Snyder, 2005). It is therefore less flexible than the full
translog form. However, in complicated models, the simplicity of Cobb-Douglas can be an asset
since it makes it easier to estimate parameters.

5.1.1.2 Distributional Assumptions for the Inefficiency Effect

The SF model requires an imposition of distributions on the random error, and inefficiency
terms. The random error is generally assumed to be normally distributed, and independent from
the inefficiency term (Aigner, Lovell and Schmidt, 1977; Kumbhakar and Lovell, 2005;
Kumbhakar, Wang and Horncastle, 2015). The inefficiency term is often assumed to take on a
truncated normal distribution, truncated to include only non-negative values (in the case of the
cost function) or non-positive (in the case of the production function) (Aigner, Lovell and
Schmidt, 1977; Kumbhakar and Lovell, 2005; Kumbhakar, Wang and Horncastle, 2015; Schmidt
and Sickles, 1984). The truncated normal distribution allows for more inefficiency than the half
normal (truncated at zero) distribution, which can therefore better reflect the reality of some
sectors, particularly those that are known for inefficiency, like supply managed and co-operative
sectors, since the mean inefficiency value is higher than zero (Kumbhakar, Wang and Horncastle
2015). While the choice of distributional form can impact the specific efficiency estimates, it is
unlikely to impact efficiency ranking of firms (Forsund, Lovell and Schmidt, 1980; Kumbhakar and Lovell, 2000).

5.1.2 Data Envelopment Analysis

The second most commonly used approach is Data Envelopment Analysis (DEA). DEA creates a frontier that represents the envelopment of all observed production possibilities (Ondrich and Ruggiero, 2001; Simar and Wilson, 2015).

In the traditional DEA model, all departures from the frontier are considered as inefficiency (Aigner, Lovell and Schmidt, 1977; Esho, 1997; Ferrier and Porter, 1991; Hailu, 2005; Hailu, Jeffrey and Goddard, 2007b; Singh, Coelli and Fleming, 2001). This can result in unrealistically high inefficiency scores (Esho, 1997). Furthermore, in the DEA model, because all observations must lie below the frontier, this model is particularly susceptible to measurement error and outliers (Aigner, Lovell and Schmidt, 1977; Hailu, 2005; Simar and Wilson, 2011). However, new techniques within the DEA model and new approaches that modify DEA are being developed to address some of its main limitations, including the non-separation of the error term, the limited possibility for statistical testing, and sensitivity to outliers (Huang et al., 2013; Murova and Chimdi, 2013; Simar and Wilson, 2015).

DEA has the advantage of not imposing a strong assumption about distribution on the inefficiency term (Esho, 1997; Ferrier and Porter, 1991). Furthermore, the model does not require a pre-determined functional form describing the production technology (Alvarez and Crespi, 2003; Singh, Coelli and Fleming, 2001; Simar and Wilson, 2015). Overall, the non-parametric approach imposes less structure on the data, and is therefore more flexible (Ferrier and Porter, 1991; Simar and Wilson, 2011).
5.1.3 Evaluating the Impact of Environmental Factors on Efficiency

When using the SF model, the relationship between efficiency and environmental or exogenous variables can be evaluated in one stage, by employing a maximum likelihood estimation approach to simultaneously estimate the equation to measure inefficiency, and the equation to assess the impact of environmental factors on inefficiency (Battese and Coelli, 1995; Wang and Schmidt, 2002).

This study uses a one-stage approach that is proposed by Wang and Schmidt (2002) to simultaneously estimate the two equations. The one-step approach improves on the bias that is often observed when estimating the equations separately. This bias emerges because the second step regresses a vector of potential factors (z variables) on the inefficiency term. If the independent variables in the first step are correlated with the z variables, then the first step will be biased, as the z variables should have been included in the first step. As such, the one-step approach is generally recommended (Kumbhakar, Ghosh and McGuckin, 1991; Kumbhakar, Wang and Horncastle, 2015; Wang and Schmidt, 2002).

Within the one-stage approach, the effect of exogenous variables on the pre-truncation mean of inefficiency will be estimated. While this is the more common way to estimate the effect of these variables (e.g., Battese and Coelli, 1995), it may be more appropriate to estimate the marginal effect of exogenous variables on the post-truncation mean, since this is the actual mean efficiency estimate, and therefore the variable that can carry economic implications (Amsler, Schmidt and Tsay, 2015). The post-truncation effects can be estimated using marginal effects, and their statistical significance can be determined using the bias corrected bootstrap confidence intervals. In this study, both the pre- and post-truncation estimates for the impact of exogenous variables will be reported.
5.2 Empirical Model

This study will estimate inefficiency and the impact of financial capital constraints using two equations, to be estimated in one stage, using the stochastic frontier model. The specific models used are either the panel model as proposed by Battese and Coelli (1995), using the *sfpanel* package (Belotti et al., 2012), and the *sfmodel* package (Kumbhakar and Lovell, 2000) in STATA. Since the *sfmodel* allows for bootstrapping and therefore the estimation of the statistical significance of the marginal effects of the exogenous variables, it was used whenever convergence could be achieved using that package.

Two separate models are estimated. The first model estimates and examines technical efficiency using a production frontier, while the second estimate and examines cost efficiency using a cost frontier. The estimation of cost efficiency adopts the additional assumption that co-operatives examined operate to minimize costs\(^7\). In addition, consistent with Battese and Coelli (1995), the Cobb-Douglas frontiers will be estimated in order to reduce estimation challenges that can arise in the one-step maximum likelihood procedure (such as non-convergence). While the overall impact of exogenous variables will be estimated in this procedure, the marginal effects will also be estimated. The statistical significance of these variables will be determined using bootstrapping.

As suggested in Hailu (2005), separate frontiers will be estimated for different industries, to account for the differences in technologies used. Therefore, four types of models will be estimated in this study: production and cost frontiers for the fruit and vegetable, and dairy industries. In addition, a second set of models will be estimated to include the limited data

\(^7\) The section on the microeconomics of co-operatives in chapter 3 reviews several alternative behavioural objectives for co-operatives.
available for the province of Quebec, as described in the data section below. Within each of
these, the effect of the financial variables (the debt to asset ratio) will be defined in terms of total
debt, and then in terms of three types of debt will be estimated in two separate models. However,
the generalized forms for the frontiers across the industries will be the same.

5.2.1 Production Frontier and Technical Efficiency

The stochastic production frontier (SPF) takes the following generalized form, measuring
technical efficiency as departures of actual observed level of production compared to optimal
production levels in order to measure technical efficiency:

\[
y_{it} = f(x_{it}, \beta) + (v_{it} - u_{it}), i=1...I, t=1...T
\]  

(10)

where \( y_{it} \) is the actual output for the \( i^{th} \) co-op in time period \( t; x_{it} \) is the quantity of inputs used; \( \beta \)
is a vector of parameters to be estimated; \( v_{it} \) is the stochastic error term, representing random and
measurement errors; and \( u_{it} \) is the inefficiency term.

Using this formula, technical efficiency for each producer is then calculated using the
following formula:

\[
TE_i = \exp(-\hat{u}_i), \text{ where } \hat{u}_i = E[u_i|\varepsilon]
\]  

(11)

where \( TE \) is technical efficiency, \( \hat{u} \) is the observed inefficiency of each producer, estimated using
the expected value of \( u_i \) as a point estimate for \( \hat{u}_i \), the estimated technical inefficiency term.

The stochastic error term \( (v_{it}) \) is assumed to follow a normal distribution, and the
inefficiency term \( (u_{it}) \) is assumed to follow a non-negative truncated normal distribution. Both
terms are also assumed to be distributed independently of each other and the regressors.
(Kumbhakar and Lovell, 2000). In the case of the production function, the inefficiency term is subtracted, since inefficiency will decrease the level of output.

