MARKETING INSTITUTIONS OF AFFORESTATION GENERATED CARBON OFFSETS IN CANADA: POLITICAL SUSTAINABILITY, IDEOLOGY AND THE NEW INSTITUTIONAL ECONOMICS

By

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Abstract

Anthropogenically forced climate change has emerged as one of the most important, and 
polarizing, issues of our time. Afforestation generated carbon offset projects hold a 
position in Canada as potentially influential, yet frustratingly under-utilized, options to 
mitigate climate change. This dissertation responds to the question, “what are the 
economic implications of afforestation generated carbon offset institutions in Canada – 
and how appropriate are the tools of the New Institutional Economics (NIE) in their 
identification?” I establish the context for discussion by arguing that the NIE, as 
practiced, seems incapable of providing rigorous analysis while simultaneously 
responding to questions of power and distribution. The case of afforestation generated 
carbon offset marketing is presented as an appropriate context for exploring this point. A 
literature review is then used to establish general patterns regarding aggregating 
institutions for offset production and marketing, and aggregating institutions are
presented as a response to the effects of transaction costs on the Canadian offset market. I then develop supply and demand curves to describe the equilibrium state of the Canadian offset market, into which the transaction costs borne by three aggregators are integrated. Their performance in fulfilling various policy objectives is evaluated. The results indicate that the primary variation between scenarios is the distribution of benefits. This focus on the distribution of benefits continues through demonstrating how subtle variations in modeling coefficients affect the regional distribution of afforestation projects within Canada, identifying the power associated with policy maker ideology. The role of policy maker ideology is then explicitly examined through a survey of government analysts and technicians and the application of discriminant analysis. The primary axes of afforestation ideology are identified, and demonstrated to be independent of concerns of transaction costs and aggregation. These results are integrated to argue that distributional concerns, particularly when ideologies are active in informing policy maker preferences, are critical to achieving sustainable policy outcomes, and that the NIE can respond to such concerns, but only if reform takes place to legitimate these techniques as part of the standard economic discourse.
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Glossary of acronyms

ACX – Asian Carbon Exchange
A/R – Afforestation/Reforestation
AWB – Australian Wheat Board
BO – Business Opportunity
CCX – Chicago Climate Exchange
CDM – Clean Development Mechanism
CER – Certified Emission Reduction
CFS-AFM – Canadian Forest Service Afforestation Feasibility Model
CFS-FBM – Canadian Forest Service Forest Bioeconomic Model
CFU – Carbon Finance Unit
CIMS – Canadian Integrated Modelling System
CP1 – 1st Commitment Period
CV – Contingent Valuation
CWB – Canadian Wheat Board
ECX – European Climate Exchange
EI – Environmental Integrity
ERU – Emission Reduction Unit
ETS – Emissions Trading Scheme
EUA – European Union Allowance
GATT – General Agreement on Tariffs and Trade
GHG – GreeHouse Gases
GY – Growth and Yield
IPCC – Intergovernmental Panel on Climate Change
JI – Joint Implementation
KP – Kyoto Protocol
LCF – Linear Classification Function
LCF CP – LCF model based on Criteria Performance
LCF CW – LCF model based on Weighted Criteria performance
LCF DP – LCF model based on the Difference of criteria Performance
LCF DW – LCF model based on the Difference of criteria performance Weighted
LD – Linking Directive
LDA – Linear Discriminant Analysis
LFE – Large Final Emitter
MACC – Marginal Abatement Cost Curve
MAI – Mean Annual Increment
MVCP – Multi-Variate model based on Criteria Performance
MVDW – Multi-Variate model based on the Difference of criteria performance Weighted
NAP – National Accounting Plan
NIE – New Institutional Economics
NSW GGAS – New South Wales Greenhouse Gas Abatement Scheme
OIE – Old Institutional Economics
RIM – Research In Motion
SDS – Single Desk Seller
TAC – Transaction Cost
TCE – Transaction Cost Economics
VER – Verified Emission Reduction
WB – World Bank
WCI – Western Climate Initiative
WTO – World Trade Organization
No explanation of environmental change is complete… without serious attention to who
profits from changes in control over resources, and without exploring who takes what
from whom.

Paul Robbins (2004, p. 52)

Chapter 1.0 – The response of Institutional Economics to problems of distribution
and power in forest management

1.1 Introduction

The ultimate challenge of social science is the explanation of human behaviour. In the
context of forest management in contemporary Euro-American societies, this task
typically falls to economics, for both normative and descriptive purposes. The goal of this
dissertation is to examine the role of various afforestation generated carbon offset\(^1\)
marketing institutions designed to fulfill climate change mitigation policy goals in
Canada – and an economic approach will be used so to do. Simultaneously, this
dissertation will examine the tools available within mainstream forest economics for
engaging in this type of investigation, specifically the transaction cost\(^2\) economics (TCE)
of the New Institutional Economics (NIE). That is, this dissertation is a response to the
questions, “What are the economic implications of afforestation generated carbon offset
institutions in Canada – and how appropriate are the tools of the New Institutional
Economics to respond to this question?” While the relevance and importance of climate

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\(^1\) The process by which afforestation sequesters carbon dioxide (CO\(_2\)) from the atmosphere is assumed to be
prior knowledge for readers. In short, the metabolism of growing trees converts carbon dioxide into a
variety of functional and structural elements within them – resulting in a net sink of CO\(_2\) for the period
during which a stand of trees is growing, ceteris paribus. By establishing tree cover as an aspect of land-use
change on a relatively low carbon landscapes (such as marginal farmland) the emission of greenhouse gases
can be mitigated.

\(^2\) In brief, costs associated with economic activities that do not result directly from the production function.
That is, those associated with planning, negotiation and risk. A much more detailed treatment is given in
Chapter 2.0.
change mitigation can safely be taken as understood, assuming a general understanding of
the importance of aggregating institutions and transaction costs is perhaps less justified.
Briefly, it is through our established and organized patterns of collective action (that is,
our institutions) that the vast majority of humans, the vast majority of the time, interact
with each other and our physical environment. Participation in these established and
organized patterns of collective action is typically unquestioned, and debates as to
whether or not these institutions are worthy of continuance tends to be treated as, at
worst, a purely academic exercise, and at best, the peculiar preoccupation of
undergraduate students, socialists, feminists, and other slightly untrustworthy but
reassuringly irrelevant supporters of left-wing political parties. That these institutions are
both established and unquestioned is not a cause for alarm – they are created for the
purpose of minimizing the costs (pecuniary, emotional, physical, temporal, analytical)
that arise in situations of conflict so as to achieve the best foreseeable result at a
minimum of effort. The very fact that they can be participated in unreflectively is
therefore one of their greatest strengths. However, collective action to achieve certain
benefits while minimizing costs entails a distribution of those costs and benefits among
the individuals and groups involved in the institution. The distribution of those costs and
benefits, while usually just as unquestioned as the institutions themselves, not
surprisingly reflects and reinforces the power relationships of the individuals and groups
involved. A significant percentage (to what degree will depend upon the worldview of the
reader) of the history of the 20th Century has resulted from a global and public
recognition of this fact, with a concomitant response from various groups, exercising
power in various ways, to either reinforce or challenge those institutions.
In the case of climate change, its global effects and recognized importance, coupled with waves of globalization and general environmental concern, has led to a relative novelty in human affairs: the intentional creation of new institutions (such as the Kyoto Protocol) to minimize the effects of climate change that, while based on the experience of identifiable predecessors, have arisen more or less spontaneously, *ex nihilo*. While the importance of the climate change problem is large enough that it requires immediate action, it must not be forgotten that the institutions created to address it, like others, will distribute costs and benefits between their participants. This distribution will be influenced by relationships of power. If recent lengthy and painful conflicts over such questions of distribution and power are to be avoided (which they must be for immediate and effective action to mitigate climate change to be achieved) then these institutions must, from the beginning, be designed with their powered, distributive nature explicitly considered. Given that afforestation has been promoted as an important means for Canadians to meet their climate change mitigation goals, that transaction costs have been identified as a major barrier to afforestation projects, and that aggregating institutions stand out as the most likely means of minimizing transaction costs, identifying means by which such institutions can be differentiated, with particular emphasis on their distributive effects, is necessary.

The logic of my analysis is as follows:

a) policies promoting afforestation generated offsets are a potential tool in climate change mitigation, but,
b) transaction costs are a key barrier to their effective use, suggesting that
c) aggregating institutions, through their transaction cost limiting effects, may facilitate certain climate change mitigation goals, and that
d) the transaction cost economics of the NIE is an appropriate approach to analyze tools to mitigate these transaction costs, requiring
e) an examination of the NIE itself to determine whether and in what ways it is appropriate to do so, especially since
f) the practice of economic policy analysis has traditionally ignored the influence of distribution, power and ideology on policy efficacy, a weakness to which the NIE may be less susceptible than the prevailing neoclassical paradigm.

This logic provides the basis for the layout of this dissertation, which begins in this chapter with an initial examination of the NIE (in dialogue with neoclassical economics), followed by a review of the role of transaction costs in the marketing of afforestation generated carbon offsets, a comparative analysis of the performance of various aggregating institutions (with a particular focus on the distribution of benefits) and an exploration of the impacts of power on modeling outcomes and ideology on project design. I will show that,

a) a variety of marketing institutions are reasonable depending on the goals of policy makers, which can only be discerned by both spatial and sectoral analysis of the distribution of benefits,
b) transaction costs play a key role in these distributional effects,
c) the political sustainability of climate change policy is at stake in this distributional analysis,

d) that there are no *apolitical* means of responding to these issues, since they are located in questions both of power and ideology, and

e) that even NIE analysis reformed in practice to incorporate these foci does not provide the type of results which inform the decisions of policy-makers.

To begin, however, it will be necessary to establish the theoretical context within which this analysis will be made. I will do so through a standard Hegelian model: I present a dominant thesis (the prevailing neoclassical paradigm), a dissenting antithesis (Veblen’s and Commons’ institutional critique) and a resulting synthesis (the NIE). This exercise is necessary because since Faustmann (1849), mainstream economists have struggled to produce analyses of forest management decision making that simultaneously produce sustainable outcomes while remaining rigorously grounded in theory. In this task, they have largely failed (Kant 2003). This introductory chapter will not concern itself with demonstrating this fact (see Kant 2003, Samuelson 1976) but with focusing on a single proposed solution to the problem: the New Institutional Economics, in particular its transaction cost economics. In order to do so, the origins of TCE within the institutional critique of classical economics will be traced through to its current location in the NIE, which has recently moved from the periphery into the core of the neoclassical economic approach. I will show that the NIE, as currently practiced in forest economics and policy, has not been used to provide mathematically rigorous, quantification based analysis while simultaneously dealing with questions of power and distribution. Furthermore, I will
conclude that the TCE fails to fully respond to the Old Institutional Economics (OIE) critique on the grounds that neither does it give enough attention to questions of distribution, nor provide a genuinely political perspective on the creation and function of institutions, specifically with respect to the distributional implications of governance institutions. By a “political” perspective, I mean one which considers systems of power and resistance as immanent to all human action and/or decision-making. That is, a Foucauldian concept of exercises of power as those which “structure the field of other possible actions,” (Foucault 1982).

1.2 The Evolution of Institutional Economics

The origin of the NIE is often inappropriately located in Coase’s classic The Nature of the Firm (1937), though his work’s importance to NIE in general and transaction costs specifically cannot really be overstated (Williamson 1998). Rather, the NIE should be said to have originated in the OIE critique of classic economics, best represented by the writings of Thorstein Veblen and John Commons. While the OIE critique was broad and experienced multiple incarnations, the pertinent elements for this discussion are captured in the following quote from Veblen’s 1898 essay, Why is Economics Not an Evolutionary Science?

The hedonistic conception of man [sic] is that of a lightning calculator of pleasures and pains who oscillates like a homogeneous globule of desire of happiness under the impulse of stimuli that shift him about the area, but leave him intact. He has neither antecedent nor consequent. He is an isolated definitive human datum, in stable equilibrium except for the buffets of the impinging forces that displace him in one direction or another. Self-imposed in elemental space, he spins symmetrically about his own spiritual axis until the parallelogram of forces bears down upon him, whereupon he follows the line of the
resultant. When the force of the impact is spent, he comes to rest, a self-contained globule of desire as before. Spiritually, the hedonistic man is not a prime mover. He is not the seat of a process of living, except in the sense that he is subject to a series of permutations enforced upon him by circumstances external and alien to him (Veblen 1898a).

That is, Veblen found that the classic economics model of human motivation – utility maximizing self-interest – failed to include any realistic treatment of human psychology or community experience.³ That is, the classic model incorrectly described the process of economic activity (Tool 1993). While Veblen did not deny the role of self-interest, he regarded it as secondary to the primary explanation of human behaviour in economic life: emulation (Tilman 2002, Veblen 1898b). Unlike Veblen (whose observation arose from primarily philosophical grounds), Commons’ long study of United States Supreme Court decisions nonetheless led to the identification of the same failure in classic economics:

The decisions of these tribunals began with conflict of interests, then took into account the evident idea of dependence of conflicting interests on each other; then reached a decision by the highest authority... endeavoring to bring – not harmony of interests – but order out of the conflict of interests.... Meanwhile I was trying to find what could be the unit of investigation which would include these three constituents of conflict, dependence, and order. After many years I worked out the conclusion that they were found combined together only in the formula of a transaction, as against the older concepts of commodities, labor, desires, individuals, and exchange (Commons 1934, p. 4).

Though distinct in many other ways, both Commons and Veblen assert this foundational observation of OIE: human interaction does not take place in a controlled, isolated, economic Petri dish, but rather, because of conflict between individuals and groups, institutions are created to govern the conflict inherent to all transactions. These institutions Commons (1934) defines as, “collective action in control of individual

³ This attention to psychology is closely compatible with the behavioural economics of, for instance, Tversky and Kahneman (1981). However, Veblen’s (and later institutionalists’) focus on community experience remains distinct from the behavioural school.
action,” and thus comprise a broad range of familiar social structures, such as cultural norms, legal codes and organizations.4 Marriage, property rights, the Supreme Court of Canada and Research In Motion (RIM) are all institutions in this sense.

For Veblen, Commons, and the entire institutional school, classical economics failed as a model of human psychology: humans make individual and collective decisions primarily on the basis of their experience with established institutions rather than on “lightning” calculations of how best to maximize the utility of consuming a basket of available goods given a budget constraint. That is, economic behaviour is neither constrained nor mediated by institutions – economic behaviour is an institution which is maintained by emulation and conflict, not for any (pseudo) rational means.

Members of the institutional school emphasized this to greater or lesser degrees. Veblen objected to the very existence of economics as a discipline, while Commons desired rather to modify mainstream economics from within (Veblen 1898a, Commons 1934). Regardless, mainstream economists argue that institutional economics (as the school of Veblen and Commons came to be identified), failed to survive a single generation of economists (the existence of Marc Tool, Paul Bush, John Kenneth Galbraith and their latter day followers notwithstanding), primarily because the institutional critique failed to establish a vigorous research program for substantiating its claims or a rigorous

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4 Very reminiscent of Foucault’s (1982) definition of power as “a mode of action on actions.”
mathematical theory from which to predict human decisions (Coase 1998, Williamson 1998).\footnote{Veblen, of course, would declare that Williamson (among others) was missing his entire point: there is no point in attempting to mathematically model human behaviour if the guiding principal of human behaviour is to “do what I see others doing.”}

While Commons made conflict laden transactions the basic unit of analysis for his economics, he did not explicitly formulate a concept of transaction cost, which Coase (1937) later did in his attempt to more rigorously define the determinants of firm size. Coase’s focus on transaction costs as a determining element of production (rather than Commons’ as a manifestation of institutionally driven conflict of interest) was more amenable to the neoclassical economics which dominated the latter half of the 20th Century in Euro-American economic discourse (Galbraith 1958, Williamson 1998)\footnote{This is not to say that Coase (1937) does not consider transaction costs to spring from conflicts of interest – it is central to his concept of the firm. Rather, that he then subsumes this conflict of interest into simply another cost to be minimized in the production process, as opposed to making it the fundamental fact of human interaction.}. Most prominently by Williamson (1971) in discussing vertical integration, Alchian and Demsetz (1972) in describing the cost of information, and Davis and North (1971) in their model of institutional change, the role of institutions was shifted away from being the nature of economic interaction in and of itself, to being the solution to minimizing transaction costs in production. Thus Alchian and Demsetz (1972) are able to state that, “[r]esource owners increase productivity through cooperative specialization and \textit{this leads to the demand} for economic organizations which facilitate cooperation,” and Coase (1998) to argue that what makes institutions interesting is their effect on transaction costs, and thereby the overall productivity of society (emphasis added). This approach was dubbed the New Institutional Economics (NIE) by Oliver Williamson, and like the OIE
before it, it levied a critique against the mainstream (neo)classical economics (Coase 1998). Like the classic economics to which the OIE objected, neoclassical economics posits perfectly competitive markets made up of rational, utility maximizing individuals with perfect knowledge trading homogeneous goods whose price reflects the marginal benefit of their consumption (Wang and van Kooten 2001). NIE criticizes unreformed neoclassicism on four points (from Wang and van Kooten 2001):

1. Individuals in the market have a “bounded” rationality. While they act in their own best interest (“opportunism”), they lack perfect information, giving rise to transaction costs.

2. Markets are imperfect\(^7\) and frequently fail.

3. The price of goods on the market often does not fully describe their benefit to society and many valuable goods are not marketed.

4. Institutions of various origins affect the function of the market in important ways.\(^8\)

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\(^7\) Market imperfections are described by various writers in various ways, a helpful treatment in a forestry context is given by Pearce (1990) who describes market failures through a series of equalities necessary for markets to yield efficient results, including that: marginal social benefit must equal the value of the marginal product, which must equal the marginal revenue product, which must equal the marginal factor cost, which must equal the value of the marginal factor, which must equal the marginal social cost. None of these relationships, of course, ever hold as a result of lack of information, lack of complete control over resources, unstable and unknown socially optimal time preferences, indivisible inputs and outputs, externalities in consumption and production and inequitable distribution of income.

\(^8\) This objection to (neo)classical economics as fundamentally failing to recognize actual human behaviour, particularly as it pertains to imperfect knowledge and the importance of institutions in the market, as well as their tendency to a verbal formalism and mistrust (or outright rejection) of prediction, is a point of contact between the OIE/NIE and the Austrian School of Menger, Mises and Hayek (among many others). However, the rejection by Veblen and other Institutionalists of the existence of a universally valid ‘objective’ economic theory, the Austrian rejection of history as a valid grounds for theory, and the emphasis in the Austrian school on the necessity of the entrepreneurial capitalist (relatively) free from the constraints of government as necessary for the function of any “rational” society, result in a fundamental distinction which cannot easily be overcome (see Foss 1994, Huerta de Soto 2008).
After a brief struggle, the NIE has been incorporated into neoclassical economics for the most part, either as a component of the suite of standard techniques or as a necessary “supplement” (Wang and van Kooten 2001). This inclusion has been beneficial to economic discourse as a whole, providing greater explanatory power, particularly in questions of institutional diversity, the description of human agents and the firm and the “scaling up” of theory (Williamson 1998). Furthermore, the NIE has taken a vital place in the criticism of “unreformed” neoclassicists and their often blind promotion of market liberalization and privatization at any cost: Williamson’s (2000) critique of the privatization agenda of Maxim Boycko, Andrei Schleifer and Robert Vishny (see Boycko et al. 1996) if only it had been levied with more timeliness and louder volume, may have avoided a decade of upheaval in Russia.

1.3 Weaknesses of the NIE

However, both as a result of its origins and its assimilation into neoclassical economics, the NIE must be criticized on two levels. First, like neoclassical economics, while paying lip service to distribution it has largely failed to address it as a central economic concern – relegating distribution to a role well below that of efficiency in production. As observed by Balland and Platteau (1998):

By giving pride of place to efficiency considerations in their explanatory scheme, they [NIEconomists] have unduly neglected the potentially powerful influence of distributive considerations. It is simplistic to assume that once aggregate benefits from an institutional innovation exceed the costs, this innovation will spontaneously emerge. The way the benefits are distributed among the various actors involved and the respective political weight of the latter are bound to influence outcomes, as the history of institutions amply attests.
This is particularly problematic given the role of power asymmetry (and thereby, capture of benefits) in the evolution and perseverance of social institutions (for further discussion, see Knight 1992).

A second objection to the current practice of NIE is related to the first, springing from it, but subtly different. It is best described by Bardhan (1989):

[A] shift in the focus of attention from the efficiency aspects of an institution to the distributive aspects inevitably confronts us with the question of somehow grappling with the elusive concept of power and with political processes which much of neoclassical institutional economics would abhor.

This is very close to the quote from Robbins (2004) with which this chapter opened, which summarizes the primary critique from political ecology of the social sciences in general. That is, the NIE, though helpful, as a result of its general ignorance of the distributional affects of institutions, fails to fully explain the function of institutions in an economy by ignoring the role of power as expressed through control, particularly as those means of control are levied over rural managers of natural resources. In political ecology this is known as the “conservation and control” hypothesis, and can be summarized as the extension of government control into resource management decisions at the expense of the rights of rural producers, for the purpose of the protection of a purportedly jeopardized environmental resource. Studies of the conservation and control hypothesis have been focused in tropical regions (e.g. Bryant 2002, Neumann 1997, Delius and Schirmer 2000) but, particularly in the context of climate change mitigation policy, it can productively be examined in affluent, temperate countries, such as Canada.
These two weaknesses in the practice of NIE (largely ignoring both distribution and the political, powered nature of policy creation) are weaknesses that the OIE did not suffer. Both Veblen and Commons were acutely aware of (and largely motivated by) the distributional and coercive role of institutions in the economy (Gonce 1996, Viano 2004). Coase (1998), in his discussion of the evolution of the NIE, notes of mainstream economics that “though it purports otherwise, it is in fact little concerned with what happens in the real world.” Insofar as neoclassical economics has nearly completely assimilated the NIE into the mainstream, a return to the original critiques of Veblen and Commons is necessary for institutions to finally supplant the individual, firm and market as the focal points of a political, truly realistic model of human interaction.

As described by North (1992) and Schluter (2007), a typical NIE approach to analyzing the role of transaction costs in the selection of market institutions would resemble something like Figure 1.1 (from Schluter 2007).

**Figure 1.1 – Typical model for understanding institutional change within NIE**
In this framework, various institutional alternatives (each with distinct means of responding to transaction costs) are elaborated in society, and they compete with each other (either in a market or not). This competition provides information to rational actors, who will favour the transaction cost minimizing alternative.\(^9\) This will result in increases in efficiency for society. If the analyst can simply identify in advance the transaction cost minimizing option, then the analysis need go no further. The critical failure of this scenario (nonetheless remaining the typical analytical framework, see Wang and Van Kooten 1999 for an example) was identified by North as early as 1992. Figure 1.1 (and most of the NIE) ignores the role of ideology. Ideology in this sense, is not a pejorative term, rather:

I...
Turning our attention away from the general practice of NIE towards its specific manifestation in the current forest economics literature reveals a similar pattern, though there has been an unfortunate lack of attention paid to the NIE in forest economics, which has remained focused largely on production costs (Zhang 2001). What research has been done can usefully be divided into two distinct camps, a pattern which reflects a broader division within the NIE (Williamson 1998). The origins of the first group (which I will call the transaction costs group) can be traced directly to Coase (1937). It focuses on the role of transaction costs in the market, and treats institutions primarily (if not solely) as means of minimizing transaction costs. Research in this stream tends to be more easily integrated into reformed neoclassical theory and produce quantifiable results and microeconomic models. The origins of the second group (which I will call the property rights group) are found in Coase (1960)\(^{10}\). It focuses on the role of property rights in the evolution of institutions. This research is typically much more interested in questions of distribution and the political implications of certain redistributions of rights, but is rarely linked to microeconomic theory or quantification.

A brief review of how each of these groups is manifested in forest economics is worthwhile. The transaction costs group has only lightly participated in the literature of forest economics, and Zhang (2000) represents the underlying philosophy of the group well, with his statement, “[b]ecause of transaction costs, institutions matter.” This is reminiscent of the quote from Alchian and Demsetz (1972) above, and is in direct opposition to the OIE work of Veblen and Commons because of a) its limited definition

\(^{10}\) That Ronald Coase’s 1991 Nobel Prize in Economics was overdue is well attested by his ability to found two influential yet distinct (though related) schools of thought in the social sciences more than 20 years apart.
of “institution” (“transactions”, “costs” and “transaction costs” are all institutions in their conceptualization, and therefore on their terms Zhang’s statement makes no sense), but also b) that even with a limited concept of “institution” as relating to group organization within society that governs the marketing of particular goods, these institutions are created and maintained not through efficiency, but either emulation or conflict that transcends simple exchange. Wang and Van Kooten (2001) (and its predecessor Wang and Van Kooten 1999) is an example of high quality research within this group. Institutions governing silvicultural practice in British Columbia are described, located within reformed neoclassical theory, and modeled according to their implications for the transaction costs associated with producing timber. While their analysis is compelling, they nonetheless largely ignore questions of distribution and power. Similarly, Adhikari and Lovett (2006) attempt to quantify transaction costs within community forest management in Nepal. They do discuss the distribution of transaction costs between different income groups in rural Nepalese society, but the role of the institutional structure on this distribution is largely ignored. In fact, given their technique for quantifying transaction costs (labour days), it is not possible for them to realistically compare the distribution of benefits, since they have implicitly assumed that labour has the same monetary value between each class, which is not likely the case given the large reported difference in average annual income between the poorest and richest group (~900%). Sakurai et al. (2004) attempt a similar effort in Nepal, though they are not able to quantify their transaction costs and do not treat distributive effects. Zhang (2000) is able to quantify some transaction costs (through examining redundant labour in publicly managed Chinese forests) but provides no treatment of distribution. The defining
elements of these papers, for my purposes, are that they focus on quantifying transaction
costs and microeconomic theory, but like the neoclassical school which they are
attempting to reform, they neglect questions of power and distribution.

The property rights group has a larger role in current discussion of forest economics,
though the analysis found therein is similarly limited. Behera and Engel (2006), for
instance, have a thorough discussion of the distribution between villagers and local
officials of the benefits of forest management institutions in India as a result of changing
property rights regimes, but provide no attempt to either quantify those benefits or
integrate them into a microeconomic theory which they could use to describe the results
of future institutional change. They also include a worthwhile, though limited, political
discussion (that is, the impact of local elites) though their lack of a critique of the role of
caste in distribution limits its applicability. Similarly, De Oliveira (2008) uses the
property rights tools of the NIE to describe patterns of deforestation in the Brazilian
Amazon and its relationship with domestic logging companies. His treatment of the
political processes which supported these property rights regime changes and their
dynamic distributive effects is exemplary, but are non-quantified and atheoretical. Kufuor
(2004) applies an almost identical analysis to deforestation in Ghana, with an equally
trenchant discussion of distribution and politics, but unfortunately equally absent
quantification or microeconomic theory. In these papers, a more realistic consideration of
power and politics has been executed, with a welcome focus on distribution, but the lack
of quantification or integration into microeconomic models makes attempts to study the
impacts of institutions created ex nihilo extremely limited.
In the context of climate change mitigation, of course, it is the creation of institutions *ex nihilo* that is particularly important. If the implications of climate change for Canada and the globe are even a fraction of those predicted, immediate steps must be taken to organize effective, timely action. Furthermore, the implications of those actions for the distribution of costs and benefits between different groups in society must be clearly defined in advance to ensure long-term political support for the institutions created. What is needed, therefore, is a treatment of NIE within forest economics which attempts quantification and integration with microeconomic theory, while at the same time considering distribution, politics and power.

**1.4 The organization of this dissertation**

Given the importance of the role of institutions in responding to climate change, the potential of afforestation generated offsets to meet Canadian climate change mitigation goals and the strengths and weaknesses of the OIE and NIE relative to neoclassical economics, this dissertation is organized after this introductory chapter to examine the implications of aggregating institutions for the distribution of benefits within the nascent Canadian market for afforestation generated carbon offsets, as well as the ability of the NIE so to do. In Chapter 2.0, the scope and function of important institutions in the marketing of carbon credits and offsets globally and in the Canadian context are described, including the European Union Emission Trading Scheme, the New South Wales Greenhouse Gas (GHG) Abatement Scheme, the Chicago Climate Exchange, the
Western Climate Initiative, the Clean Development Mechanism and the World Bank. This review demonstrates the existence of a series of functioning, though strongly regionalized, carbon markets. Current and past Canadian climate change mitigation policies are examined, and characterized by their ineffectiveness and attendant creation of risk in the Canadian carbon market. I then show how risk leads to different types of transaction costs, and demonstrate how these transaction costs decrease the efficiency of carbon offset markets. In particular, when these markets are accompanied by binding credit constraints in the agricultural sector, I argue that the opportunities for small-scale producers to engage in carbon offset creation via afforestation is severely limited without aggregating mechanisms, such as banks, co-operatives or single-desk sellers. In so doing, Chapter 2.0 lays the conceptual groundwork for the analysis of the succeeding chapters: the roots and importance of transaction costs are clearly identified, and the options for responding to transaction costs via aggregating institutions are described.

In Chapter 3.0 I attempt to integrate the distributional and power concerns of the property rights group within NIE into the analytical framework of the transaction costs group. The components of transaction costs (search, negotiation, monitoring and approval costs) are identified and quantified within a global and Canadian carbon offset context. I then argue that each of these components will be different under a series of aggregating institution scenarios (banking, co-operative, single-desk seller and no aggregating institution), leading to different equilibria in a standard NIE market analysis. Comparing the outcomes of these scenarios (volume of offsets sold, equilibrium price, consumer and producer surplus) should therefore provide data for policy makers to select an
aggregating institution according to some objective decision rule. However, I introduce the (non-pejorative) concept of ideology as critical to the policy making process. That is, existing institutions of thought and value would take the scenario outcomes as inputs – competing ideologies would result in the selection of different aggregating institutions, in spite of the same data and scenarios. With this theoretical underpinning, a bioeconomic modeling exercise is used to develop small-scale carbon offset supply and demand curves. These are incorporated with the corresponding transaction costs into the aggregating scenarios, and a variety of decision rules (minimizing cost, maximizing offset output, maximizing societal welfare and maximizing producer surplus) and a sensitivity analysis are used to compare the results. A precautionary decision rule is also used, which indicates the supremacy of the outcomes associated with co-operatives in an ideologically uncertain context. This simultaneous demonstration of the distributional effects of aggregating institutions in an environment with high transaction costs and the crucial role played by ideology in the outcomes of policy development demonstrate the potential for a reformed transaction cost focused NIE to usefully respond to issues of distribution and power, while demonstrating how an unreformed transaction cost focused NIE would fail to accurately describe policy-making frameworks as they actually exist.

In Chapter 4.0, I continue to challenge the principle of governmentality, that is, that policy makers are capable of taking apolitical action. I accomplish this by continuing to focus on the distributional effects of policy, in this case not through the role of transaction costs or offset marketing institutions, but through the basic exercise of modeling itself. The growing regionalization of climate change mitigation policy in
Canada is described in the context of failed federal policies, and a bioeconomic model is then used to explore the distributional effects of minor variations in policy prescribed modeling parameters such as growth and yield curves, project duration and discount rates. The outcomes of this exercise clearly demonstrate that small variations of even seemingly objective parameters have significant impacts on the distribution of benefits within the Canadian federation, in this case, between Ontario and the Prairie provinces of Alberta and Saskatchewan. In the succeeding discussion, I argue that the common practice of the NIE which ignores questions of politics and power must therefore result in politically unsustainable policies. While a useful tool, unless the NIE is adjusted to explicitly include questions of power and distribution, it is ultimately of limited use.