The Cobb-Douglas functional form is used for the production function. Since output is defined as value added, the quantity of raw materials used is already accounted for. The specific Cobb-Douglas stochastic production frontier to be estimated is:

\[
\ln(y_{it}) = \beta_0 + \beta_L \ln L_{it} + \beta_K \ln K_{it} + (v_{it} - u_{it}), \quad i=1\ldots I, \quad t=1\ldots T
\] (12)

where \(y_{it}\) is the actual output for the \(i^{th}\) co-op in time period \(t\); \(\beta_0, \beta_L, \) and \(\beta_K\) are parameters to be estimated; \(L\) is the quantity of labour used; \(K\) is the quantity of capital used; \(v_{it}\) is the stochastic error term, representing random and measurement errors; and \(u_{it}\) is the inefficiency term.

### 5.2.2 Cost efficiency

The stochastic cost frontier (SCF) takes the following generalized form, which allows cost efficiency to be estimated as a ratio of the estimated frontier to the observed total cost:

\[
C_{it} = C(w_{it}, y_{it}; \beta) + (v_{it} + u_{it}), \quad i=1\ldots I, \quad t=1\ldots T
\] (13)

where \(C_{it}\) is the actual total cost for the \(i^{th}\) co-op in time period \(t\); \(C(\cdot)\) is the ideal cost frontier, which depends on \(w_{it}\), the price for a given input, \(y_{it}\), the level of output, and \(\beta\), which is a vector of parameters to be estimated; \(v_{it}\) is the stochastic error term, representing random and measurement errors; \(u_{it}\) is the inefficiency term.

The stochastic error term \((v)\) is assumed to follow a normal distribution, and the inefficiency term \((u)\) is assumed to follow a non-negative truncated normal distribution. Both terms are also assumed to be distributed independently of each other and the regressors (Kumbhakar and Lovell, 2000). Here, the inefficiency term is added, since inefficiency will increase total cost.
For this study, total cost is defined as the sum of labour costs and capital costs. The cost function is defined by a (Cobb-Douglas) function. Since output is defined as value added, raw material cost is already accounted for. As such, the specific cost function to be estimated is:

\[
\ln(C_{it}) = \beta_0 + \beta_L \ln w_{L_{it}} + \beta_K \ln w_{K_{it}} + \beta_Y \ln y_{it} + (v_{it} + u_{it}), \ i=1...I, \ t=1...T
\]  

(14)

where \( C_{it} \) is the actual total cost for the \( i^{th} \) co-op in time period \( t \); \( \beta_0, \beta_L, \beta_K \) and \( \beta_Y \) are parameters to be estimated; \( w_{L_{it}} \) is the price of labour; \( w_{K_{it}} \) is the price of capital; \( y_{it} \) is the level of output; \( v_{it} \) is the stochastic error term, representing random and measurement errors; and \( u_{it} \) is the inefficiency term. The cost function is estimated using a maximum likelihood function.

Cost efficiency can then be calculated using the following formula:

\[
CE_i = \exp(-\hat{u}_i), \text{ where } \hat{u}_i = E[u_i|\epsilon]
\]  

(15)

Where \( CE \) is cost efficiency, \( \hat{u} \) is the observed inefficiency of each producer, estimated using the expected value of \( u_i \) as a point estimate for \( \hat{u}_i \), the estimated cost inefficiency term.

5.2.3 Impact of environmental factors

In both the cost and technical efficiency models, a second equation is used to determine the relationship between efficiency and various environmental variables (financial leverage and firm size). The equation for inefficiency effects for both stochastic cost and production frontiers is given by

\[
u_{it} = \delta'z_{it} + \epsilon_{it}
\]  

(16)

where \( u_{it} \) is efficiency term in the \( i^{th} \) co-op at time period \( t \); \( \delta \) is a vector of parameters to be estimated; \( z_{it} \) is a vector of exogenous variables; and \( \epsilon_{it} \) is the error term.
In this study, the exogenous variables considered are financial constraints (the debt to asset ratios, defined by different sources of debt), and co-op size measured in the size of assets. The equations for the frontier and the inefficiency effects are simultaneous estimated, (Battese and Coelli 1995; and Wang and Schmidt, 2002). I follow Wang and Schmidt (2002) to estimate the marginal effect of the inefficiency effect variables and use bootstrapping to determine the statistical significance of the marginal effects.

5.3 Description of data sources

The data used is from the Annual Survey of Canadian Co-operatives. This survey is distributed to all incorporated co-operatives in Canada annually, who voluntarily responded to the survey. The response rate in 2010 was about 65% across all sectors (Industry Canada, 2015). Most of the data is federally collected by the Co-operatives Policy Unit at ISEDC. However, Quebec and Nova Scotia collect their data provincially, and communicate it to ISEDC for inclusion with the national data set (Industry Canada, 2015). Beginning in 2003, Quebec has reported only aggregated data to the federal government. The data used in this study firm level data from 1984-2010 (1984-2002 for the province of Quebec). Because of this limitation in the data available for the province of Quebec, two sets of models will be estimated: one including data from all provinces from 1984-2002, and using data from all years, but excluding the province of Quebec.

While data is available across all sectors, two industries are chosen for this study: fruit and vegetable co-operatives, and dairy co-operatives. Fruit and vegetable is chosen since this is the category of marketing and processing co-operatives with the most observations. Dairy is selected to see if there are noticeable differences in supply-managed industries. For a summary
of the number of co-operatives in each sector by year (excluding the province of Quebec), see Appendix B.

Some additional data was collected from Statistics Canada’s CANSIM database. The specific table numbers are noted in the relevant variable description.

5.4 Definition of key variables

5.4.1 Data preparation

The initial challenge with the database is combining the data sets managed by Agriculture and Agri-Food Canada (1984-2008) and Innovation, Science and Economic Development Canada (2009-2010). This included communicating with the Co-operatives Policy Unit to match the new and old co-op identifiers so each firm’s information would be as complete as possible, and to convert the activity numbers from the old to new systems so the data could be appropriately sorted.

I then proceeded to replace missing values to have as much data available as possible (since the natural log of zero is undefined, any zero values are essentially missing observations within the context of the model). There were two primary approaches used in this step: interpolation and estimation. In the case of number of employees, salary information, depreciation costs, and long-term external term debt interest the missing values were generally interpolated using the average of the preceding and succeeding observations where possible, or the two closest observations. In cases where all the data reported by the firm were zero, it was not possible to estimate. Missing values for other variables were replaced using identities (such as balance sheet identity). This was the case of cost of goods sold (COGS=total sales-gross margin), gross income (GI= sales income + patronage dividends received+ sundry and other
income+ grants and subsidies-non-operating expenses-cost of goods sold), and gross margin (GM= total sales-cost of goods sold), although this imputation for gross margin was only used in cases where the cost of goods sold was known so that circular reasoning problems did not arise.

Finally, all the financial variables (value added, salaries, value of capital used) used directly in the model were deflated using the consumer price index, based on the size of the values observed, from the Bank of Canada’s core index, which excludes certain very volatile products (CANSIM table 326-0021). In addition, the data for total assets, total equity and total liabilities were checked to ensure that the total assets were equal to total equity + total liabilities.

5.4.2 Key variables

This section describes the construction of the variables used in the three key equations.

5.4.2.1 Production function

Quantity of Output ($y_{it}$)

Value added, determined by the difference between sales and the cost of goods sold is used as a proxy for output.

Quantity of Labour ($L_{it}$)

Quantity of labour is defined as the number of hours worked by full and part time staff. The hours worked is estimated by assuming a 40 hour work week (2,080 hours worked per year) for full time employees and a 20 hour work week (1,040 hours annually) for part time employees.
**Quantity of Capital (K<sub>t</sub>)**

The quantity of capital used is defined as the value of capital used in a given year (depreciation amount plus long-term interest expense) divided by the price of capital. Note that in this case, the depreciation and long-term interest amounts are deflated by the capital price, which accounts for inflation in its derivation (see below).