While the preceding chapters will have demonstrated that within a traditional economics approach, the NIE (subject to some reform to common practice) has the potential to provide valuable information to policy makers in the context of climate change mitigation, in Chapter 5.0 I challenge this result by demonstrating that policy makers do not evaluate carbon offset project alternatives based on the type of information that the NIE provides. That is, I use a multi-criteria framework and the tools of discriminant and factor analysis as well as least-squares regression on the results of a survey sent to researchers and policy analysts at ministries of forests, natural resources and the environment in Ontario, Alberta and Saskatchewan. This survey solicits information on project criteria performance and overall project attractiveness according a variety of attributes, with the goal of identifying the factors that inform the decision making process of policy makers when choosing between alternative afforestation project designs. In
addition to the important result that the ideology of policy makers differs significantly between the Prairies (who prefer profit oriented projects) and Ontario (who prefer projects oriented toward environmental benefits) I also show that the key attributes informing project attractiveness are permanence, market clarity, Kyoto Protocol compliance and opportunities for profit. Furthermore, I demonstrate that the role of aggregating institutions and transaction costs do not contribute to the decision-making process of policy makers. While this result undoubtedly provides valuable information for project designers about likely directions for Canadian carbon offset policy, it also challenges the usefulness of the NIE approach to climate change mitigation. That is, the outputs of NIE analysis are not of interest to policy makers: their underlying ideologies are focused on the performance of other criteria.

Chapter 6.0 integrates the results and conclusions of the previous chapters, and discusses their implications for federal and provincial afforestation generated offset policy, aggregating institutions, multi-criteria analysis and the New Institutional Economics. In particular, the necessity of other actors in civil society than policy-makers (such as farmer organizations or ENGOs) to promote co-operatives (if such is a policy goal) is emphasized, given the lack of interest in the policy making community revealed in Chapter 5.0. Continued political pressure contributing to provincially oriented, rather than federal, climate change mitigation policy (given the results of Chapter 4.0) is also stressed, as is both the potential of the NIE to deliver realistic recommendations to the policy community and the barriers which it faces (based on the dissertation as a whole). The dissertation concludes by identifying typical economic practice with Galbraith’s
conventional wisdom and offers hope for a renewed realism in forest policy and economics.
Economic theory has suffered in the past from a failure to state clearly its assumptions. Economists in building up a theory have often omitted to examine the foundations on which it was erected. This examination is, however, essential not only to prevent the misunderstanding and needless controversy which arise from a lack of knowledge of the assumptions on which a theory is based, but also because of the extreme importance for economics of good judgment in choosing between rival sets of assumptions.

Ronald Coase (1937)

Chapter 2.0: Transaction costs, credit constraints, and the role of aggregating institutions in the promotion of forest based climate change mitigation

2.1 Introduction

Since the goal of this dissertation is to both examine the role of various institutions to govern the marketing of afforestation based carbon offsets while evaluating the ability of transaction cost economics to do so, it is necessary to thoroughly describe both the existing institutions which govern the marketing of these assets and the role of transaction costs in that exchange. This chapter will perform this task, while testing some assertions in the literature as to what sort of institutions are worth investigating. Given Coase’s solemn injunction in his seminal 1937 paper The Nature of the Firm to firmly establish the basis of economic theorization, no less could be done.

With the EU’s Emission Trading Scheme (ETS) going online January 1, 2005 and Russia’s ratification of the Kyoto Protocol (KP) leading to its coming into force February 16, 2005, the international carbon market can be said to have been formally active for at least four years. In this time advocates of carbon trading have had some reasons to be satisfied: volumes traded for EU Allowances (EUAs) exceeded 2 billion tCO₂e with a value of over 50 billion USD in 2007. Project generated emissions reductions purchases
have continued to grow, with the average price for certified emissions reductions (CERs) topping 7.23 USD/tCO$_2$e in 2005 and climbing to 11.45 USD/tCO$_2$e in the first quarter of 2006 and continuing to trade at approximately that level (Capor and Ambrosi 2008, Capoor and Ambrosi 2006). However, most of this period showed an increasing gap between the prices of EUAs and both emission reduction units (ERUs) generated from joint implementation (JI) and CERs generated from the clean development mechanism (CDM) (Lecocq and Capoor 2005). Furthermore, though landuse, landuse change and forestry (LULUCF) as carbon mitigation tools were ratified at COP9 in 2003, offsets generated from such projects were excluded from trade on the ETS (Jacob 2005). In addition, and in spite of strenuous arguments to the contrary, grandfathered permits distributed under national accounting plans (NAPs) resulted in an oversupply in the ETS and significant price fluctuations with a precipitous price drop in April-May 2006 from 30 €/tCO$_2$e to 8 €/tCO$_2$e (Ahman and Zetterburg 2005, Green 2006). Plans for the Canadian market have become, if anything, more obscure, with federal election results in 2006 and another election in 2008 leading to an apparent abandonment by all parties of the carbon market plans proposed in previous years. With what they will be replaced is unknown. In addition to this institutional uncertainty, it has become clear that projects generating offsets <50 000 tCO$_2$e per year will continue to be rare as a result of high transaction costs (Capor and Ambrosi 2006). This means that a Canadian afforestation/reforestation (A/R) hybrid poplar project with 16 m$^3$/ha growth rates would require a minimum area of 4500 ha$^{11}$. Given that the bulk of hypothetical A/R projects would take place on marginal agricultural land, and that as of 2003 average farm size in Canada is 274 ha, the ability of individual farmers to participate in the carbon offset

$^{11}$Assuming .187 t-C/m$^3$, 3.67 t-CO$_2$ per 1 t-C and not including below-ground sequestration
market is limited (McKenney et al. 2004, Van Kooten et al. 1999, StatsCan 2003). Furthermore, though farmers have repeatedly expressed the necessity of additional sources of finance in order for non-traditional crops (such as A/R) to be pursued by small-scale agriculturalists in both rich and poor countries, credit limitations remain binding in many regions (Darroch and Muchsyanyama 2006, DeMarsh 1999, Rashid et al. 2004). This chapter will discuss the constraints that risk, transaction costs and binding credit limitations place on the contribution of LULUCF to mitigating climate change globally and with particular reference to A/R in Canada, while recommending a solution: aggregating institutions.

2.2 Marketing institutions for carbon

The nature of the KP is by now well understood: Annex B ratifiers have committed to limiting their emissions to a negotiated percentage of 1990 CO$_2$e levels through market mechanisms. They have multiple means to do so, including CDM (where offsets are generated in non-Annex B states and transferred to Annex B states) and JI (where offsets are generated in an Annex B state and transferred to another). In addition, states are expected to distribute their limits among heavily emitting firms in the form of emission allowances, and allow those firms to participate in the purchase and sale of allowances with firms from other states. Firms are also permitted to invest in projects that either through emission avoidance or carbon sequestration generate carbon offsets either unilaterally or through a financial instrument. These projects can include LULUCF. A broad distinction between marketing institutions for carbon can be drawn at this level:
those that trade allowance based assets (either voluntarily assumed or otherwise) and those that trade project based assets. The allowance based institutions will be addressed first.

The most important institution governing the trade of allowances (after the United Nations Framework Convention on Climate Change itself) is the EU ETS; the EU created market for EUAs which addresses CO$_2$ allowances alone (Lecocq and Capoor 2005, Jurgens et al. 2006). There are over 11 000 ETS participating installations, representing 45% of EU CO$_2$ emissions and trading on six platforms, the largest being the European Climate Exchange (ECX) (Capor and Ambrosi 2006, Clough 2006, Kleppner and Peterson 2006). Most are power generators and energy intensive industries such as cement, iron and steel (Clough 2006). Both prices and volumes were high in 2005, leading to significant optimism for the continued well-functioning of the market (Capor and Ambrosi 2006). Furthermore, the adoption of the Linking Directive (LD) allowed CERs to be sold on the ETS (as long as they were not derived from LULUCF or nuclear power projects). In April-May 2006 it was revealed that the NAPs for Germany, France, the Czech Republic, Finland and Denmark had been in excess of actual emissions by their ETS firms, while another 10 countries showed surplus allowances for the first year of trading (Clough 2006, Green 2006). Only the UK, Spain, Italy, Ireland and Austria emitted more than their allotted allowances (Green 2006). Overall, 67.5 Mt less CO$_2$ was emitted in 2005 than was allocated (a 3.4% surplus of EUAs). This resulted in the aforementioned price collapse for EUAs (see Figure 2.1).
Figure 2.1 – ECX Futures Contracts for EUAs: Price and Volume

(source: ECX 2007).

Note that though the bottom dropped out of the price for Dec06 futures contracts, Dec08 contracts stabilized, and volume remained strong. The same pattern exists for Dec09 futures. The over-allocation that caused this problem has largely been blamed on the grandfathering process of the NAPs, leading to most EUAs being given to participating firms for free (auctioned EUAs were limited in Phase 1 to a maximum of 5% of the total allocation) (Clough 2006). More auctioning and tougher NAPs was necessary for the market to function smoothly in Phase 2 (2008-2012) (Green 2006). Given the pattern for 2008 futures seen in Figure 2.1, and those reported for 2009 and 2012 futures by the ECX, the market itself was expecting these types of reforms (Capoor and Ambrosi 2006). Those reforms were instituted, with the NAP allocation in 2007 for Phase 2 quite tight, and likely leading to a short market: 10% lower than member states had originally proposed, and 160 MtCO₂e lower than 2007 verified emissions (Capoor and Ambrosi 2008). However, even these reforms will result in uncertain increases in market
efficiency, as the ETS is dependent on exogenous policies often at odds with GHG emission reduction – particularly energy supply/price and project based (particularly CDM) policies (Haar and Haar 2006, Kleppner and Peterson 2006).

On the New South Wales GHG Abatement Scheme (NSW GGAS) prices of emissions allowances for high emitting firms in New South Wales continued to increase through 2005 and 2006, but fell in late 2007 as a result of an oversupply of credits, with prices fluctuating between 4 and 11.10 USD/tCO$_2$e, slightly below the post-tax level of the fine for non-compliance (11.31 USD/tCO$_2$e). Trades at prices significantly higher than the fine have occurred for forward contracts, revealing market expectations of tighter regulations in the near future and concern with corporate image (Capoor and Ambrosi 2008, Capoor and Ambrosi 2006). The NSW GGAS remains the largest non-Kyoto regulated cap-and-trade market for carbon assets in the world (Hamilton 2008).

A similar trend can be seen on the voluntary Chicago Climate Exchange (CCX), which continued to increase its trading volume through 2007, with average prices stable at around 3.15 USD/tCO$_2$e. The CCX also announced expansion to create a New York Climate Exchange and a regional Northeast Climate Exchange. At the same time, the project based voluntary market has grown considerably through 2007, with total volume reaching 42 MtCO$_2$e (compared to 23 MtCO$_2$e in the CCX), accompanied by rising prices, which averaged 6.10 USD/tCO$_2$e (Hamilton et al. 2008).
Though the CCX has shown a correlation in sign with EU ETS prices, the major differences between the prices in all three major allowance markets and the different drivers of price (negotiated caps in the ETS, voluntary caps on the CCX, and fines on the NSW GGAS) indicate that the markets are only imperfectly linked. An international market for allowances does not exist, rather, a series of regional markets is evolving, and the performance of the largest of which (the EU ETS) will not be confidently ascertained until Phase II is well underway such that the determination of the EU to set tight NAPs can be confirmed.

The potential role of the emerging Western Climate Initiative (WCI) must also be noted in this discussion. While it will not come online until 2010, its influence on the market for carbon assets in North America will be large. A cap-and-trade system with mandatory participation for all emitters over 25 000 tCO$_2$e/a in Arizona, California, Montana, New Mexico, Oregon, Utah, Washington, British Columbia, Manitoba, Ontario and Quebec, it will require 15% reductions in emissions from 2005 levels by 2020. Its scope represents 20% of US GDP and 19% of US population (from its US partners) and 73% of Canadian GDP and 79% of Canadian population (from its Canadian partners). Particularly in the Canadian context, the WCI essentially represents the federal cap-and-trade program that has been debated for many years, but never put into effect (see the succeeding section). WCI documentation has consistently promoted the inclusion of afforestation based carbon offsets, though the rules governing project management and how they will be included have yet to be published (WCI 2008a, WCI 2008b). When the WCI is officially
instituted, Canadian debate at the federal level on this subject will become moot: such a plan will already exist.

The distinction between allowance based trade and project based trade cannot be emphasized too strongly. While institutions like the EU ETS, NSW GGAS and the CCX have created large, relatively stable regional markets within which one can speak of ‘one price’ for allowances, project based offset trades continue to be negotiated bilaterally, with a large range in prices (Capor and Ambrosi 2008). In 2007, over 874 MtCO$_2$e were traded from project-based transactions, 87% of which were generated from CDM and JI compliant projects, with average price of CERs in the first quarter of 2008 at 13.60 USD/tCO$_2$e. Though the ETS slump negatively affected trading volume and price, trading in CERs has recovered, with auctions on the Asia Carbon Exchange (ACX) of 106 MtCO$_2$e for three projects at 15.32, 15.71 and 12.99 USD/tCO$_2$e. On the same day (Dec 21, 2006) Dec07 EUAs were trading for less than 8.44 USD/tCO$_2$e as a result of the ETS price slump (ACX 2006). After years of trading below EUA prices, CDM projects are (at times) trading higher than allowances (Lecocq and Capoor 2005). Sellers have also begun to emerge as price makers rather than price takers on the offset market, with auction results from the ACX showing a consistent pattern of sellers rejecting bids and holding on to CERs rather than accepting what they view as low bids (ACX 2006, Capoor and Ambrosi 2006). Buyers of CERs are in Europe (87% of volume in 2007) and Japan (11%) with the former shifting from being dominated by purchases of national governments to the private sector (70% of purchases), and the latter by a small number of large trading houses for sale on the secondary market. Purchases by Canadian firms have
fallen from 4% of the market in 2004 to negligible in 2008 (Capoor and Ambrosi 2006, Capoor and Ambrosi 2008). After an initial period of significant interannual fluctuation, China has emerged as by far the largest supplier of CERs, supplying 73% of volume in 2007, followed by India and Brazil (at 6% each).\footnote{Note that the market is concentrating in large middle-income countries, counter to the original goals of the CDM to aid Less Developed Countries (LDCs) (Lecocq and Capoor 2005).}

The CDM itself continues to evolve. Though the CDM was envisioned as a bilateral instrument under the Marrakech Accords (with emphasis placed on financing by an Annex B partner or financial agency), unilateral CDMs have increased in prominence, particularly in India (Brechet and Lussis 2005, Lecocq and Capoor 2005). The volume of CERs became dominated by high efficiency non-CO$_2$ projects in the mid-2000s, leading some to denounce the failure of the CDM to live up to its potential as a development tool (e.g. Pearson 2007). The majority of offsets were generated by hydrofluorocarbon (HFC) destruction, which with more than 10 000 times the global warming potential of CO$_2$ can generate large volumes of CO$_2$e in a very short period at a cost of 0.34 to 1.00 USD/tCO$_2$e with payback times of less than a year. HFC destruction accounted for 58% of the total offset supply between January 2005 and March 2006 (Pearson 2007). However, with tighter regulatory restrictions and the plucking of these ‘low-hanging fruit’, HFC destruction has since fallen to 8% of total trades by volume. Energy efficiency, fuel switching, and hydroelectric, wind and biomass based energy generation projects are now 64% of the CER market by volume. LULUCF projects represent well less than 1% of trades. Regulatory complexity resulting in high transaction costs and lack of access to EU markets have been blamed for this low production, in spite of an
expressed preference from buyers for projects that show community benefits (Capor and Ambrosi 2006). The additionality constraint may also be acting as a barrier to LULUCF projects, as this is easier to demonstrate for gas destruction or capture projects than A/R or agricultural best practices projects that may be beneficial even without a carbon market (Brechet and Lussis 2005).

The World Bank (WB) has emerged as the single biggest non-state actor in the CDM market, through a series of financial institutions overseen by the Carbon Finance Unit (CFU) (Jurgens et al. 2006, Pearson 2007). The CFU facilitates investment in CDM through attracting partners from Annex B states, and requires projects to be in compliance with the directives of the CDM Executive Board and Methodology Panel. The funds currently active include the Biocarbon Fund (53.8 million USD capital, 55.8% private funding, 14 investing institutions and 2.9 MtC02e under contract from LULUCF focused projects), Prototype Carbon Fund (180.0 million, 63.6%, 23 and 29.8 Mt for pilot CDMs) and the Community Development Carbon Fund (128.6 million, 45.1%, 25, 4.3 Mt for community development and clean energy), in addition to the Italian Carbon Fund (154.9 million, 30.2%, 7, 9.6 Mt), Danish Carbon Fund (67.6 million, 54.3%, 6, 2.0 Mt), Spanish Carbon Fund (275.0 million, 22.7%, 12, 9.8 Mt), Netherlands CDM Facility and Netherlands European Carbon Facility (data unavailable) which the WB coordinates at the behest of various national governments (CFU 2006, Jurgens et al. 2006).

The other supposedly significant project-based mechanism is JI, which has lagged behind the growth in volume and price experienced in CDM and allowance based trade in recent
years, showing little or no growth. This has been blamed largely on methodological and regulatory uncertainty, due to delays in finalizing the JI pipeline and the risk associated with no binding requirement for third party verification of reductions. However, price increases in the first quarter of 2006 through 2007 may indicate that JI is beginning to catch up (Capoor and Ambrosi 2006, Capoor and Ambrosi 2008). In spite of the potential (and again, possibly because of Canadian policy uncertainty) LULUCF plays a marginal role at best, currently accounting for far less than 1% of all JI projects (Buen 2006). Focusing on Canada in particular, this is not surprising. The last coherent Canadian offset system plan included a cap to Large Final Emitters (LFEs) of ~12.75 USD/tCO₂e, which has already been surpassed by many CDM transactions, implying a low role for CDM or unilateral JI in Canada (Weersink et al. 2005). Once opportunity costs are included some models have indicated only marginal benefits from modified cropping and other agricultural sink options unless full afforestation is considered (Morand and Thomassin 2005). Other exercises observe important supply function kinks that produce threshold offset prices for farmers below which no production will occur. Even past these thresholds, high transaction costs (up to 5.10 USD/t-CO₂e), the temporary nature of LULUCF credits and a perceived necessity of inflexible, long-term contracts has made participation by Canadian farmers in soil management based projects uncertain (Weersink et al. 2005). Institutions that decrease transaction costs, lower the price difference between temporary and permanent offsets and improve flexibility are required for significant Canadian LULUCF offset volume to be generated.
However, other barriers to significant offset volumes generated in Canada remain. Specifically, and in spite of warnings to the contrary (e.g. Biggs and Laaksonen-Craig 2006) there has been little-to-no movement towards a comprehensive (or even patchwork) federal policy toward climate change mitigation in general, and afforestation sourced offsets in particular. Mark Jaccard and Nic Rivers have published valuable material in reviewing Canadian federal climate change policies, specifically in their demonstration of the lack of any discernible impact of these policies on GHG emissions (see Jaccard et al. 2006, Jaccard and Rivers 2007a, Jaccard and Rivers 2007b and Simpson et al. 2007 for a detailed analysis). In particular, their work with the Canadian Integrated Modelling System (CIMS) energy-economy model (see Chapter 3.0) has enabled them to produce the following informative figure.

Figure 2.2 – Actual and projected greenhouse gas emissions and Canadian policies
As is clear from Figure 2.2, no federal climate change mitigation plans (regardless of
government or party in power) have had, or are projected to have, any effect on
greenhouse gas emissions. While various provinces have initiated policies of their own,
which make it clear that afforestation will play some role in mitigating climate change in
Canada, the lack of federal scope makes any market projections for afforestation sourced
offsets unclear (British Columbia 2004, Alberta 2007, Ontario 2007). Nonetheless, an
attempt to do so based partially on CIMS model output will be executed in Chapter 3.0.

Two important factors emerge from this review of carbon trade institutions; first,
significant heterogeneity of both the underlying assets and the institutions that govern
their trade exist (Lecocq and Capoor 2005). This diversity creates large informational
requirements on the part of both producers and consumers, which may act as a
disincentive to market participation for producers of offsets from supplementary activities
(e.g. LULUCF). Bohringer et al. (2006) have associated this information gap with
increased lobbying on the part of LFEs, whose objective function regarding carbon offset
purchases remains cost-minimization rather than profit maximization. Second, and
related, the differing risk profiles of the heterogeneous assets creates a disincentive to
invest in LULUCF projects relative to other CDM options, from the perspective of both
financial institutions and producers (Lecocq and Capoor 2005). In the following section
the importance of risk and its role in influencing transaction costs will be highlighted.

2.3 Risk in the carbon market
Carbon offset marketing based risk can be discussed from several perspectives: the non-permanence of LULUCF assets relative to emissions reductions, risks associated with the time required to generate offsets relative to when the contract to purchase the product has been signed and risks associated with buyer performance in decreasing their own emissions endogenously.\textsuperscript{13} With respect to non-permanence, whether or not non-permanent offsets can be considered a substitute for permanent emissions reductions has been a contentious issue since the creation of the KP, with both ontological (are they the same thing?) and normative (should they be considered the same thing?) arguments proposed (Marland \textit{et al}. 2001). This debate has been settled for the first Commitment Period (CP1: 2008-2012) by the inclusion of non-permanent offsets (under certain restrictions) for countries to meet their commitments. Though they have been included, they remain only imperfect substitutes for permanent credits, because they suffer from the risk of catastrophic destruction of the asset, a risk permanent emission reductions do not face. They can nonetheless be traded as substitutes using a traditional understanding of rental contracts. As described by Sedjo and Marland (2003), the buyer of a temporary credit is essentially allotting a portion of their carbon liability in a temporary sink for a fee, as one would with a limited-term capital asset or real estate, distributing the limited-term benefits of the asset to the renter, while the host retains long-term control. In this case, the role of insurance would be to cover the carbon liability if the buyer goes out of business. Rental price, $R$, could therefore be determined by Equation 1.

\textsuperscript{13} A fourth risk could be considered, the ‘hot-air’ risk, that is, the risk of Ukraine and Russia flooding the market with so many ‘hot-air’ generated ERUs that the price of other carbon assets is driven to 0. This should be considered unlikely as this is not the profit-maximizing strategy for Ukraine/Russia, and EU/national regulators would likely impose significant restrictions on the ability of their LFEs to meet their commitments with such credits in that event.
\[ R = P_{p} r^{*} \]  

Equation 1

Where \( P_{p} \) is the price of a permanent credit and \( r^{*} \) is the risk adjusted discount rate including transaction costs. This is slightly different from the temporary CER (tCER) considered by the EU ETS (Locatelli and Petroni 2006), which includes a global expiry date. Under Sedjo and Marland’s (2003) argument, the length of the contract would be included in the negotiations of sale, like any other rental contract. A market including both non-permanent and permanent assets can be considered analogous to the residential real estate market, where the presence of temporary alongside permanent residences on the market fails to result in market destabilizing collapse (in the presence of parallel insurance and landlord-tenant legislation).\(^{14}\) As such, when contracts of not extraordinary complexity are present, there is no reason to expect that a nonpermanent asset in and of itself introduces unacceptable risk into the carbon market.

The timing of contracting relative to delivery risks associated with offset trade derive primarily from the project-based nature of carbon offsets. That is, most project-based transactions to date have followed a commodity model in which buyers purchase ERUs, verified emission reductions (VERs) or CERs as they would any commodity or service, rather than an investment model where equity (or debt) is invested and offsets are paid out as returns (Lecocq and Capoor 2005). The risks associated with this model include project risk (whether the expected level of production of offsets is achieved), country risk (whether a consistently enabling environment for the project in the host country will

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\(^{14}\) A system has been considered in Canada for which temporary credits would be assumed to be permanent with the government being the sole purchaser and holder of liability (Sedjo and Marland 2003).
exist) and regulatory risk (whether the project meets relevant KP standards). These risks are eliminated once the credits have been officially certified by the appropriate body, assuming the project can be executed without an influx of buyer capital until after completion, and at which time the price the prospective buyer faces is higher than earlier in the project cycle. Contracts distribute these risks between the two parties, as in any other commodity transaction. The KP has created two different assets to explicitly address the distribution of some of these risks. For VERs, buyers contract to purchase the offsets even if the project fails to be registered, that is, the buyer takes on the regulatory risk. For CERs, the seller takes most of the regulatory risk, as the buyer can cancel the sale under particular conditions (Lecocq and Capoor 2005). This distribution of risk is reflected in the highest prices for project-based transactions received by secondary sales of CERs, then CERs, then ERUs (believed to have lower country and project risk) and finally VERs (Capoor and Ambrosi 2006). Like many other commodities (in particular agricultural products), the key to the value of the asset is its compliance grade and whether the delivery will be on schedule, and to a lesser extent the creditworthiness and experience of the project sponsor, confidence of the buyer in the ongoing asset management of the producer, the structure of the contract (forward vs. spot market), the vintage of the offsets, validation/certification costs and whether there are social/environmental benefits that can be used by the buyer to reputational advantage (Capoor and Ambrosi 2006). Each of these aspects contributes to increased costs associated with the contracting process, that is, to transaction costs.

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15 Since EUAs are government-issued, compliance grade assets from Annex B countries with significant KP commitments, country risk and regulatory risk are largely eliminated. Therefore, if NAPs are tight, EUAs should trade at higher prices on spot and forward markets.
The final form of risk discussed here considers the ability of buyers to decrease their emissions endogenously without the need to purchase allowances or offsets on the market. A risk averse emitter will prefer certain outcomes to uncertain outcomes with identical expected values. As such, and as noted by Rong and Lahdelma (2007), the emitter will have no incentive to speculate on the allowance/offset market if current prices are the best estimate for future prices. This creates two cases, if future emissions are accurately known but there is great uncertainty about future price, a risk averse emitter should trade early to meet emissions targets and reduce price risk. If future price is well-known but uncertainty exists about future emissions, trade should be postponed to avoid having to rebalance emissions in the face of potentially high transaction costs. Of course, the current EUA price is a particularly poor indicator of future prices if NAPs will indeed be tightened, and CER/VER prices may also be poor guides as they have been dominated by a limited number of low cost HFC destruction projects. Again, the information problem associated with multiple layers of regulation and the resulting risk increase becomes important, as significant information asymmetry in a risk averse environment could lead to a majority of buyers waiting until the end of CP1 (in the event of more confidence in price than emissions) while speculators destabilize price in a thin market at the beginning of CP1 when only buyers certain of their longterm emissions are purchasing. Institutions need to be introduced which improve confidence in future price and decrease transaction costs to avoid both speculative behaviour and sudden increases in market activity (and thereby price volatility) at the end of CPs. Decreasing transaction costs is also the primary means to reduce timing of contract to delivery risks, motivating the recommendation that the primary means of decreasing risk in the carbon offset market
should be through decreasing transaction costs, which is also key to increasing the participation of potential small-scale LULUCF suppliers in the Canadian market.

The transaction costs present in the carbon offset market consist of three types\textsuperscript{16} general to all contracts, and one specific to carbon offset trades: search costs (incurred by suppliers in finding buyers and buyers in finding suppliers), negotiation costs (the exercise of coming to mutually understood and agreeable terms in a contract, which are decreased through repeated contracting), monitoring costs\textsuperscript{17} (in which performance is evaluated and penalties are enforced) and finally approval costs (through which the quality of the offset is evaluated by a regulatory agency to determine whether it can be used to meet emission reduction requirements) (Krey 2005, Van Kooten et al. 2002). Van Kooten et al. (2002) review methods for reducing transaction costs in the context of incomplete contracting, including means for renegotiation, repeated partnerships, detailed contracts and governance modification. They also note the tendency for market transactions to give way to bilateral contracts as asset specificity increases. Given the asset heterogeneity in the carbon offset market already discussed, this observation supports the assertion that project-based, bilateral contracts are likely to continue to dominate the offset market.

Reported values of transaction costs for project-based transactions (LULUCF or otherwise) vary widely. Kleppner and Peterson (2006) report transaction costs for the

\textsuperscript{16} Krey (2005) adds another form of transaction costs, which he calls insurance costs. Rather, insurance costs are a means for decreasing transaction cost inflating risk, rather than an additional form of transaction costs. Sedjo and Marland (2003) as well as Cospel and Miceli (2005) concur.

\textsuperscript{17} Krey (2005) treats these costs as two separate forms, monitoring and enforcement, while Van Kooten et al. (2002) treat them as one. I prefer the more parsimonious option.
CDM of ~1.30 USD/tCO$_2$e, within the range reported by Krey (2005) of 0.25-4.00 USD/tCO$_2$e. Krey (2005) observes economies of scale in decreasing transaction costs, with the transaction costs of large CDM projects averaging 0.19-0.71 USD/tCO$_2$e associated with a pattern of exponential decay of transaction costs with increasing project size. These economies of scale are created through decreasing search costs and approval costs, the former dominated (90% of total search costs) by the preparation of project documentation, the latter consisting primarily of flat registration fees and the costs associated with project proposal and design. Most of these are generated through hiring a consultant to guide the project through a complex registration process. These results demonstrate the higher burden of transaction costs borne by small-scale projects and the need to introduce mechanisms to decrease them if increased production by small suppliers is a policy goal.

As noted by Niamir-Fuller et al. (2007), the role of transaction costs in limiting the competitiveness of forestry projects is critical. Examining the data presented from Hamilton et al.’s (2008) survey of project origins for the voluntary market underlines this effect. Fifteen percent of the volume of the voluntary market was sourced from forestry projects in 2007, compared to less than 1% of the CDM/JI market (with its much higher regulatory costs). This indicates that the emphasis placed on transaction costs as limiting to afforestation projects is justified. Several caveats are, however, necessary. First, 47% of total voluntary credits are sourced from the North America, Europe, Russia, Australia and New Zealand, regions where many ‘low-hanging fruit’ projects (e.g. HFC decomposition) that have played such a large role in the CDM are unavailable. As Asia’s
role in sourcing voluntary credits has increased, the share of forestry projects in the voluntary has decreased. Even with low transaction costs, it is unclear whether forestry offsets would be able to compete with these low-cost sellers. Furthermore, 49% of voluntary credits were sourced from large-scale projects generating more than 100 000 tCO₂e/a – suggesting a limited role for small-scale producers. Finally, the voluntary market remains small compared to the other, regulated markets: only 3% of the size of the EU ETS by volume (<1% by value) and 8% of the size of the CDM by volume (<3% by value). This implies that the absolute volume of forestry offsets in the voluntary market is approximately the same as that in the CDM. However, transaction costs are not the only asymmetric burden faced by small-producers: many also face binding credit limits.