**5.4.2.2 Cost function**

**Total cost (C<sub>t</sub>)**

Total cost is defined as the sum of the costs for capital and labour. The total cost for labour is given by salary costs. The cost of physical capital is measured as the depreciation cost plus long-term interest rates, since depreciation rate approximates the cost of capital used up, and interest rate is amount paid for the capital that was used in a given year (opportunity cost of capital).

**Labour price (w<sub>La</sub>)**

The labour price is determined by dividing the total amount paid out in wages and salaries annually by the estimated number of hours worked by full and part time staff. The hours worked is estimated by assuming a 40 hour work week (2,080 hours worked per year) for full time employees and a 20 hour work week (1,040 hours annually) for part time employees. The hourly wage rates were truncated at $10.30, reflecting the lowest provincial minimum wage in Canada as of February, 2016 (Government of Canada Labour Program, 2015), and $33.21 (reflecting a 45% increase over the average hourly wage from the most recent Labour Force Survey [CANSIM table 282-0225]). The use of a single minimum and maximum value for truncation follows the method used in Hailu (2005).
Physical Capital Price \((w_{Kt})\)

The price of capital is determined based on the formula in equation 13, based on McKenzie and Thompson (1997):

\[
C = q(i + \delta - \pi)
\]  \hspace{1cm} (17)

where \(C\) is the cost of physical capital; \(q\) is the price of a unit of capital relative to its output; \(i\) is the opportunity cost of capital; \(\delta\) is the depreciation rate; and \(\pi\) is the inflation rate.

The price for a unit of capital relative to its output \((q)\) is given by the ratio of the implicit price index for gross domestic product (GDP) [CANSIM table 384-0036] to the index for investment in fixed capital [CANSIM table 384-0036]. In other words, \(q\) represents the proportion of GDP (economic output) for each unit of capital, in relative terms.

The opportunity cost of capital refers to the potential income that could be generated by financial capital if it were not used to purchase physical capital. This value is estimated by the annual interest rate on Treasury Bills [CANSIM table 176-0043]

The depreciation rate is calculated using data from Statistics Canada. Statistics Canada provides the year-end gross asset stocks (which can be used to approximate the next year’s beginning asset stock) and the linear depreciation values for the agricultural, forestry, fishing and hunting industry. Depreciation rate can be calculated by taking the ratio of linear depreciation to capital stock [CANSIM table 031-0006].

Finally, the inflation rate is calculated using the consumer price index for all items [CANSIM table 326-0021].
Output (y)

Output is defined as value added, defined above

5.4.2.3 Environmental factors

Debt to asset ratio

The debt to asset ratio is used as a measure of the financial leverage (or credit constraints) of the co-operative. This is used as a measure of the degree to which co-operative access to certain types of capital. The ratio is initially defined by the total liabilities divided by the total assets. This ratio should take values between 0 and 1. However, some observations took other values, which may have been due to measurement error in the survey. To account for this, values that were under 0 were replaced with 0, and values above 1 were replaced with 0.8.

To examine whether the source of debt capital matters, we separate borrowed capital into debt to members, long-term external debt, and short-term debt (i.e., current liabilities).

Firm size

Firm size is measured by the log of the volume of sales of the firm.

5.5 Chapter Summary

This chapter provided an overview of the stochastic frontier model, as it will be used in this study, including the functional forms and distributions to be used, and the data and variables included. In the next chapter, the results of the application of the model will be presented.

8 The number of observations changed were: 2 corrected to 0 and 113 to 1 for fruit and vegetable co-operatives, and 44 corrected to 1 for dairy co-operatives.
Chapter 6: Results and Discussion

This chapter describes the results obtained using the stochastic frontier models described in Chapter 5. The first section provides descriptive statistics of the variables included in the models. The chapter is divided into two sections: results for fruit and vegetable co-operatives, and for dairy. Within each section, separate results are presented for the production frontier (technical efficiency) and the cost frontier (cost efficiency). Separate results are also presented for models for models that distinguishes between the different types of debt sources (debt from members, long-term debt from external sources and short-term debt). Separate models are also estimated with data Quebec (1984-2002) and without Quebec (1984-2010). The structure of the chapter is illustrated in Figure 4.

Figure 4: Estimated Models
6.1 Descriptive Statistics

Table 4 provides descriptive statistics for the variables used in the models. It is clear that there is a higher level of value added in the dairy co-operatives than in fruit and vegetable co-operatives, consistent with both the higher level of total cost and sales. This would indicate that dairy co-operatives tend to be larger than fruit and vegetable co-operatives. It follows that dairy co-operatives also have more employees and members than fruit and vegetable co-operatives. Dairy co-operatives also have more total assets, and liabilities than fruit and vegetable co-operatives. However, fruit and vegetable co-operatives have higher degrees of indebtedness, as measured by the debt to asset ratio. There are also more than twice as many fruit and vegetable co-operatives than dairy co-operatives.

Table 4: Descriptive Statistics (mean) for Agricultural Marketing Co-operatives by Sector and data sub-set

<table>
<thead>
<tr>
<th>Sector</th>
<th></th>
<th>Fruit and Vegetable</th>
<th>Dairy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost</td>
<td>Min</td>
<td>0.863</td>
<td>0.993</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>17.831</td>
<td>14.519</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>250.334</td>
<td>250.334</td>
</tr>
<tr>
<td>Sales</td>
<td>Min</td>
<td>4.524</td>
<td>0.094</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>80.835</td>
<td>61.849</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>869.140</td>
<td>869.140</td>
</tr>
<tr>
<td>Value Added</td>
<td>Min</td>
<td>-15.041</td>
<td>-11.886</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>24,101</td>
<td>19,261</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>396,352</td>
<td>396,352</td>
</tr>
<tr>
<td>Total Assets</td>
<td>Min</td>
<td>0.559</td>
<td>0.390</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>34,300</td>
<td>26.211</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>443,665</td>
<td>443,665</td>
</tr>
<tr>
<td>Total Liabilities</td>
<td>Min</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>26,074</td>
<td>20,220</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>329,877</td>
<td>329,877</td>
</tr>
</tbody>
</table>
### Debt to Asset Ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>0.62</th>
<th>0.59</th>
<th>0.56</th>
<th>0.60</th>
</tr>
</thead>
</table>

### Debt to members to Asset Ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>0.072</th>
<th>0.061</th>
<th>0.124</th>
<th>0.085</th>
</tr>
</thead>
</table>

### Long-term external debt to Asset Ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>0.176</th>
<th>0.191</th>
<th>0.119</th>
<th>0.149</th>
</tr>
</thead>
</table>

### Short-term Debt to Asset ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>0.417</th>
<th>0.383</th>
<th>0.358</th>
<th>0.388</th>
</tr>
</thead>
</table>

### Employees (#)

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
</table>

### Members (#)

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>3</th>
<th>3</th>
<th>5</th>
<th>5</th>
</tr>
</thead>
</table>

### Number of C-ops (n)

<table>
<thead>
<tr>
<th></th>
<th>78</th>
<th>109</th>
<th>30</th>
<th>39</th>
</tr>
</thead>
</table>

### Number of Observations (n x t)

<table>
<thead>
<tr>
<th></th>
<th>915</th>
<th>970</th>
<th>390</th>
<th>441</th>
</tr>
</thead>
</table>

#### 6.2 Fruit and vegetable co-operatives

##### 6.2.1 Production Frontier and Technical Efficiency

Estimation results for technical efficiency in fruit and vegetable co-operatives are reported in Tables 5 and 6. The tables present parameter estimates for models using different measures of financial leverage. Columns 2 and 3 present the models without Quebec, for years 1984-2010, using total debt (column 2) or different types of debt (column 3) to define the debt to asset ratio. Columns 4 and 5 do the same, for models that include all provinces, for years 1984-2002.