2.4 Binding credit limits in the agricultural sector

The last thirty years have been a time of rapid change in the agricultural finance sector reflecting a growing policy commitment in the industrialized countries towards market liberalism. As reviewed by Coleman and Grant (1998), for most of the twentieth-century, the nature of agricultural credit markets put them outside of the usual operations of commercial banks, in that farmers need both long-term and intermediate credit for purchasing and developing land, equipment and facilities, while banks prefer the short-term liabilities available for industrial and trading firms. At the same time, farms often need short-term operating credit perceived has high-risk with only long-term rewards. This led to a development model of extensive state intervention to promote expanding
agricultural credit and productivist agriculture as well as price and income support. This period lasted until 1970 when general pressure to reduce protection, particularly as expressed in the Uruguay Round negotiations of the General Agreement on Tariffs and Trade [GATT; later, the World Trade Organization (WTO)], included agricultural finance in general trade negotiations. This shifted some states from a development model to an almost completely free-market model in which the state was largely eliminated from agricultural finance (e.g. New Zealand, Ireland, the UK), while other states (e.g. Canada, Australia) pursued a mixed-market approach, and still others moved toward freer markets, albeit at a slower pace (e.g. EU, USA). A common element in many of these revolutions was the commercialization of the national ‘lender of last resort’: the Farm Credit Corporation in Canada, the Commonwealth Development Bank in Australia and the Rural Bank and Finance Corporation in New Zealand, decreasing the ability of public institutions to invest in small-holders and marginal farmers (Argent 2000, Coleman and Grant 1998). In Australia and New Zealand, this has led to claims by farmers that they do not have access to enough credit to expand/modify their practices, calls that have been echoed elsewhere in industrialized countries, including the US and France (Benjamin and Phimister 1997, Bierlen et al. 1998, Blancard et al. 2006, Lee and Chambers 1986). In addition to demonstrating the presence of binding credit constraints upon farmers in France, Blancard et al. (2006) showed that non-constrained farmers are able to grow larger and make more productive investment decisions as a result of this credit access. In the non-industrialized and industrializing world, credit constraints for small-holders has long been accepted, and demonstrated in as disparate regions as Guatemala, Bangladesh, China, West Africa and Pakistan, and is universally blamed for lower productivity than
would otherwise occur (Barham et al. 1996, Feder et al. 1990, Kandkher and Faruqee 2003, Rashid et al. 2004, Toulmin and Gueye 2006). Barham et al. (1996) support the commonly held intuition that it is the poorest farmers who are the most credit constrained. While De Meza and Webb (2000) have demonstrated that if the risk of project failure is due to the quality of the farmer, then credit-rationing behaviour by lenders may be Pareto optimal and therefore should not be treated as a market failure, poverty itself must not be considered as indicating poor entrepreneurship. For instance, West African small-holders have significantly outperformed large-scale operators over the last 50 years at improving agricultural yields in spite of very low capitalization and decreasing rainfall levels throughout the region (Toulmin and Gueye 2006).

This pattern of credit constraint has not been perceived in Canada, however, with steadily rising overall debt-levels implying access to ample credit. Figure 2.3 demonstrates not only rising liability levels, but high equity ratios (equity divided by total assets) relative to US levels (which average 64% in the Midwest) indicating strong creditworthiness (Featherstone et al. 2006). The same figure, however, shows plummeting acid-test ratios (cash, bonds, savings and accounts receivable divided by total liabilities) indicating poor liquidity and declining creditworthiness. This combination of high equity but low liquidity describes a picture of too much credit, rather than too little.
Figure 2.3 – Canadian Farm Indebtedness

Source: Canadian Agricultural Statistics – Statistics Canada 2007

Furthermore, in spite of the claims of Coleman and Grant (1998), the sources of farm debt outstanding have not shifted significantly over this putatively revolutionary period of market liberalization (see Figure 2.4).
Figure 2.4 – Holders of Canadian Farm Debt Outstanding

Source: Statistics Canada 2007

Since 1981, the percentage of overall debt supplied by chartered banks has fallen slightly (but with no consistent trend), from 42.8% to 42.3%, while that of federal agencies (the vast majority of which is from the Farm Credit Corporation) has risen from 20.6% to 21.6%. The only consistent trends are a steady increase in the role of credit unions offsetting a decrease in the role of provincial lending. These data reveal no dramatic regime change in terms of the role of banks and the Canadian federal government.

However, over the same period as Canadian farm credit has been too abundant with the role of federal agencies and banks essentially unchanged, the total number of Canadian farms has decreased by 22% (between 1981-2001) while average farm size increased by 32%. That is, small-holders are exiting the Canadian agricultural production market. This is compatible with the credit constraint problems seen elsewhere referenced above: as
agricultural financial markets have liberalized, large-scale farmers are able to increasingly access credit at preferred rates while small-scale farmers are increasingly marginalized (Gloy et al. 2005). Whether or not these smallholders are credit constrained in Canada, given the overall credit-worthiness of Canadian farmers seen in Figure 2 it can safely be concluded that they soon will be. The primary implication of a general state of (or looming) credit constraint facing small-scale agriculturalists globally is a lack of funds available for the adoption of new agricultural technologies (Rashid et al. 2004). Given that it is these same small-scale producers by whom most A/R projects in Canada and abroad are expected to be undertaken, it is clear that new means of delivering credit to these producers is necessary if A/R projects are to contribute significantly to mitigating climate change.

2.4 Aggregating institutions

While streamlining the requirements for offset registration and planning will decrease transaction costs for small producers, especially if accompanied by the institutional learning that will accelerate processing, efforts aimed at small-scale producers themselves are necessary. The most straightforward (if crude) response would be for a government institution to record average transaction costs and either pay them itself or reimburse producers. Indeed, this is reportedly being done for six small-scale CDM projects by the Finnish Government (Pearson 2007). However, not only would this incur significant monitoring and administrative costs at a larger scale, but as a direct form of aid to the suppliers, it is likely only politically feasible for CDM projects promoted primarily for
development goals, and therefore unacceptable in Canada. For the same reason, direct subsidy of producers to promote A/R activities (such as advocated by DeMarsh 1999) is unlikely to be politically feasible either domestically or internationally, given the general trend towards declining agricultural subsidies in many industrialized states (seen in Figure 2.5)\(^{18}\) post Uruguay Round negotiations of the GATT (WTO) that began in 1986 (Coleman and Grant 1998).

**Figure 2.5 – Average National Producer Support Estimates (selected countries)**

![Figure 2.5](image)


Given economies of scale, promoting offset aggregating institutions is a reasonable policy response. Aggregating institutions are typically used to manage risk, and there is a

\(^{18}\) Agricultural subsidy in Figure 2.5 is represented by producer support estimate – the percentage of gross farm receipts measured at the farm gate transferred to producers from consumers and taxpayers as a result of economic, social, environmental and tax policies.
long history of product aggregation among small-scale resource producers such as Indian rubber tappers (Zant 2001), Ivoirian Cocoa farmers (Lloyd et al. 1999) and Western Canadian wheat farmers (Biggs et al. 2006) among others. Increased scale of production and risk distribution have been achieved through such aggregation, as has increasing creditworthiness (either through scale or being closely associated with the state) and the ability of such institutions to participate in international markets and adjust pricing behaviour in the face of uncertainty has been well documented (Tucker 2001, Zant 2001).

Esuola and Weersink (2006) have proposed a means of decreasing transaction costs, distributing risk through aggregation and increasing credit aimed specifically at the Canadian offset market through traditional financial institutions: banks. In their understanding, small scale offset generators would deposit offsets at a bank, which would give them a return for maintaining their ‘savings’ at the bank in a way analogous to interest, determined from the basic investment formula (see Equation 2).

\[
Annual\ Payment = p(1 + r)^n + c\frac{(1 + r)^n - (1 + r)}{r} \quad \text{Equation 2}
\]

In this case \(p\) is the principal (that is, the funds from the sale of the temporary credit), \(r\) is the interest rate, \(c\) is the annual payment made to the farmer (equal to \(p\)) in year \(n\) of the contract. The return received from a temporary credit would increase with the length of the project period just as interest rates increase with the period over which a savings certificate is held. Penalties for withdrawal of offsets before fulfillment of the pre-established term are analogous to penalties common to early withdrawal of assets from a
bank. Firms seeking ‘loans’ (i.e. temporary offsets) would approach the bank in the same way they would for typical loans, which the bank would provide for a fee. In order to ensure liquidity, the bank would have more deposits than the number of credits sold, and the risks associated with impermanence would be shared between the bank and the supplier through the interest rate. They advocate for existing banks to serve as carbon banks to lower establishment and regulation costs and encourage investment. The offset generator would be paid for their deposit after a compulsory 5-yr review at which time verification would occur. In the event of early withdrawal, the bank would pay the supplier the returns on their investment to date less penalties. Given a negotiated temporary credit cost of 0.78 CAD/t-CO_{2eq}^{19} and provision of credits by the bank to LFEs at 1 CAD/t-CO_{2eq} with the bank retaining a 10% by volume reserve, they are able to generate Table 2.1.

### Table 2.1 – Returns on Carbon Investment in Banks (Esuola and Weersink 2006)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative C Received</th>
<th>Purchase of credit</th>
<th>Interest earned by depositor (3%)</th>
<th>Cumulative C sold</th>
<th>Receipt of sale</th>
<th>Interest from sale (7%)</th>
<th>Net return to bank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MgCO_{2eq}</td>
<td>$ CAD</td>
<td>MgCO_{2eq}</td>
<td>$ CAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 000</td>
<td>780</td>
<td>23.40</td>
<td>900</td>
<td>900</td>
<td>63</td>
<td>159.60</td>
</tr>
<tr>
<td>2</td>
<td>2 000</td>
<td>1 560</td>
<td>70.90</td>
<td>1 800</td>
<td>1 800</td>
<td>193.41</td>
<td>362.51</td>
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<tr>
<td>3</td>
<td>3 000</td>
<td>2 340</td>
<td>143.23</td>
<td>2 700</td>
<td>2 700</td>
<td>395.95</td>
<td>612.72</td>
</tr>
<tr>
<td>4</td>
<td>4 000</td>
<td>3 120</td>
<td>241.13</td>
<td>3 600</td>
<td>3 600</td>
<td>675.67</td>
<td>914.54</td>
</tr>
<tr>
<td>5</td>
<td>5 000</td>
<td>3 900</td>
<td>365.36</td>
<td>4 500</td>
<td>4 500</td>
<td>1037.96</td>
<td>1272.60</td>
</tr>
<tr>
<td>Total</td>
<td>15 000</td>
<td>11 700</td>
<td>844.02</td>
<td>13 500</td>
<td>13 500</td>
<td>2365.99</td>
<td>3321.98</td>
</tr>
</tbody>
</table>

This system has the advantage of decreasing transaction costs through aggregation and risk reduction while providing flexibility for suppliers who wish to withdraw their

---

19 Esuola and Weersink (2006) generate this cost by discounting the maximum cost of an emissions allowance (15 CAD/t-CO_{2eq}) announced under an early Canadian carbon market plan at a 3% discount rate over 100 years, their assumed lifetime of a “permanent” emissions allowance.
investment (i.e. land-use change before the end of contract), meeting important recommendations this chapter (and others, e.g. Soleille 2006) have made. Unfortunately, it also has several drawbacks. It has already been established that the largest portion of transaction costs associated with offset projects comes from project planning and registration, but it is unclear how a bank would assist in decreasing these costs. Given a government institution charged with setting regulations for offset project compliance and licensing, interacting with the institutions (and the associated costs of that interaction) would still fall to the small-scale supplier. Assume transaction costs of 1 USD/t-CO$_{2eq}$, on the low end of the range provided by Krey (2005) and Kleppner and Peterson (2006). Given an exchange rate of .849 USD/CAD, this represents 1.18 CAD/t-CO$_{2eq}$. Based on the transaction cost breakdown of Krey (2005) for projects with low transaction costs, a maximum of 39.4% of transaction costs are accounted for by non-documentation related search and negotiation costs. Assume these are completely eliminated through a farmer working with a well-established and familiar bank. This leaves documentation related search costs, monitoring and approval costs of 0.715 CAD/t-CO$_{2eq}$ only slightly less than the return on the investment to the farmer. If these costs are shared equally between the farmer and the bank, are distributed evenly throughout the lifetime of the project, and the bank has 100% pass-through$^{20}$, then Table 2.1 becomes Table 2.2.

---

$^{20}$ This increases the cost to carbon emitters of an offset from 1 CAD/t-CO$_{2eq}$ to 1.36 CAD/t-CO$_{2eq}$, as assumed by Esuola and Weersink (2006). Any pass-through higher than 0% maintains the pattern of the following analysis in spite of changes in magnitude.
Table 2.2 – Corrected Returns on Carbon Investment in Banks

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative C Received</th>
<th>Purchase of credit</th>
<th>Interest earned by depositor (3%)</th>
<th>Cumulative C sold</th>
<th>Receipt of sale</th>
<th>Interest from sale (7%)</th>
<th>Net return to bank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MgCO₂eq</td>
<td>$</td>
<td>MgCO₂eq</td>
<td>$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 000</td>
<td>423</td>
<td>12.69</td>
<td>900</td>
<td>900</td>
<td>63</td>
<td>527.31</td>
</tr>
<tr>
<td>2</td>
<td>2 000</td>
<td>846</td>
<td>38.45</td>
<td>1 800</td>
<td>1 800</td>
<td>193.41</td>
<td>1 108.96</td>
</tr>
<tr>
<td>3</td>
<td>3 000</td>
<td>1 269</td>
<td>77.67</td>
<td>2 700</td>
<td>2 700</td>
<td>395.95</td>
<td>1 749.27</td>
</tr>
<tr>
<td>4</td>
<td>4 000</td>
<td>1 692</td>
<td>130.76</td>
<td>3 600</td>
<td>3 600</td>
<td>675.67</td>
<td>2 452.90</td>
</tr>
<tr>
<td>5</td>
<td>5 000</td>
<td>2 115</td>
<td>198.14</td>
<td>4 500</td>
<td>4 500</td>
<td>1 037.96</td>
<td>3 224.82</td>
</tr>
<tr>
<td>Total</td>
<td>15 000</td>
<td>6 345</td>
<td>457.72</td>
<td>13 500</td>
<td>13 500</td>
<td>2 365.99</td>
<td>9 063.27</td>
</tr>
</tbody>
</table>

As a result of the bank’s ability to pass-through its transaction costs to the buyers, the bank’s net returns increase relative to their expenditures to the farmer\(^{21}\) from an average of 26% in Table 2.1 to 133% in Table 2.2. Not only do transaction costs significantly decrease the benefit to the farmer, but the superior pass-through of the bank allows it to engage in exploitative behaviour. If the bank is able to transfer any of its financial services provided and middle-man profit extraction costs to the producer (which does not seem unlikely), it would decrease returns to farmers further. Additionally, evidence from India indicates banks are unwilling to participate in carbon offset projects (Pearson 2007).

It is unclear how a national government could compel existing banks to use their admittedly analogous services to manage carbon assets when their institutional history involves the management of purely financial ones. Given a high level of competition in a national market for financial services, the ability of any given bank to possess the carbon assets necessary to effectively act as an aggregator is also open to question. Finally, the support services a bank can provide would be limited solely to the financial, leaving producers to seek specifically carbon related support (e.g. technical advice on cropping, planting, rotation, etc.) from other sources. Though there is an intuitive appeal to

\(^{21}\) Net returns to bank/(Purchase of credit + Interest earned by depositor)
directing producers to the existing financial services market, it fails to address several of the most important requirements of a mechanism for increasing the participation of small-scale producers in a carbon market, as well as the powered relationship between farmers and banks.