In Table 5, consistent with theoretical expectations, the estimates for the log of capital and labour quantity are positive in all models, suggesting that total output generally increases when the amount of input increases. The coefficient for capital in the total debt to asset model (without Quebec), for example, indicates that if the quantity of capital used increases by 10%,

---

9 The debt to asset ratios can only take a value between 0 and 1 by definition.
then output will increase by 1.92%. The other coefficients can be interpreted similarly. In addition, the returns to scale are decreasing in all the models suggesting that the co-operatives are not operating at the optimal point on the production function, supporting the argument of inefficiency within the model.

In addition, some of the pre-truncation inefficiency effect parameters are statistically significant and positive. These would suggest that higher total debt decreases technical efficiency (column 2), as does higher short-term debt. In addition, all four models suggest that larger co-operatives are more efficient. As discussed in the data section, the estimates of pre-truncation inefficiency effect parameters are not very informative, since they are not measured with respect to the actual (post-truncation) measure of efficiency (Wang and Schmidt, 2002; Amsler, Schmidt and Tsay, 2014). The marginal effects (Table 6) therefore carry more meaning, since they are measured with the post-truncation inefficiency measures. The pre-truncation measures are included here, however, since it is these values that are commonly reported in determining the relationship between exogenous variables and inefficiency estimates ($u_0$) (e.g. Battese and Coelli, 1995, Kumbhakar, Wang and Horncastle, 2015).
Table 5: Production Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratio

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td><strong>Production Frontier Parameter Estimates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>0.192***</td>
<td>0.263***</td>
</tr>
<tr>
<td></td>
<td>(0.054)</td>
<td>(0.095)</td>
</tr>
<tr>
<td>Labour</td>
<td>0.427***</td>
<td>0.420***</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.048)</td>
</tr>
<tr>
<td>Constant</td>
<td>4.479**</td>
<td>3.611**</td>
</tr>
<tr>
<td></td>
<td>(0.989)</td>
<td>(1.721)</td>
</tr>
<tr>
<td><strong>Pre-truncation parameters of Inefficiency Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Debt to asset ratio</td>
<td>0.891**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.390)</td>
<td></td>
</tr>
<tr>
<td>Debt to members to asset ratio</td>
<td>-</td>
<td>-0.263**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.632)</td>
</tr>
<tr>
<td>Short-term debt to asset ratio</td>
<td>-</td>
<td>0.032**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.287)</td>
</tr>
<tr>
<td>Long-term external debt to asset ratio</td>
<td>-</td>
<td>1.594**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.183)</td>
</tr>
<tr>
<td>Size</td>
<td>-0.697***</td>
<td>-0.638***</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.064)</td>
</tr>
<tr>
<td>Minimum efficiency</td>
<td>0.006%</td>
<td>0.007%</td>
</tr>
<tr>
<td>Average efficiency</td>
<td>24.150%</td>
<td>27.723%</td>
</tr>
<tr>
<td>Maximum efficiency</td>
<td>88.225%</td>
<td>89.358%</td>
</tr>
<tr>
<td>N</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>NxT</td>
<td>698</td>
<td>698</td>
</tr>
</tbody>
</table>

Note: ***,*** refers to 10 percent, 5 percent and 1 percent, respectively, level of significance. Figures in parentheses are robust standard errors. All models estimated using the sfmodel package.

The distribution of technical efficiency estimates are shown in Figures 5-8. All the models showed considerable heterogeneity across the co-operatives examined in each model. The mean efficiency varies between 15% and 28%. Since none of the co-operatives are 100% efficient, there is room for improvement in technical efficiency in fruit and vegetable co-operatives.
Figure 5: Distribution of Technical Efficiency Estimates for Fruit and Vegetable Cooperatives Outside the Province of Quebec (1984-2010) (modeled with Total Debt)

Figure 6: Distribution of Technical Efficiency Estimates for Fruit and Vegetable Cooperatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt)
Table 6 depicts the marginal effects for the financial leverage ratios and for firm size on technical inefficiency. The results for total debt, long term debt and size are statistically significant. The total debt models (columns 2 and 4) suggest that higher total levels of debt increase technical inefficiency. In addition, all four models suggest that larger co-operatives are
more technically efficient. This also holds when size is measured by the number of employees (see Appendix C). However, the type of debt models (columns 3 and 5) show mixed results. In the debt to asset ratio by type of debt (column 3), debt to member and short term debt have no statistically significant relationship with technical efficiency. This may be because of the lower cost of capital associated with these types of debt, particularly debt to members. In addition, debt to members may show higher willingness by membership to contribute to the capital of the co-operative, which may be reflective of a higher degree of member engagement. This has been reported as important to the success of the co-operative (Fulton and Girard, 2015). These additional factors could act to counterbalance some of the negative effects of debt. In contrast, co-operatives with more long-term external debt tended to be less technically efficient.

These parameters can be interpreted in terms of the relationship between the exogenous variables and levels of output. For example, the coefficient of 0.588 for the total debt to asset ratio in column 2 can be interpreted as showing that for each one percentage point increase in the relative amount of total debt in the capital structure of the co-operative, output will decrease by 0.588%. Though this may seem like a small change, the actual effect will depend on actual output of the co-operative. For example, in the model excluding the province of Quebec, the mean value of output is $24,101, so this change would represent a decrease of $142 in output. However, if we consider the co-operative with the highest output, $396,352, this change would decrease output by $2,330.

The firm size variable is interpreted in terms of percentage change, since the variable is in logarithmic form. Looking again at the model excluding Quebec (column 2), the coefficient of -0.46 suggests that as the size of the co-operative (measured in terms of sales) increases by 1%, output will also increase by 0.46%.
Table 6: Fruit and Vegetable Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Technical Efficiency

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td>Total Debt to asset</td>
<td>0.588**</td>
<td>-</td>
</tr>
<tr>
<td>ratio</td>
<td>(0.230,0.930)</td>
<td></td>
</tr>
<tr>
<td>Debt to members to</td>
<td>-</td>
<td>-0.157</td>
</tr>
<tr>
<td>asset ratio</td>
<td></td>
<td>(-0.968,0.415)</td>
</tr>
<tr>
<td>Short-term debt to</td>
<td>-</td>
<td>0.019</td>
</tr>
<tr>
<td>asset ratio</td>
<td></td>
<td>(-0.444,0.334)</td>
</tr>
<tr>
<td>Long-term external</td>
<td>-</td>
<td>0.947*</td>
</tr>
<tr>
<td>debt to asset ratio</td>
<td></td>
<td>(0.076,1.376)</td>
</tr>
<tr>
<td>Size</td>
<td>-0.460**</td>
<td>-0.379**</td>
</tr>
<tr>
<td></td>
<td>(-0.587,-0.250)</td>
<td>(-0.570,-0.218)</td>
</tr>
</tbody>
</table>

Note: *, ** refers to 10 percent, and 5, respectively, levels of significance. Figures in parentheses are bias corrected 95% confidence intervals generated by bootstrapping (unless otherwise noted). For both type of debt models, the confidence interval for long-term external debt is given at the 90% level.

6.2.1.1 Discussion

In all the models, size was found to be statistically significantly negatively related to (pre-truncation and post-truncation) technical inefficiency, indicating that as co-operatives get larger, they become more technically efficient. This is consistent with studies that find a positive relationship between size and technical efficiency (Esho, 1997; Idda, Furesi and Madau, 2004).