Given that a financial services model is flawed, two other aggregation scenarios remain, both of which are familiar to Canadian agriculturalists: a) producer co-ops, and b) single-desk sellers. In each case, the production of many small suppliers is pooled and marketed by a single agency, thereby consolidating risk, while potentially providing economies of scale in sales, market development, R&D and the provision of financial services. Returns from the sales of the goods are then distributed (less administrative costs) to the producers. The difference between the two is one of participation: in the former it is voluntary (such as the 9271 Canadian co-operatives incorporated in 2004) and in the latter mandatory (through some act of legislation, such as the Canadian Wheat Board [CWB] being governed by the CWB Act) (Co-operatives Secretariat 2004, Schmitz and Furtan 2000). Each of these options has potentially significant effects on transaction costs. Generally, aggregating would decrease the impact of fixed transaction costs on per unit costs through simple pooling of output. Furthermore, accelerated and concentrated learning would decrease search and approval costs, which would also be reduced through eliminating the necessity of hiring consultants. Access to financial services for LULUCF projects would be easier from an institution dedicated to promoting and managing LULUCF projects rather than one dedicated to maximizing returns on capital. If market power is achieved, negotiation costs could be reduced. Some large single-desk sellers (the
Canadian Wheat Board and Australian Wheat Board [AWB]) enjoy significant reputational advantages over their competitors for timely delivery, dependability of supply, customer service, technical support, contract execution efficiency and high quality, allowing them to charge a price premium\(^{22}\) in certain markets, which are attributed to their status as single-desk aggregators (Lavoie 2002, WGMP 1996; as found in Schmitz and Furtan 2000). Again, depending on market power, search costs could be dramatically reduced by being the sole (or one of few) source(s) for high-grade offsets. Finally, through the ability to develop long-term contracts with consulting firms and certification agencies, per unit monitoring costs would be reduced. They have the additional benefit of being familiar to Canadian farmers, who have identified a preference for working with government organizations and producer oriented cooperatives/corporations over free-market options in an hypothetical offset market (Reedy 2003, Van Kooten et al. 2002).

Ussivuori and Kuuluuvainen (2001) introduce a two-period consumption savings model examining collaboration of woodlot owners that, with some modifications, makes a valuable contribution to this discussion.\(^{23}\) Consider equations 3 to 5.

\[
V^{1,2} = \sum_{i=1}^{2} [u(C_i^1) + \beta^i u(C_i^2)] \quad \text{Equation 3}
\]

\[
C_i^1 = \sum_{j=1}^{n} p_i a_j^i Q_j^i + B^i \quad \text{Equation 4}
\]

\(^{22}\) Though the reputational advantages are accepted, the ability of the CWB to charge a price premium is hotly contested by, eg. Carter and Loyins (1996), though convincingly demonstrated by Kraft et al. (1996), Brooks and Schmitz (2001), Schmitz et al. (1997) and particularly Lavoie (2002).

\(^{23}\) This paper considers only one application of their model and does not include a full examination of their results. Readers are recommended to Ussivuori and Kuuluuvainen (2001) for more detailed information.
\[ C_2^i = \sum_{j=1}^{n} p_j (1-a_j^i) Q_j^i (1+f_j) - (1+r)B^i \]  \hspace{1cm} \text{Equation 5}

\[ B^i \leq \overline{B}^i \text{ for } i = 1, 2 \]

Equation 3 represents the sum of the strictly concave utility functions of consumption of two farmers \((i = 1, 2)\) based on their consumption \((C)\) from periods 1 and 2. \(\beta^i = 1/(1 + \delta^i)\) and are discount factors reflecting subjective discount rates \((\delta^i < 1)\). Each farmer has divided their land into tracts, some of which they are farming and some of which were afforested \(j\) years ago, which demonstrate linear growth from period one to period two represented by \(f_j, j = 1, \ldots, n\), where growth rates decrease from younger to older stands.\(^{24}\)

The prices of timber net of harvesting costs are represented by \(p_1\) and \(p_2\), while \(Q_j^i\) are the initial sizes of timber stocks in each tract before any cutting. The \(a_j^i\) define tracts whose land-use is converted from timber to agriculture in period one, and take the value 1 when the tract is cleared, and 0 when it is left unharvested, continuing to sequester carbon.

Woodlot management decisions of the two farmers are made during the first period including \(B^i\) representing borrowing \((> 0)\) or lending \((< 0)\), where \(\overline{B}^i\) are borrowing constraints, the limit to which the farmer may borrow at the market rate \(r\) in their solving for \(a_j^i\). By substituting equations 4 and 5 into equation 3 and solving the resulting Lagrange function a set of three conditions labeled equation 6 can be derived from the Kuhn-Tucker conditions.

\(^{24}\) This is obviously a simplified model of forest growth dynamics, but is acceptable for comparing two periods of arbitrary length.
\[
(1 + f_j) \frac{p_2}{p_1} > 1 + r^* \Rightarrow a_j = 0
\]
\[
(1 + f_j) \frac{p_2}{p_1} = 1 + r^* \Rightarrow 0 < a_j < 1 = 0 \quad \text{Equation 6}
\]
\[
(1 + f_j) \frac{p_2}{p_1} < 1 + r^* \Rightarrow a_j = 1
\]

Where \( r^* \) is the virtual interest rate, \( r^* = r + \lambda [u'(C_i^j)\beta^i]^{-1} \) and the marginal costs of the borrowing constraints \( \lambda_i = u'(C_i^j) - u'(C_i^j)(1 + r)(1 + \delta)^{-1} \). As a result of equation 6, a tract will only be left uncut if the increase in its value is greater than the virtual interest rate, but since the virtual rate is higher than the market rate, progressively younger stands will be cut as borrowing constraints become increasingly tight. In this case farmers will reduce present consumption and shift their land away from A/R based carbon management, relative to an unconstrained case. At a certain virtual interest rate, they will shift away from carbon management completely and resume traditional farming activities. This effect will be exacerbated as the farmer ages, since \( \beta^i = 1/(1 + \delta) \) the virtual interest rate will increase with the time preference rate.\(^{25}\) Given adequate farmer awareness of credit constraint \( j \) years ago, trees would never be planted in the first place and no attempt at diversification into forest carbon management would be attempted.

Consider, however the case in which utility is maximized under collaboration between the two farmers described by the objective function in equation 7, and the constraints in equations 8 and 9.

\[
V^{i+2} = \sum_{i=1}^{2} [u(C_i^j) + \beta'iu(C_i^j)] \quad \text{Equation 7}
\]

\(^{25}\) This is of particular concern in the Canadian context, where median farmer age increased from 47 to 49 between 1996 and 2001 according to the 2001 Census of Agriculture (StatsCan 2002).
\[
\sum_{i=1}^{2} C_i = \sum_{i=1}^{2} \sum_{j=1}^{n} p_i a_j Q_j + \sum_{i=1}^{2} B^i 
\]

Equation 8

\[
\sum_{i=1}^{2} C_i^2 = \sum_{i=1}^{2} \sum_{j=1}^{n} p_2(1 - a_j^i)Q_j(1 + f_j) - \sum_{i=1}^{2} (1 + r)B^i 
\]

Equation 9

\[B^i \leq \overline{B}^i \text{ for } i = 1,2\]

A comparison of equations 8 and 9 to equations 4 and 5 demonstrate a more relaxed constraint structure, in which consumption for each farmer can be met from the returns from each farmer, though the borrowing quotas are not pooled. As a result of the relaxed constraints, a collaborative management scheme must always provide at least as high combined utility as in the non-collaborative management scheme. Further, consider that if one of the farmers is credit constrained while one is unconstrained, then the former will be basing land-use change decisions on \(r^* > r\), the basis of land-use change for the latter. If the unconstrained farmer were to lend funds to the constrained farmer at some rate \(r'\) between \(r^*\) and \(r\) then the welfare of each would be increased in that forested tracts accumulating value at rates less than \(r^*\) but greater than the market rate of \(r\) (that is between \(r^*\) and \(r'\)) would be kept in forest carbon management. In this way, a farmer oriented co-operative in which management decisions and returns from forest carbon management were made jointly that offered internal financing to participating farmers would increase welfare in a credit constrained environment over a non-collaborative environment. These results are consistent with observations from Guatemala that cooperatives improve welfare and credit access among the poorest credit constrained farmers.

\[26\] Uusivuori and Kuuluvainen (2001) are able to extend this analysis to a case in which borrowing and lending rates differ between forest managers, with the same results of joint benefit from collaboration.
farmers (Barham et al. 1996), and that credit constraint limits the ability of small farmers to adopt new landuse strategies in Bangladesh (Rashid et al. 2004).

In spite of these benefits, both co-operatives and single-desk sellers have a significant weakness. For co-ops, optional participation could easily lead to the largest, most profitable projects maintaining an independent status rather than subsidizing less viable projects by allowing them to ‘ride on their coat-tails’. In this case, the co-op would experience higher costs and lower sales volume than if participation of all producers was mandatory, lowering the transaction costs gains. A single-desk seller, however, since it does not face competition and is government protected remains open to charges of cost inefficiency, as has often been asserted (and denied) with respect to the CWB (see the long-standing, public and judicial controversy between Colin Carter and Andrew Schmitz (Carter and Loyns 1996, Carter et al. 1998, Schmitz et al. 1997 and Schmitz and Furtan 2000). In the case of carbon offsets, however, a single-desk seller would face significant domestic competition from both allowance sellers and potentially CDM projects, exposure to which would presumably motivate efficiency in the same manner as that of a free-market. The single-desk seller faces additional charges: that their existence violates international trade legislation, and that they are inherently corrupt and immiserating to farmers. Paddock (1998) and McCroriston and MacLaren (2002) have ably demonstrated that single-desk sellers do not violate the GATT based WTO’s rules governing state trading enterprises, as long as they do not deny competitors market access, are transparent to investigation, regularly notify the WTO of their activities, and do not use quantitative

27 It is this incentive that has been motivating Alberta wheat farmers to lobby (to date unsuccessfully) to have the mandatory status of the CWB revoked, while Saskatchewan and Manitoba farmers remain largely in favour of its single-desk status.
restrictions; that is, they neither price discriminate nor violate favoured nation principles. Even price discrimination is acceptable if it is done for commercial reasons (i.e. in pursuit of profit rather than for undercutting or dumping) (Biggs et al. 2006). In reference to their inherent corruption and tendency to impoverish their constituents (as asserted by Boycko et al. 1996 and to a lesser extent by Shirley and Walsh 2000), it is critical to note that their analysis depends on the decision rule used to distribute revenue among producers, and whether the institution is required to distribute a share of revenues to the national treasury (which leads to corruption and inefficiency, particularly if the seller is an important source of government revenue). However, this outcome is not inevitable, as the CWB and AWB are required by legislation to return all revenues (less costs) to producers, and remit no funds to their respective treasuries. Even for producers in regions with less legislatively rigorous protections for producers’ rights, some state operated export agencies have operated with a (to many, surprising) pro-small-scale producer orientation, for instance, the St. Vincent Banana Growers Association (Grossman 1993). Neither corruption, nor the exploitation of small-scale producers is inevitable when discussing STEs – the political-economic history of the region and the institutional design are paramount.

2.5 Conclusions

It is clear that transaction costs play an important role in the marketing of carbon assets in general, and afforestation based carbon offsets in particular, with indications that the lower transaction costs are kept, the more scope for forestry projects exists. In spite of
price instability for pre-2008 vintage carbon allowances on the ETS and the failure of A/R CDM and JI projects to penetrate any of the regional carbon markets currently functioning, significant potential remains for such projects to mitigate climate change given an enabling policy environment. Decreasing transaction costs through the introduction of (an) aggregating institution(s) is a reasonable goal for Canadian climate change mitigation policy and the ability of such institutions should be evaluated as a means to increasing Canadian A/R offset generation from small-scale producers. Cooperatives and single-desk sellers offer the most promise in this regards as compared to banks, though their performance relative to each other and to a baseline with no marketing institution must be identified. In Chapter 3.0, this evaluation will be made.
Ideology not only plays an essential role in political choices, but also is a key to individual choices that affect economic performance. Individual perceptions about the fairness and justice of the rules of the game obviously affect performance…. If measuring and enforcing contract performance can be done at low cost, then it makes very little difference whether people believe the rules of the game are fair or unfair. But because measurement and enforcement are costly, ideology matters.

Douglass North (1992)

Chapter 3.0: Evaluating the performance of small-scale afforestation generated carbon offset aggregating institutions

3.1 Introduction

Now that it has been established that a) transaction costs are critical to the feasibility of afforestation generating carbon offsets in Canada, b) aggregating marketing institutions are a primary means for doing so, and c) that co-operatives and state trading enterprises (STEs) are the preferred aggregators for evaluation, the stage is now set for a comparison of their performance, according to a variety of different criteria. Recall from Chapter 1.0 that a primary failure of the transaction cost analysis of the New Institutional Economics (NIE) is neglect of issues of distribution and politics. This chapter will therefore pursue a traditional microeconomic approach to comparing the performance of these institutions in an hypothetical Canadian market for carbon offsets, but with a strong emphasis on distributional outcomes.

This analysis is particularly necessary, since the Canadian Federal Government, recognizing that Canada’s abundance of forest resources and marginal land under low-productivity agriculture makes it a potentially significant source of forest based sequestration projects, has long promoted the inclusion of forest mechanisms in its
climate change policies (Forest Sector Table 1999, Van Kooten et al. 1999). Though it now seems unlikely that Canada will meet its KP commitments (to reduce GHG emissions by 6% below 1990 levels during the period of 2008-2012), the federal government continues to publicly promote a longterm GHG emissions reduction plan comparable to the rest of the G8, that is, a 50% reduction of CO$_2$e below 1990 levels by 2050 (Laghi 2007). However, the role of forest-based projects under such a plan is uncertain. Despite what appears to be considerable potential (Bernoux et al. 2002), studies have been mixed as to whether the afforestation of farmland to generate carbon offsets can be cost-effective in Canada (Biggs and Laaksonen-Craig 2006, McKenney et al. 2004, Van Kooten et al. 2002). McKenney et al. (2004) have demonstrated that significant volumes of afforestation based carbon offsets would require higher than previously envisioned carbon prices, and the previous chapter and Van Kooten et al. (2002) have shown that transaction costs represent the largest barrier to Canadian farmers’ participation in afforestation projects, a situation not unique to Canada (Kleppner and Peterson 2006, Krey 2005). Various institutional options have been proposed to decrease transaction costs with the goal of increasing the participation of Canadian farmers in producing forest based carbon assets, though the ultimate policy goal of this increased participation is not clear. These institutions include providing carbon marketing through the existing banking system (Esuola and Weersink 2006), introducing producer cooperatives and creating a single-desk offset seller. However, the market impacts of these options have not been studied at either a national scale or from a firm theoretical base. This chapter addresses this problem, reviewing the existing literature to identify a range of likely transactions costs, identifying institutions that have been
proposed to meet these needs and evaluating their potential effects in the Canadian context.

3.2 Transaction costs and forest carbon projects

The four types of transaction costs present in the forest carbon offset market have already been described: suppliers incur search costs in order to locate buyers and buyers to locate suppliers; coming to mutually comprehensible and agreeable terms in a contract create negotiation costs which can be decreased through repeated contracting; contract compliance and penalty enforcement produce monitoring costs and approval costs occur when a regulatory agency verifies the quality of an offset to determine whether it meets institutional requirements (Krey 2005, Van Kooten et al. 2002). While values for transaction costs in carbon asset marketing in general were described in the previous chapter, for the purpose of microeconomic modelling, it will be necessary to establish a much tighter range, focused on afforestation and reforestation (A/R) projects specifically.

Michaelowa et al. (2003) and Michaelowa and Jotzo (2005) are critical references for this purpose, both for their systematic review of available studies which quantify the components of these costs and for distinguishing the costs into pre-implementation (search, negotiation and approval) and post-implementation (monitoring) types. Reviewing all of the KP flexibility mechanisms, they find that search, monitoring and components of approval costs are fixed and thereby decrease per unit of production as the scale of the project increases. They report unit negotiation costs as digressive, that is,
decreasing as the scale of the project increases, and the remaining approval costs as a mix of digressive and proportional. This is a clear indication that unit transaction costs in carbon assets are decreasing with project size, and is supported by Krey (2005).

Transaction costs figures most applicable to a Canadian context are those from Joint Implementation (JI) projects. Michaelowa and Jotzo (2005), reviewing the results of published case studies and large-scale international afforestation projects report average transactions costs of 0.14 $/tCO$_2$e$^{28}$. Michaelowa et al. (2003) report values for Eastern Europe of 0.58 $/tCO$_2$e$. Ahonen and Hamekoski (2005) report a range from 0.54 to 2.73 $/tCO$_2$e$ for JI projects. Looking specifically at forest projects, Marbek Resource Consultants (2004) report a range of transaction costs from 1.05-2.30 $/tCO$_2$e$, which fall to 0.13-0.46 $/tCO$_2$e$ if the offsets are temporary (Fulton et al. 2005). Examining forestry projects in India, Bolivia, Brazil, Chile and the USA, Wetzelae et al. (2007) identify transaction costs of 1.70 $/tCO$_2$e$ for projects sequestering less than 370 000 tCO$_2$e/a, which fall to 0.10 $/tCO$_2$e$ when annual production is greater than 3 400 000 tCO$_2$e. Though all of these prices fall in the range of 0.10 to 2.73 $/tCO$_2$e$, Fichtner et al. (2003) report transaction costs up to 274 $/tCO$_2$e$! However, the majority of the projects Fichtner et al. sampled were not originally designed to produce carbon offsets, but were reframed as such post-implementation to take advantage of learning-by-doing research funding. As a result, this high-end value can be safely dismissed.

Of at least as much importance is the breakdown of transaction costs into their components. Michaelowa et al. (2003) and Michaelowa and Jotzo (2005) present ranges

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$^{28}$ All monetary values in this chapter are given in Canadian dollars.
of transaction costs components for diverse project types. It is reasonable to take their high end values, since small-scale forestry projects have the highest per unit transaction costs, next to agriculture (Marbek 2004). A range for each cost component can thereby be constructed: search 3-19%, negotiation 45-74%, approval 20-25% and monitoring 3-15%. Ahonen and Hamekoski (2005) report a range for pre-implementation costs for JI of 68-78%. These figures are slightly lower than those reported by Michaelowa et al. (2003) and Michaelowa and Jotzo (2005), which range from 85-97%. This is possibly because of a difference in dividing certain approval costs between pre-implementation and post-implementation phases.

Excluding the option pursued by an exploratory program in Finland to simply pay the transactions costs for six small-scale CDM projects (Pearson 2007), three institutions have been proposed to decrease the transaction costs faced by Canadian farmers. Esuola and Weersink (2006) suggest that the preferred instrument should be the existing banking system. They argue that by ‘investing’ carbon offsets in banks, which the banks would then sell to buyers in large blocks, licensed farmers would face lower transaction costs. However, while search and negotiation costs would thereby be decreased, there is no compelling reason why monitoring and approval costs would be affected, significantly decreasing the utility of the institutional framework (given that these unaffected costs represent 23-40% of total transactions costs).\(^\text{29}\) As a result, a cooperative model in which a small number of farmer organized marketing agencies (already familiar in Canadian agriculture) or a single-desk seller option in which a federally legislated farmer-oriented pooling agency (akin to the Canadian Wheat Board) was the sole licensed marketer of

\(^{29}\) Refer to the previous chapter for a more in-depth critique.
small-scale afforestation sourced offsets into the market, would decrease transaction costs more completely (through providing streamlined monitoring and approval procedures to its members, repeated contracting and larger aggregated volumes) while simultaneously providing the market power necessary to achieve preferable distributive results for farmers.

It is at this point that this analysis diverges from a traditional NIE approach, through including the important influence of ideology on institutional change that was discussed in Chapter 1.0 and modeled in Figure 1.1. Given the information costs which necessitate a bounded rationality as the context of human decision-making, it is upon ideology (recall North’s non-pejorative definition) that decision-makers depend when choosing between institutional frameworks. In this analysis, therefore, it will be necessary not only to identify reasonable transaction cost levels under different institutions, but also to continue the analysis past that point (indeed, transaction cost identification will be but the first step) to identify the effect of these options on distribution, leading to explicit outcomes upon which the ideology of various stakeholders (consumers, producers, policy makers) can act. A modelling framework is described below to allow the comparison of these options.

3.2 Methodology

Rather than merely describing the Canadian market in terms of production and consumption (e.g. Biggs and Laaksonen-Craig 2006, McKenney et al. 2004) this paper
seeks to describe the distributive effects of public policy. From a policy perspective, it is not enough to simply demonstrate that a particular suite of policies will result in the increased profitability of the Canadian agricultural sector, if it does not demonstrate what share of that profit producers will be able to capture. As such, this modelling effort seeks to identify a basic equilibrium between the supply of small-scale afforestation of agricultural land based carbon offsets and their demand, under four different institutional settings: a ‘natural’ market where no public institutions exist to mitigate transaction costs, one in which the existing banking system is used to market forest sourced carbon offsets, a cooperative\(^3\) model in which a small number of farmer organized marketing agencies control supply and one in which a single-desk seller is the sole marketing agency for all such offsets. Consumer surplus and producer surplus will also be calculated to identify distribution effects. Given the uncertainty of both the availability and the political desirability of purchasing credits abroad, this study will consider the Canadian carbon market as meeting its emissions reductions solely through domestic means. The main challenge in this research is identifying defensible supply and demand curves for afforestation sourced carbon offsets on agricultural land. Each curve includes its own unique challenges, and they will therefore be treated in turn.

\(^3\) Based on the results of Fulton and Gianiakas (2001) and Leathers (2006) these cooperatives are assumed to have either homogeneous members, very high member commitment or membership required by legislation to ensure that members do not participate in an intra-cooperative game to minimize their individual transaction costs. Given that transaction costs are prohibitively high to individual production in this first place, this is a reasonable assumption.
3.2.1 Deriving the offset supply curve

It is more useful to provide sequestration supply curves (e.g. Stavins 1999, Richards et al. 1993) than to postulate individual “average” prices for carbon assets (e.g. Biggs and Laaksonen-Craig 2006, Van Kooten et al. 2004). As Boyland (2006) correctly notes, this is because offset supply curves could (and do) take on a variety of surprising shapes, including asymptotic (Maynes 2003), linear (Stavins 1999) and negative exponential (Richards et al. 1993). Further, the method of establishing cost is critical, specifically whether flow summation, average stock or levelization techniques are used.\textsuperscript{31} Given that neither the flow summation nor the average stock techniques adequately consider the impact of either permanence or delivery of benefit, a levelization technique is preferred (Boyland 2006, Van Kooten et al. 2004). In the cost levelization technique, the present value of costs is annualized over the period of the carbon flows and divided by the rate of carbon capture. In practice, this requires constant capture rates, which are rarely seen. However, the levelization technique is mathematically equivalent to that of discounting the annual flow of carbon at the social discount rate.\textsuperscript{32} While discounting a physical quantity is counterintuitive, it is only this technique that includes the effect of the long delayed ‘consumption’ of atmospheric benefits required by carbon sequestration projects.

In this research, the Canadian Forest Service – Afforestation Feasibility Model (CFS-AFM) was used to generate the offset supply curve. In the CFS-AFM, a biophysical

\textsuperscript{31} Readers are invited to examine Boyland (2006) for a thorough comparison of these different techniques.

\textsuperscript{32} See the technical appendix in Richards and Stokes (2004) for a proof.
model calculates growth rates and timber yields from plantations. A cost-benefit module then uses these outputs, silvicultural and opportunity costs and product prices to calculate break-even prices using the levelization technique. Results from this model have been widely published, and detailed information can be acquired through McKenney et al. (2004), Yemshanov et al. (2005) and McKenney et al. (2006). CFS-AFM is spatially explicit, in that it includes differing growth rates and opportunity costs (generated from the annual rental expenses reported in the 2001 Canadian Census of Agriculture) for each of the census subdivisions of Canada.

While capable of establishing values through an infinite series of sustained yield rotations and for a suite of carbon pools, in this case the model was run for live carbon pools only (to model participants choosing the easiest, least costly pools to monitor), with forest products pools excluded (to reflect the spirit of the KP), and with a 4% discount rate. These are all within the boundaries of the literature (McKenney et al. 2006). Modifications to established technique include a mask to randomly eliminate 25% of all potentially productive area. This choice was made to include the evidence of Van Kooten et al. (2002) that 25% of Western farmers would be unwilling to engage in afforestation for carbon sequestration regardless of the level of compensation. A further innovation was to model the temporary sequestration benefits of a single 21-year rotation of hybrid poplar (including harvest) while recording carbon sinks for the first 20 years only. While unjustifiable in a ‘carbon graveyard’ project model, this choice is completely justified from a temporary storage perspective. If sequestration projects are considered as leased,

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33 This important result from Van Kooten et al. (2002) will be returned to in Chapter 4.0.
such as in Sedjo and Marland (2003) or Locatelli and Pedroni (2006), in which an emitter is sinking a portion of their carbon liability into an impermanent project for a contracted length of time for a price lower than that of a permanent asset, it is appropriate for them to receive temporary carbon benefits. In this case contract length is assumed to be 20 years – the maximum length of time Western farmers were willing to engage in binding contracts according to the polling of Van Kooten et al. (2002). Upon contract expiry there is no reason for which farmers providing a temporary service should be penalized for harvesting their timber. This choice does not, in fact, assume that farmers will indeed choose to harvest their timber, they could pursue an additional sequestration contract.\textsuperscript{34} However, it does assume that in making their initial land-use change decision, farmers will plan on reverting to their current livelihood generating activity: farming. Therefore, as long as the price of a temporary credit is appropriately discounted from the price of a permanent credit and national greenhouse gas reduction policies are in place requiring the buyer to reduce future emissions (or purchase new temporary offsets) to balance the expiry of their temporary offset, no compelling reason exists to raise the break-even carbon price by including penalties for the emission of CO\textsubscript{2}e that could accompany contract expiry.\textsuperscript{35}

The Canadian supply curve for temporary carbon offsets generated by small-scale afforestation of farmland is shown in Figure 3.1.

\textsuperscript{34} Of course, a harvest would preclude the farmer from engaging in a new afforestation activity under KP-like rules for establishing plantations after land-use change, but this is beside the point.

\textsuperscript{35} If the hypothetical climate change policy which would prompt such an investment changed over the 20 years of the project to prevent small-scale producers from emitting greenhouse gases (rather than only impacting large-scale emitters as envisioned currently), any land-use change would have to be considered permanent, that is, a ‘carbon graveyard’.
Figure 3.1 – Carbon supply curve from small-scale afforestation in Canada

Note that only sequestration up to 125 MtCO$_2$e is included in the range. The effects of including break-even temporary prices up to 35 $/tCO$_2$e were modeled (resulting in sequestration of over 11 000 MtCO$_2$e), but this is well beyond the range of feasible values established for potential offset demand (see the following section). If this much larger range is included, the shape of the curve is distinctly different, with the line of best fit more closely approximating an exponential rather than a power function. However, close to the origin (where any equilibrium would occur) the explanatory power of the exponential function is quite poor, and a power function is preferable. Therefore, over the set of feasible volumes in the Canadian market for temporary, afforestation generated offsets, a power function of the form $p_s=4.0934 q_{offset}^{0.0706}$ (with an $r^2$ over 0.98) describes Canadian domestic supply.
3.2.2 Deriving the offset demand curve

A demand curve for sequestration offsets can be produced through generating a marginal abatement cost curve (MACC) using the technique of Ellerman et al. (1998) and manipulating it appropriately. A computable general equilibrium model is used to calculate the cost to a given region of decreasing GHG emissions by an absolute or relative amount over a given period. Using the outputs from several scenarios with different abatement levels, the shadow price of a certain reduction in emissions can be calculated, which when plotted against abatement level produces an upward sloping MACC. Given these marginal costs, the price of the final unit of emissions reduction in an economy with a given abatement policy can be identified (see Figure 3.2).

Figure 3.2 – Deriving a carbon offset demand curve from a MACC
By subtracting the abscissa value of the MACC from the abatement target and plotting it on the x-axis with its corresponding shadow price, a demand curve for non-abatement based (that is, sequestration based) offsets is generated\textsuperscript{36}. Of course, at equilibrium between offset supply and offset demand, the level of offsets traded should be subtracted from the initial abatement target used to generate the demand curve.

In terms of the form of a MACC, several alternatives exist in the literature. Ellerman \textit{et al.} (1998) derive regional and national MACCs using the EPPA model which have the form of $kq^2+jq+c$ with $r^2$ values over 0.99 for each. Kleppner and Peterson (2006) derive national MACCs with the same form using DART. Bohringer and Loschel (2003) and Gheresi (2001) using POLES and the average results of 10 distinct models find the form $kq^n$. This research used a MACC from MKJA (2006), which was generated specifically for the Canadian market using the Canadian Integrated Modelling System (CIMS). CIMS models energy flows in a full-equilibrium context, incorporating macroeconomic demand feedbacks, demand dependent energy supply costs and energy trade.\textsuperscript{37} MKJA (2006) produced aggregate MACCs for a 2030 policy framework and carbon taxes of 10 to 250 $/tCO_2e, initiated in 2006, which can be modeled by both $kq^2+jq+c$ and $kq^n$ forms with $r^2$ values of 0.99. However, over the range in reductions within which this research is interested (a reduction of 250 MtCO$_2$e by 2030) the variation in the MACC is explained with an $r^2$ of over 0.999 for each of polynomial, exponential and linear ($kq+c$) forms. For ease of computation, the linear form has been chosen here.

\textsuperscript{36} This argument only holds if the region under consideration is closed to imports of carbon assets. As yet this is not an unreasonable assumption in the Canadian case. If the possibility of imports existed, this could be incorporated simply by subtracting whatever national cap on imports was instituted as a constant from demand.

\textsuperscript{37} For further CIMS detail, visit http://www.emrg.sfu.ca/
However, it is important to note that the technique described so far would only produce a demand curve for permanent carbon assets. Given the unique risks inherent to sequestration projects (see Chapter 2.0) impermanent carbon assets have tended to trade at lower prices than permanent (Captor and Ambrosi 2006). One method for considering impermanence is to market expiring carbon offsets. These assets have either a negotiated or legally predetermined expiry date: the buyer allots a portion of their carbon liability in a temporary carbon asset for a fee, distributing limited-term benefits to the renter, with the seller retaining long-term control (Sedjo and Marland 2003). This is the method used by the EU ETS for pricing their two different types of impermanent assets (Locatelli and Pedroni 2006).

Locatelli and Pedroni (2006) describe a method for calculating the value of impermanent carbon assets based on the value of permanent carbon assets (Equation 1).

\[
P_{\text{impermanent}} = P_{\text{permanent}} \left[ 1 - \left( \frac{1 + j}{1 + i} \right)^{\text{lifetime}} \right]
\]  

(1)

Where \( P_{\text{impermanent}} \) is the price of an expiring carbon asset, \( P_{\text{permanent}} \) is the price of a permanent carbon asset, \( j \) is the evolution rate of the market price of permanent carbon assets, \( i \) is the discount rate for the buyer and \( \text{lifetime} \) the number of years until the asset expires.\(^{38}\) The portion of Equation 1 in square brackets will be referred to hereafter as the impermanence deflation factor. By multiplying the impermanence deflation factor against

\(^{38}\) Note that Equation 1 only has meaning if the evolution rate \( (j) \) is less than the discount rate \( (i) \). While this is accepted practice, it should be recognized that this defines longterm investments in carbon offsets as unprofitable. The purpose of Equation 1, however, is not to justify the lower value of impermanent assets, but rather to model them using a tool that reflects their value as less than that of permanent credits, while also derivative of the value of permanent credits, the lifetime of the project and the rate of time preference.
price for a permanent carbon asset, its value if it were impermanent can be determined. Similarly by multiplying the demand curve for permanent non-abatement carbon assets by the impermanence deflation factor, the curve will now represent the demand for impermanent non-abatement carbon assets, which will represent the demand for afforestation generated carbon offsets. This assumes that the sole difference as perceived by investors between impermanent carbon assets and permanent carbon assets is permanence, that there is no significant contribution to the impermanent carbon asset market from agriculture and that Canada does not import any carbon offsets.