The marginal effects of the total debt to asset ratios and long term external debt to asset ratio were found to be positive in all cases, indicating that firms with more total debt or more external debt are less efficient. This is consistent with Hadley (2006), who found that more efficient firms had lower debt to asset ratios. This could be because, for example, there may be a higher tendency to use inputs that are more easily monitored in firms with more debt (Kim and Maksimovic, 1990), or because of the agency costs of debt (Weill, 2003). However, the other types of debt considered, debt to members and short-term debt, were both found to have no
A statistically significant relationship with technical efficiency. The different relationships for different types of debt are consistent with Liu (2006), who found that the source of debt could impact a firm’s financial decisions, which can impact their performance.

### 6.2.2 Cost frontier and cost efficiency

Estimation results are reported in Tables 7 and 8. As with the production frontier models, the tables present estimates for models using different measures of financial leverage.

The coefficients for capital price, labour price and output are all positive, which is consistent with theoretical expectations. These values indicate that as the price of capital or of labour increase, or as the level of output increases, the total cost increases. Specifically, the coefficient for capital price in column 2, for example, indicates that if the price of capital increases by 10%, the total cost will increase by 4.14%. Similarly, if output increases by 10%, then total cost will increase by 8.82%.

All the models in Table 8 demonstrate homogeneity of degree one, which is one of the key properties of a cost function. This supports the reliability of the models. In addition, since they all demonstrate increasing returns to scale, none of the models show full cost efficiency, since none are minimizing cost.

In addition, in the model with Quebec, the long term (external) debt to asset ratio was found to be statistically significantly positively related to cost inefficiency, suggesting that cooperatives with higher levels of external debt are less cost efficient.
Table 7: Fruit and Vegetable Cost Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratios

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td>Cost Function Parameter Estimates</td>
<td>0.414**</td>
<td>(0.203)</td>
</tr>
<tr>
<td>Capital price</td>
<td>0.593**</td>
<td>(0.230)</td>
</tr>
<tr>
<td>Labour price</td>
<td>0.581***</td>
<td>(0.113)</td>
</tr>
<tr>
<td>Output</td>
<td>0.882***</td>
<td>(0.030)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.161***</td>
<td>(0.563)</td>
</tr>
<tr>
<td>Homogeneity of degree 1 (β₁+β₉)</td>
<td>Fulfilled</td>
<td>-0.051</td>
</tr>
<tr>
<td>Pre-truncation parameters of Inefficiency Effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Debt to asset ratio</td>
<td>327.427 (813.314)</td>
<td>-</td>
</tr>
<tr>
<td>Debt to members to asset ratio</td>
<td>-</td>
<td>-7.059</td>
</tr>
<tr>
<td>Short-term debt to asset ratio</td>
<td>-</td>
<td>0.126</td>
</tr>
<tr>
<td>Long-term external debt to asset ratio</td>
<td>-</td>
<td>14.751</td>
</tr>
<tr>
<td>Size</td>
<td>-36.479 (85.701)</td>
<td>-0.906</td>
</tr>
<tr>
<td>Minimum efficiency</td>
<td>0.110%</td>
<td>0.089%</td>
</tr>
<tr>
<td>Average efficiency</td>
<td>57.137%</td>
<td>55.051%</td>
</tr>
<tr>
<td>Maximum efficiency</td>
<td>89.003%</td>
<td>88.968%</td>
</tr>
<tr>
<td>N</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>NxT</td>
<td>747</td>
<td>747</td>
</tr>
</tbody>
</table>

Note: ***,*** refers to 10 percent, 5 percent and 1 percent, respectively, level of significance. Figures in parentheses are robust standard errors. The models in columns 2-4 used sfmodel, which the model in column 5 uses sfpanel.

As with the production models, there is variation in the cost efficiency estimates within each model and across the models, as shown in Figures 9-12. However, the mean estimates for all models are between 55% and 69%.
Figure 9: Distribution of Cost Efficiency Estimates for Fruit and Vegetable Co-operatives Outside the Province of Quebec (1984-2010) (modeled with Total Debt)

Figure 10: Distribution of Cost Efficiency Estimates for Fruit and Vegetable Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt)
As with the production models, total debt was found to be positively related to inefficiency in both total debt models, indicating that co-operatives with more total debt are less cost efficient. In addition, as with the all years production models, debt to members and short-term debt were found to have no statistically significant relationship with inefficiency. However, long-term external debt was found to be positively related to cost inefficiency in the model.
excluding Quebec. The total debt models also shows that larger co-operatives tend to be more cost efficient, although the coefficients are very small, so may not carry any economic significance.

Table 8: Fruit and Vegetable Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Cost Efficiency

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td>Total Debt to asset ratio</td>
<td>0.622**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.291,0.971)</td>
<td></td>
</tr>
<tr>
<td>Debt to members to asset</td>
<td>-</td>
<td>-0.388</td>
</tr>
<tr>
<td>ratio</td>
<td></td>
<td>(-3.073,-0.222)</td>
</tr>
<tr>
<td>Short-term debt to asset</td>
<td>-</td>
<td>0.007</td>
</tr>
<tr>
<td>ratio</td>
<td></td>
<td>(-0.416,-0.369)</td>
</tr>
<tr>
<td>Long-term external</td>
<td>-</td>
<td>0.812**</td>
</tr>
<tr>
<td>debt to asset ratio</td>
<td></td>
<td>(0.549,0.917)</td>
</tr>
<tr>
<td>Size</td>
<td>-0.069**</td>
<td>-0.050</td>
</tr>
<tr>
<td></td>
<td>(-0.082,-0.037)</td>
<td>(-0.082,0.415)</td>
</tr>
</tbody>
</table>

Note: *, **, *** refers to 10 percent, 5 percent and 1 percent, respectively, level of significance. Figures in parentheses are bias corrected 95% confidence intervals generated by bootstrapping (columns 2-4), or standard deviations (column 5).

6.2.2.1 Discussion

The marginal effects suggest that firms that carry more total debt are less cost efficient, which is consistent with Hailu (2005) and Hailu, Jeffrey and Goddard (2007a and 2007b). However, debt to members and short-term debt show no statistically significant relationship with cost inefficiency. This may be because higher member debt could indicate higher member

¹⁰ The statistical significance of the marginal effects could not be estimated because the sfpanel was used.
engagement, which has been found to increase co-op success (Fulton and Girard, 2015). It may also be because of lower costs associated with debt to members.

6.3 Dairy co-operatives

The following tables present the results for dairy co-operatives. The members of these co-operatives are subject to supply management, which controls their level of production through a quota system (see section in chapter 2 about supply management in Canada for more details). This section is organized in the same way as the above section on fruit and vegetable co-operatives, starting with technical efficiency estimated using production frontiers, then cost efficiency, estimated using cost frontiers.

6.3.1 Production frontiers and technical efficiency

Tables 9 and 10 report the estimates for technical efficiency in the all years for dairy co-operatives (excluding the province of Quebec). As in the fruit and vegetable co-operatives, the coefficients for capital and labour quantity are positive, which follows our theoretical expectations. All models exhibit decreasing returns to scale, indicating that they are not operating optimally. It should be noted that since the specific types of debt model (without Quebec) does not converge, the results should be interpreted with caution. This could be due to model misspecification, or errors in the data reported. It could also be that the amount of data available is not adequate to estimate a model of this complexity.

The pre-truncation parameters for size are significantly negative in all four models, indicating that larger co-operatives are more efficient. In addition, the pre-truncation parameter
for the debt to members to asset ratio in the model that includes Quebec suggests that co-operatives with more debt to members are more technically efficient.

Table 9: Dairy Production Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratios

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td><strong>Production Function Parameter Estimates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>0.048</td>
<td>0.082</td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td>(0.055)</td>
</tr>
<tr>
<td>Labour</td>
<td>0.826***</td>
<td>0.802***</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.072)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.977*</td>
<td>0.702</td>
</tr>
<tr>
<td></td>
<td>(0.520)</td>
<td>(0.544)</td>
</tr>
<tr>
<td><strong>Pre-truncation Parameters for Inefficiency Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Debt to asset ratio</td>
<td>-3.184</td>
<td>-111.125</td>
</tr>
<tr>
<td></td>
<td>(2.497)</td>
<td>(246.057)</td>
</tr>
<tr>
<td>Debt to members to asset ratio</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.929)</td>
</tr>
<tr>
<td>Short-term debt to asset ratio</td>
<td>-</td>
<td>2.376</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.929)</td>
</tr>
<tr>
<td>Long-term external debt to asset ratio</td>
<td>-</td>
<td>0.310</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.280)</td>
</tr>
<tr>
<td>Size</td>
<td>-1.395**</td>
<td>-1.632***</td>
</tr>
<tr>
<td></td>
<td>(0.636)</td>
<td>(3.565)</td>
</tr>
<tr>
<td>Minimum efficiency</td>
<td>0.475%</td>
<td>0.678%</td>
</tr>
<tr>
<td>Average efficiency</td>
<td>66.961%</td>
<td>76.505%</td>
</tr>
<tr>
<td>Maximum efficiency</td>
<td>92.920%</td>
<td>97.579%</td>
</tr>
<tr>
<td>N</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>NxT</td>
<td>353</td>
<td>353</td>
</tr>
</tbody>
</table>

Note: *,**,*** refers to 10 percent, 5 percent and 1 percent, respectively, level of significance. Figures in parentheses are robust standard errors. The models in columns 2 and 4 use sfmodel, and the models in columns 3 and 5 use sfpanel. The model in column 3 does not converge.

As with all previous models, the models in this section exhibit a high degree of variation in the levels of efficiency within the sector, about 67% to about 82%, evident in Figures 13-16.
Figure 13: Distribution of Technical Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Total Debt)

Figure 14: Distribution of Technical Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt)
The statistical significance of the marginal effects could only be estimated for the models that converged using sfmodel. From the models that converged (columns 2, 4 and 5), we can see that there are no statistically significant relationships between total debt or any of the types of debt examined. From the total debt models, we can also see that size is positively related to technical efficiency, although no significant relationship was found in the models by type of debt.
Table 10: Dairy Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Technical Efficiency

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td>Total Debt</td>
<td>-0.912</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(-1.086,-1.086)</td>
<td></td>
</tr>
<tr>
<td>Debt to members</td>
<td>-</td>
<td>-11.229</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(23.131)</td>
</tr>
<tr>
<td>Short-term debt</td>
<td>-</td>
<td>0.240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.495)</td>
</tr>
<tr>
<td>Long-term external debt</td>
<td>-</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.064)</td>
</tr>
<tr>
<td>Size</td>
<td>-0.400**</td>
<td>-0.165</td>
</tr>
<tr>
<td></td>
<td>(-1.025,-0.931)</td>
<td>(0.340)</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses that are not italicized are bias corrected 95% confidence intervals generated by bootstrapping (columns 2 and 4) or standard deviation (columns 3 and 5). The confidence interval in italics is the percentile 95% confidence interval, because of the bias corrected interval could not be calculated.

6.3.1.1 Discussion

In these models, none of the exogenous financial variables were found to have a statistically significant effect on post-truncation technical efficiency. This may be because of the competing effects on efficiency from debt, as shown in the inconclusive literature on this relationship. For example, some studies found that the debt to asset ratio is negatively related to efficiency (Alarcon, 2007) and others found the opposite (Hadley, 2000). The insignificance of the effect of total debt (in contrast with the significant positive effect) could also be due to the reduction in agency costs of debt due to supply management (Hailu, 2005). However, the models that use total debt suggest that size may still tend to increase technical efficiency.

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$^{11}$ Models that do not converge or that use sfpanel cannot be bootstrapped, and the statistical significance of the marginal effects can therefore not be determined.
6.3.2 Cost frontiers and cost efficiency

Tables 11 and 12 present the estimates for cost efficiency for dairy co-operatives. While columns 2 and 3 present models that appear to follow expectations since they have positive coefficients for capital price, labour price and output, they do not fulfill the key properties of a cost function, since they are not homogeneous of degree one. This problem could have arisen for a variety of reasons. It could be because the data set is incomplete or includes misreported data or suffers from measurement error, which is plausible since the data comes from a self-reported voluntary survey. It could also indicate that the derivation of capital price is not well suited to the dairy sector, since this is the variable that consistently encounters problems. With the wide variety of sizes of co-operatives in this sector, including some particularly large ones, it is possible that the use of a single capital price for all co-operatives in a given year is not appropriate. However, based on the data available, an estimate of capital price by co-operative was not possible. Since none of these models fulfill the criteria for cost functions, they are not reliable.

Though the models for dairy cost frontier are not reliable, their general implications will be discussed for completeness. The pre-truncation parameters suggest that co-operatives with more long-term (external) debt are less cost efficient. The parameters for size are unclear, since the models in columns 2 and 3 suggest that smaller co-operatives are more efficient, while column 4 suggests that larger co-operatives are more efficient, and column 5 suggests that the relationship is not significant. However, since these models are not reliable, these results do not give much information.
Table 11: Dairy Cost Function Parameter Estimates using Different Definitions of Debt in the Debt to Asset Ratios

<table>
<thead>
<tr>
<th></th>
<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td>Cost Function Parameter Estimates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital price</td>
<td>0.039 (0.135)</td>
<td>0.039 (0.107)</td>
</tr>
<tr>
<td>Labour price</td>
<td>0.357*** (0.105)</td>
<td>0.418*** (0.090)</td>
</tr>
<tr>
<td>Output</td>
<td>-0.206*** (0.041)</td>
<td>0.219*** (0.040)</td>
</tr>
<tr>
<td>Constant</td>
<td>4.241*** (0.378)</td>
<td>4.055*** (0.314)</td>
</tr>
<tr>
<td>Homogeneity of degree 1 (β_L+β_K)</td>
<td>Not fulfilled</td>
<td>Not fulfilled</td>
</tr>
<tr>
<td></td>
<td>0.605*** (0.196)</td>
<td>0.543*** (0.161)</td>
</tr>
<tr>
<td>Pre-truncation Parameters for Inefficiency Effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Debt to asset ratio</td>
<td>0.217 (0.137)</td>
<td>-</td>
</tr>
<tr>
<td>Debt to members to asset ratio</td>
<td>-</td>
<td>-0.195 (0.179)</td>
</tr>
<tr>
<td>Short-term debt to asset ratio</td>
<td>-</td>
<td>-0.019 (0.182)</td>
</tr>
<tr>
<td>Long-term external debt to asset ratio</td>
<td>-</td>
<td>2.382*** (0.201)</td>
</tr>
<tr>
<td>Size</td>
<td>0.878*** (0.039)</td>
<td>0.809*** (0.039)</td>
</tr>
<tr>
<td>Minimum efficiency</td>
<td>0.147%</td>
<td>0.159%</td>
</tr>
<tr>
<td>Average efficiency</td>
<td>12.574%</td>
<td>13.401%</td>
</tr>
<tr>
<td>Maximum efficiency</td>
<td>97.310%</td>
<td>98.301%</td>
</tr>
<tr>
<td>N</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>NxT</td>
<td>353</td>
<td>352</td>
</tr>
</tbody>
</table>

Note: *, **, *** refers to 10 percent, 5 percent and 1 percent, respectively, level of significance. Figures in parentheses are robust standard errors. All models used sfmodel.

The models still demonstrate a wide degree of variation in the efficiency estimates across co-operatives, as shown in Figures 17-20.
Figure 17: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Total of Debt)

Figure 18: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Outside the Province of Quebec (1984-2010) (modeled by Type of Debt)
Figure 19: Distribution of Cost Efficiency Estimates for Dairy Co-operatives Including the Province of Quebec (1984-2002) (modeled by Total of Debt)

The marginal effects would suggest that total debt has no significant relationship with cost efficiency. In contrast, co-operatives with higher long-term external debt tend to have lower levels of cost efficiency. In addition, the model including the province of Quebec suggests that co-operatives with higher levels of debt to members or short-term debt tend to be more cost efficient. In addition, the models excluding the province of Quebec suggest that larger co-
operatives may actually be less cost efficient, while the models including Quebec suggests the opposite relationship. However, since these models do not conform to the key properties of the cost function, this result does not carry much significance.

Table 12: Dairy Co-operatives Post-Truncation (Marginal Effects) Parameter Estimates for Cost Efficiency

<table>
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<tr>
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<th>1984-2010 (without Quebec)</th>
<th>1984-2002 (with Quebec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Debt</td>
<td>Specific types of debt</td>
</tr>
<tr>
<td>Total Debt to asset ratio</td>
<td>0.145 (-0.206,0.323)</td>
<td>-</td>
</tr>
<tr>
<td>Debt to members to asset ratio</td>
<td>-</td>
<td>-0.138 (-0.384,0.263)</td>
</tr>
<tr>
<td>Short-term debt to asset ratio</td>
<td>-</td>
<td>-0.014 (-0.36,0.354)</td>
</tr>
<tr>
<td>Long-term external debt to asset ratio</td>
<td>-</td>
<td>1.680** (1.965,2.748)</td>
</tr>
<tr>
<td>Size</td>
<td>0.586** (0.745,0.912)</td>
<td>0.571** (0.694,0.846)</td>
</tr>
</tbody>
</table>

Note: **refers to the 5 percent level of significance. Figures in parentheses are bias corrected 95% confidence intervals generated by bootstrapping. The confidence interval in italics is the percentile 95% confidence interval, because of the bias corrected interval could not be calculated.

3.2.1 Discussion

While none of the cost efficiency models for the dairy sector can be considered to be reliable, since none follow the key properties of cost functions, some broad observations can still be drawn from the results.

The marginal effects from two models suggest that larger co-operatives tend to be more efficient, which is consistent with Hailu, Jeffrey and Goddard (2007a and 2007b). However, two other models suggest the opposite relationship. Furthermore, the findings suggest that there is no significant relationship between total debt and efficiency. However, the two models by type of debt suggest that co-operatives with more external long-term debt tend to be less cost efficient.
However, the technical efficiency models show no statistically significant relationship between external debt and technical efficiency. In addition, one model shows no significant relationship between debt to members or short-term debt and cost efficiency, while the model including Quebec suggests that co-operatives with higher levels of these types of debt tend to be more cost efficient. The different effects from different sources of debt is supported by Liu (2006), who found that the use of different source of debt can impact the financial decisions of the firm, which can in turn impact the efficiency of the firm.

6.4 Chapter Summary

Table 13 shows the mean efficiency estimates and the marginal effects for all models. We can see that there are large variations in the efficiency estimates within each model, and between models. It also shows the marginal (post-truncation) effects of the exogenous variables on technical and cost efficiency in both sectors.

The marginal effects estimates demonstrate that the relationship between debt and efficiency is somewhat unclear. In the total debt models, all fruit and vegetable models suggest that as total debt increases, cost and technical efficiency decrease. This is consistent with the findings from Hailu (2005), and the theoretical model presented in chapter 4. However, the dairy models show no significant relationship between total debt and either technical or cost efficiency. This could mean that there is a different role for debt in the dairy sector, since the negative relationship between total debt and inefficiency prevails for that sector.

Debt to members and short-term debt were both found to have no significant relationship to technical and cost efficiency in all but one model. The model in which they were found to be significant is, however, not reliable. The difference in the relationship of these types of debt,
particularly debt to members, could be a reflection of the difference in the costs of different types of capital, as explored in Chapter 4.

For three fruit and vegetable co-operatives, and two of the unreliable dairy models, long-term external debt was found to be positively related to inefficiency, meaning that co-operatives with more of this type of debt tend to be less efficient. However, in the three other models (one fruit and vegetable and the dairy technical efficiency models), the relationship was not found to be statistically significant.

Finally, the results for size in six fruit and vegetable models and two dairy models indicate that larger co-operatives tend to be more efficient. However, two fruit and vegetable models and two of the reliable dairy models show that the relationship is not statistically significant.
Chapter 7: Summary, Conclusion and Policy Implications

7.1 Summary of purpose, methods and findings

This study sought to examine the relationship between cost and technical efficiency and capital constraints in fruit and vegetable, and dairy co-operatives in Canada. The main objectives of the thesis are to (1) measure the levels of inefficiency, (2) to estimate the relationship between financial leverage variables and efficiency, and (3) to examine whether the relationship between financial leverage and efficiency depends on the sources of debt. These objectives were addressed using one-step stochastic production and cost frontier models using firm level panel data over the period 1984-2010 from the Canadian Survey of Non-Financial Co-operatives, managed by Innovation, Science and Economic Development Canada.

The main findings of the study suggest that the relationship between total debt and efficiency is negative for the fruit and vegetable industry, but not significant for the dairy industry. The member debt and short-term debt to total asset ratios were generally not significantly related to cost and technical efficiency. Long-term external debt was found to generally decrease technical and cost efficiency in the fruit and vegetable sector, and decrease cost efficiency in the dairy sector, but to have no significant relationship to technical efficiency for dairy co-operatives. Further research is worthwhile in this regard to examine the mechanism through which the various sources of debt influence production efficiency. Finally, larger co-operatives were found to be more technically and cost efficient in the fruit and vegetable sector, but size was found to have an ambiguous effect on cost and technical efficiency in the dairy sector.
7.2 Implications

The generally negative relationship between size and inefficiency observed in most of the models suggests that expansion is critical for co-operatives looking for gains in efficiency, particularly in the fruit and vegetable sector where co-operatives are generally smaller. This supports the importance of access to capital, since capital is required to make the investments necessary for expansion. For this reasons, policies that promote access to capital, particularly for co-operative expansion, are justified. However, the specific type of program that is best suited is not clear from this result.

Since total debt was found to increase inefficiency in fruit and vegetable co-operatives, but to have no significant effect on efficiency in the dairy co-operative models, this suggests that a mere increase in access to lending is not necessarily the solution to the capital constraint problem. Therefore, the type of debt targeted will be important, and may be different for different sectors.

The results for the financial variables are instructive in this area. Since long-term external debt is shown to increase inefficiency in all fruit and vegetable models, and in the dairy cost efficiency models, traditional lending programs may not be the best-suited solution. However, the data does not specify the source of this long-term external debt. It is therefore unclear whether there is a difference between debt owed to traditional lenders (banks), co-operative lenders (credit unions) or other lending programs run by organizations targeted to co-operatives (like the new Canadian Co-operative Investment Fund). As noted in the literature review, traditional lenders do not necessarily have a good understanding of the co-operative sector and may impose high interest on co-operatives based on an overestimation of current levels of debt.
within the co-op (House of Commons Special Committee on Co-operatives, 2012). This is supported by other financial literature, which states that the source of debt can have different implications for financial decisions (Liu, 2004). In addition, the dairy technical efficiency models show no significant relationship between external debt and efficiency, which may indicate that the relationship is not true of all co-operatives. Therefore, long-term external debt from different sources may not necessarily decrease efficiency, so we should not broadly discount long-term lending programs specifically targeted at the co-operative sector without further investigation, given the importance of investments in expansion in improving efficiency.

However, the results suggest that it could be more effective to target programs that promote lending from members, since these are show to have no relationship to efficiency in all but one model (which shows that it may help improve efficiency). Some programs like this exist, such as programs in Nova Scotia and Quebec, which offer tax credits to people investing in registered co-operatives, and make these types of investments RRSP eligible (House of Commons Special Committee on Co-operatives, 2012). By creating incentives for members to invest in their own co-operative, members may be more likely to contribute to their co-operative, increasing debt to members (since the contributions will generally be returned to the members). In addition, co-operatives should work to educate their members about the benefits of the membership in the co-operative, and of co-operatives to the community to increase member engagement, which may also increase the willingness of members to invest in their co-operative. Member education is doubly important, since it is promoted in the co-operative principles (principle 5: education, training and information).

Though access to credit (short-term debt) is also unlikely to directly impact efficiency, the interpretation of this variable is different since the potential source of the loan the supplier,
rather than a lending institution, in most cases. Therefore, if access to this type of capital is sought, the types of programs undertaken will be different. For example, programs to guarantee the credit of smaller co-operatives may be appropriate in this case to reassure creditors that they will be paid. These programs could be undertaken at the federation level (for co-operatives that are members are large federations, like La Co-op Fédérée) or through different apex organizations at the provincial or federal level.

7.3 Conclusion

Overall, the results have shown that there is some room for improvement in efficiency of fruit and vegetable, and dairy co-operatives in Canada. Since larger co-operatives tend to be more technically and cost efficient than smaller co-operatives, access to capital will be remain important for co-operatives since it is required to fund expansion. The results also suggest that programs should look to targeting debt from members as a source of capital, since this type of debt was shown to be not significantly related to efficiency, in contrast to long-term external debt, which was generally found to have a positive relationship with inefficiency.

7.4 Limitations

There are some limitations with the approach taken in this study. Firstly, in the models estimating cost efficiency, the behavioural assumption of cost minimization was required. As noted in the literature review, there are a number of different objectives that can be pursued within the co-operative. As such, imposing one type of behaviour may not be an accurate representation of the actual objectives of the co-operatives examined.
In addition, because of the challenges in the estimation of the model through maximum likelihood estimation, more complex functional forms were not tested. In addition, in order to incorporate more complex alternative models, it is likely that the estimation of the effects of exogenous variables would require a two-stage estimation procedure (as in Hailu, 2005), which carries drawbacks in itself (Wang, 2002). It would also likely require more data to help with convergence.

Furthermore, since some of the findings in this study were ambiguous, it is possible that non-linear (e.g. quadratic or inverse-u shaped) relationships between some types of debt and efficiency exist. However, the investigation of these relationships was outside the scope of this research.

Other limitations associated with data arose during this study. As previously noted, there is a lack of firm level data for the province of Quebec after 2002. This is a significant limitation in the Canadian context because of the importance of this province to the Canadian co-operative sector, particularly in the dairy sector. In the process of this research, firm level data was specifically requested from the provincial government in Quebec (which administers the collection of Quebec data for the Survey of Co-operatives in Canada), however there was no response. Future researchers should try to cultivate a relationship with the responsible department in order to acquire firm level data, and therefore generate more complete results.

In addition, since this survey is administered as a voluntary survey, there is risk for inconsistent reporting of variables. Furthermore, as it is self-reported, the information reported is not necessarily complete or accurate. However, this is an issue that would have to be addressed at the level of the federal government since they collect the data used in this research. The
alternative of collecting the data specifically for future studies would also likely carry these challenges.

Price information is not available at the firm level. In the current study, we used national prices indices for all co-operatives in Canada. For example, the estimation of capital price may carry limitations, as demonstrated by the cost efficiency results within the dairy sector. A method of estimating capital price individually by firm may have proven more appropriate, but was not possible with the data available.

Finally, there is some risk of endogeneity within the models. One study cited in the literature review notes that it is possible that more efficiency firms are more able to access lending, and therefore they may carry more debt (Alarcon, 2007; Liu, 2006) rather than the more common reasoning that the level of debt leads to variations in efficiency through some mechanism (Weill, 2003).

7.5 Recommendations for future research

Many of the recommendations included in this section specifically address the limitations noted in the previous section. Firstly, different behavioural assumptions could be introduced into models to account for heterogeneous objectives within the co-operative sector. Secondly, future research should focus on acquiring firm level data from the province of Quebec to address the incompleteness of the data in this area. Thirdly, alternative approaches to estimating capital price could be applied to address the possible problems observed in the dairy models. The problems in the estimation of cost efficiency could also be addressed using duality to estimate the cost function from the production function, which would also allow for the estimation of allocative efficiency. In addition, other possible (e.g. quadratic or inverse U-shaped) relationships between
debt and efficiency should be investigated to help clarify the ambiguity of some of the findings. Finally, models could be developed to test for the possibility of endogeneity within the relationship between debt and efficiency.

In addition, other research should be undertaken to further investigate the co-operative sector. As identified in the literature review, there are currently no studies that have comparatively evaluated efficiency in co-operatives and investor-owned firms in Canada. This is largely due to a data limitation in the Canadian context. However, this is an important area to investigate in the future.

Furthermore, it could be interesting to examine whether there are geographical differences between co-operatives in different provinces. In the context of the current research, this was not evaluated due to the small number of co-operatives in some provinces, which would raise confidentiality concerns if results were reported by province. However, if publically available data was used as a source for the financial data for co-operatives (for example, from annual reports), the research could be undertaken without this concern.

Finally, two additional variables could be investigated in future research. First, the impact of specific ownership structure (board of directors, direct democracy etc.) on efficiency could be investigated. This data is not available within the current data set. Second, the specific source of long-term external debt (traditional lenders, credit unions or co-operative lending programs) could generate interesting results, information which is also not included in this data set. With new programs being established as alternatives to traditional lenders, this question will become increasingly important. Further research may also explore the mechanisms through which the various sources of capital influence production efficiency.
References


Donovan, B. 2016. Co-operatives and Mutuals Canada. Personal e-mail communication, January.


Statistics Canada. 2016. CANSIM Table 282-0225: Labour Force Survey Estimates (LFS), Average Weekly Earning, Average Hourly Wage Rate and Average Usual Weekly Hours by


Appendix A: Deadweight loss from monopsony

Figure 21 shows the deadweight loss that arises from a monopsony, and that can be eliminated by the introduction of a marketing co-operative. Since, in the monopsony situation, the price offered by the firm to the suppliers (Pm) is lower than the perfect competition price (Pc), the amount that the supplier is willing to sell is also lower (Qm<Qc). This results in the deadweight loss represented by the shaded area. With the introduction of a marketing co-operative, the price offered to the suppliers (in this case, the farmer members) will move towards the perfect competition price, and the quantity will concurrently increase. With these changes, the deadweight loss will be eliminated, as in the monopoly case described in Chapter 3.

Figure 21: Monopsony and Marketing Co-operatives
## Appendix B: Number of co-operatives by year and sector (excluding Quebec)

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Appendix C: Technical Efficiency Distribution by Number of Employees

Table 14: Average Technical Efficiency by Number of Employees (all years, without province of Quebec)

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<th>Number of Employees</th>
<th>Average Technical Efficiency</th>
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</thead>
<tbody>
<tr>
<td>1-4 (smallest 25% of co-operatives)</td>
<td>11.06%</td>
</tr>
<tr>
<td>5-22</td>
<td>19.04%</td>
</tr>
<tr>
<td>23-77</td>
<td>23.04%</td>
</tr>
<tr>
<td>79-550 (largest 25% of co-operatives)</td>
<td>42.97%</td>
</tr>
<tr>
<td>Overall</td>
<td>24.15%</td>
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</tbody>
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