The final parameter necessary to produce a demand function for temporary afforestation generated carbon offsets from small-scale Canadian agriculture is to identify a reasonable emissions reduction policy. The current federal government has repeatedly stated that it is committed to a long-term strategy that would reduce emissions by 50% below 1990 levels by the year 2050 – a figure compatible with statements made by several European and Japanese leaders (Laghi 2007, Gorrie 2007). Assuming a linear decrease in emissions from 2005 to 2050, this represents an absolute decrease of approximately 250 MtCO$_2$e in 2030.

Using the MKJA (2006) MACC for 2030, a policy goal of 250 MtCO$_2$e emissions reduction and the Equation 1 supply function, following the technique in Figure 3.2 and using the impermanence deflation factor where $j = 0.02$ and $i = 0.04$, the following demand curve for afforestation generated carbon offsets from small-scale Canadian agriculture is produced (Figure 3.3).
Figure 3.3 – Baseline Equilibrium in the Canadian small-scale afforestation market

Given these functional forms, it is a simple exercise to introduce transaction costs into the market by a simple vertical transformation, as long as the distribution of transaction costs (TAC) is known. If $\theta$ is the percentage of transaction costs borne by producers, then the functions are adjusted as follows:

\[ p_d = a - (1 - \theta)TAC - bq \]  \hspace{1cm} (2)
\[ p_s = \theta TAC + kq^h \] \hspace{1cm} (3)

Given that both $TAC$ and $\theta$ are constants, though, when distributional effects (here modeled as the ratio of consumer to producer surplus) are considered, the influence of $TAC$ are seemingly eliminated from the consumer surplus (see Equations 4-6):

\[ CS = (0.5)(a - (1 - \theta)TAC - (a - (1 - \theta)TAC - bq_e))q_e = \frac{bq_e^2}{2} \] \hspace{1cm} (4)
\[ PS = q_e (a - (1 - \theta)TAC - bq_e - \int_0^q (kq_e^h + \theta TAC) dq_e = q_e \left( a - TAC - bq_e - \frac{kq_e^h}{h+1} \right) \]  

(5)

\[ \xi = \frac{CS}{PS} = \frac{bq_e}{2 \left( a - TAC - bq_e - \frac{kq_e^h}{h+1} \right)} \]  

(6)

It is important to remember, however, that \( TAC \) has been maintained in the original equilibrium solution (which produces \( q_e \)) so even though it does not appear in Equation 6, its influence is still felt.

An important distributional effect is illustrated in Equation 7.

\[ \frac{\partial \xi}{\partial q_e} = \frac{b\alpha(h+1)^2 + (h^2 - 1)kq_e^h}{2[(\alpha - bq_e)(h+1) - kq_e^h]^2} \]  

(7)

Where \( \alpha = a - TAC \). As a result of the final exponent we know the denominator of Equation 7 is positive. Since, with this functional form, \( h \) will always be between 0 and 1, \((h+1)^2 > 1\), but \((h^2 - 1) < 0\). However, over any value for \( q \) where the market clears, \( \alpha > kq_e^h \) (see Figure 4). Therefore, since \( b \) and \( \alpha \) must be positive, the numerator is positive. That is, \( \xi \) is increasing with \( q_e \). While an elementary result from a microeconomic perspective due to the nature of the supply curve, from a carbon offset point of view it is noteworthy. A priority of carbon offset research has been overcoming barriers which would limit the production of carbon offsets (e.g. Biggs et al. 2006, Michaelowa et al. 2003, Van Kooten et al. 2002). It must be recognized that while it is in the interests of potential carbon offset producers to have barriers eliminated which prevent market entry, it is not in the distributional interests of the sector to have large-scale production. Insofar as it is possible, producers would benefit most (relative to consumers) from policies which result in limited levels of production. This has significant implications for national
policies seeking to promote climate change mitigation while simultaneously addressing rural-urban income disparities: the more effective such policies are at promoting carbon offsets, the more the benefits will be captured by the urban/consuming sector.

Unfortunately, a general equilibrium solution is precluded by the polynomial form of Equation 3. By setting Equations 2 and 3 equal to each other, the equilibrium solves Equation 8.

\[ bq_e + kq_e^h = \alpha \]  

(8)

Which by implicit differentiation produces Equation 9.

\[ \frac{\partial q_e}{\partial TAC} = -\frac{1}{b + khq_e^{b-1}} \]  

(9)

Since \( b, k, h \) and \( q_e \) must all be >0, this confirms the intuition that in a competitive market, \( q_e \) decreases with increasing \( TAC \). More interestingly, since \(-1 < h - 1 < 0\), while \( b, h \) and \( k \) are constant, as \( q_e \) increases, the value of the denominator decreases. That is, \( q_e \) decreases with \( TAC \) but the influence of \( TAC \) on \( q \) decreases at higher values of \( q_e \). So, institutions which moderate \( TAC \) may only be necessary at early stages of market growth. As production expands the influence of \( TAC \) on the market will decrease.\(^{39}\)

---

\(^{39}\) Note that, in production, \( TAC \) is independent of the level of production. That is, it has been assumed that the small-scale producers making these decisions cannot increase their level of production to the point that they can decrease their transaction costs. In the following subsection means whereby aggregation can increase scale to the point where transaction costs are decreased with scale – but this assumption essentially means that small-scale producers cannot or will not choose to become large-scale producers.
3.2.3 Institutional scenarios

Given the functional forms in Figure 3.3, the behaviour of different participation promoting market institutions and their effects on transaction costs and welfare distribution can now be explicitly modeled. First, consider the baseline of a competitive market with no institutions to promote participation and $n$ producers selecting their level of production in a Cournot game to maximize their profit. The objective function of the $i$th producer is described in Equation 10:

$$\pi_i = aq_i - b\left(\sum_{i=1}^{n} q_i\right)q_i - (1 - \theta)TAC_c q_i - k\left(\sum_{i=1}^{n} q_i\right)^h q_i - \theta TAC_c q_i$$  \hspace{1cm} (10)

Assuming identical supply for $i = 1$ to $n$ and maximizing Equation 10 with respect to $q_i$ produces Equation 11:

$$(a - TAC_c)n = bq_c(n + 1) + kq_c^h (n + h)$$  \hspace{1cm} (11)

Where $q_c$ and $TAC_c$ are the competitive level of production and transaction costs. Due to the exponent $h$ on $q_c$, this expression cannot be solved directly for $q_c$.

In the case of a producer surplus (PS) maximizing institution that is the legislated single-desk seller (SDS) for afforestation generated carbon offsets, the form of the objective function is different (see Equation 12).

$$PS = (a - bq_m - (1 - \theta)TAC_m)q_m - \int_0^{q} (kq^h + \theta TAC_m) \cdot dq_m$$  \hspace{1cm} (12)
Where $q_m$ and $TAC_m$ are the monopolistically determined levels of production and transaction costs. The PS optimizing value of $q_m$ solves Equation 13.

$$a - TAC_m = 2bq_m + kq_m^h$$  \hspace{1cm} (13)

Note that, if $TAC_m \leq TAC_c$ and since $h < 1$, $q_m < q_c$, as would be expected. If a unique level of $TAC$ could be identified for single-desk sellers of afforestation generated carbon offsets, then a unique solution for Canada could be produced. For the banking and cooperative scenarios, the competitive market equation is more appropriate, as long as $n$ is carefully selected. In the case of the co-op model, given the results of McKenney et al. (2004) in identifying Alberta, Saskatchewan and Southern Ontario as likely sources of afforestation generated offsets, and the familiarity of these regions with large scale co-ops (such as the Saskatchewan Wheat Pool and Agricore), a small number for $n$ is appropriate, and will be assumed to $= 5$.\footnote{The implications of relaxing this assumption are considered in the sensitivity analysis.}

With respect to the banking scenario, given the high level of competition within the financial services sector\footnote{Over 70 domestic and foreign banks were active in the Canadian financial services sector in 2008, in addition to 35 trust companies, 200 finance companies and over 1 000 credit unions. This implies that an assumption of oligopoly in the carbon offset marketing by financial services sector lacks credibility (CBA 2008).} and the profit extracting nature of banks, it does not seem likely that banks would collude to restrict supply of offsets in the market, even if they could be compelled to offer their analogous financial services for the trade of carbon assets. As a result, in the banking scenario the $n$ value will refer to the number of farmers aggregating their offsets via banks. The CFS-AFM has a very strong linear relationship between the total volume of CO$_2$e offsets and the area under production for the range of
values under consideration, \( \text{Area} = 3263.5q - 3099.3 \), where \( q \) is in MtCO_2e and Area is in hectares. Considering that the average Canadian farm size is 274 ha (StatsCan 2002), a value for \( n \) can be calculated if \( q \) is known. By solving the scenarios iteratively with a high value for \( n \), using the resultant \( q \) values to calculate a new \( n \) and then solving again for \( q \) until the values of \( q \) and \( n \) stabilize, appropriate values of \( n \) can be selected. In this way, \( n \) was set to 185 for the competitive scenario and 302 for the banking scenario.

The other important distinction between the scenarios is how each institutional environment affects transaction costs themselves. Given the above literature review, transaction costs of 1.70 $/tCO_2e are postulated for the purely competitive scenario. This value is towards the high end of the overall range of 0.10-2.73 identified from the literature, but very close to the center of the range supplied by Marbek (2004) for specifically Canadian afforestation projects (1.68 $/tCO_2e) and identical to the average supplied by Wetzaeler et al. (2007). Marbek (2004) conclude that aggregation would decrease transaction costs by 80-88% in Canada, while Mariyappan et al. (2005) conclude that it would decrease them by 71% in the CDM. Conservatively, the value of 70% is selected for this exercise. Further distinction between the SDS and producer co-ops on their effects on transaction costs are not possible given the available data – it is therefore concluded that for the co-op and SDS scenario \( TAC \) is 70% less than the competitive scenario, that is, 0.50 $/tCO_2eq.

The banking scenario is more problematic. While utilizing banks as a clearing house would surely decrease search and negotiation costs, it is not clear how banks would affect
approval or monitoring costs. As such, in the bank scenario search and negotiation costs will be decreased by 70%, while approval and monitoring costs will be left unchanged. Using the breakdown of Michaelowa et al. (2003) and Michaelowa and Jotzo (2005), and taking the midpoint of the simple sum of their range for approval and monitoring costs (23-40%) this leaves 32% of TAC unaffected by aggregation. As a result TAC is set to 0.90 $/tCO₂e.

### 3.3 Results and Discussion

The four institutional scenarios are summarized in Table 3.1.

#### Table 3.1 – Objective functions and TAC for aggregating institution scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Objective Function</th>
<th>TAC ($/tCO₂e)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>[ \pi_i = a q_i - b (\sum_{r=1}^{n} q_r) q_i - (1 - \theta)TAC_c q_i - k (\sum_{r=1}^{n} q_r)^y q_i - \theta TAC_c q_i ]</td>
<td>1.70</td>
<td>185</td>
</tr>
<tr>
<td>Banking</td>
<td>[ \pi_i = a q_i - b (\sum_{r=1}^{n} q_r) q_i - (1 - \theta)TAC_c q_i - k (\sum_{r=1}^{n} q_r)^y q_i - \theta TAC_c q_i ]</td>
<td>0.90</td>
<td>302</td>
</tr>
<tr>
<td>Co-op</td>
<td>[ \pi_i = a q_i - b (\sum_{r=1}^{n} q_r) q_i - (1 - \theta)TAC_c q_i - k (\sum_{r=1}^{n} q_r)^y q_i - \theta TAC_c q_i ]</td>
<td>0.50</td>
<td>5</td>
</tr>
<tr>
<td>SDS</td>
<td>[ PS = (a - bq_m - (1 - \theta)TAC_m) q_m - \int_0^q (kq^h + \theta TAC_m) \cdot dq_m ]</td>
<td>0.50</td>
<td>-</td>
</tr>
</tbody>
</table>

The results of selecting \( q \) to maximize Equations 10 and 12 are found in Table 3.2.

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42 In order to identify a stable equilibrium, each of these objective functions was solved iteratively. That is, they were solved for \( q \), then that level was subtracted from the abatement target in the original demand function and repeated until \( q \) and \( n \) were stable. That is, each scenario results in a slightly different demand function, reflecting the affect each scenario would have on the distribution of national abatement goals between emissions reductions and offsets.
Table 3.2 – Results from aggregating institution scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>$q$ (Mt-CO$_2$e)</th>
<th>$p$ ($$/t$$-$$CO_2$$e$)</th>
<th>$CS$ ($\times 10^6$ $$$)</th>
<th>$PS$ ($\times 10^6$ $$$)</th>
<th>$CS+PS$ ($\times 10^6$ $$$)</th>
<th>$PS/(CS+PS)$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>16.43</td>
<td>5.85</td>
<td>8.67</td>
<td>5.53</td>
<td>14.20</td>
<td>39</td>
</tr>
<tr>
<td>Banking</td>
<td>26.28</td>
<td>5.61</td>
<td>22.18</td>
<td>9.12</td>
<td>31.30</td>
<td>29</td>
</tr>
<tr>
<td>Co-op</td>
<td>26.25</td>
<td>5.82</td>
<td>22.11</td>
<td>19.68</td>
<td>41.79</td>
<td>47</td>
</tr>
<tr>
<td>SDS</td>
<td>17.46</td>
<td>6.38</td>
<td>9.78</td>
<td>25.33</td>
<td>35.11</td>
<td>62</td>
</tr>
</tbody>
</table>

3.3.1 Modelling results

Consider first the Baseline (no institution) and Banking scenarios. The only substantive difference between them is that of decreased transaction costs.\(^{43}\) Through decreasing search and negotiation costs by 70%, sales increased by 60%, while unit price only decreased by 4%. The root of this effect is in the relatively elastic supply curve. As suspected, the reduction in transaction costs has increased the viability of production for a large number of producers (117 additional farmers, an increase of 63%). Returning to Table 3.2, note that while this represents more than a doubling of welfare, this has been disproportionately captured by consumers, whose share of the surplus has increased from 61 to 71%. This can again be explained by the shape of the supply curve. Several conclusions can be drawn from this comparison. First, a policy which was ostensibly designed to assist producers has primarily benefited consumers, increasing the number of marginal producers in the market rather than improving the livelihoods of individual producers. Second, the importance of correctly identifying the shape of the supply curve

\(^{43}\) While the value of $n$ is different, $n$ was set at 300 for the initial run of each. After adjusting $n$ to a level which reflects $q$, the values for $q$ and $p$ have changed by less than 1% of their initial values.
cannot be overstated. In this particular case, given the negative second derivative of supply (not to mention the inflection point at ~ 5000 MtCO₂e that is not shown) functional form is critical.

Consider now the comparison between the Banking and Co-op scenario. Between these two scenarios, both TAC and n have been decreased. Given the elasticity of the supply curve, further decreases to TAC would *ceteris paribus* lead to a continuation of the pattern already discussed (which can be seen by inspecting the supply and demand intersections in Figure 3.3): a small decrease in price with a large increase in quantity supplied. However, by reducing n to 5 (from 302) producers can now exert some power in the offset market and have restricted supply to increase price. Relative to the banking scenario, decreasing monitoring and approval costs by 70% (when accompanied by oligopoly) has resulted in essentially no change in production (less than a 1% decrease) and an *increase* in unit price (~4%). Societal welfare is noticeably increased: consumer surplus changes by less than 1%, while producer surplus increases by 116%. Producers and consumers now divide the surplus almost equally (47% for producers). This represents the maximum welfare case among the scenarios.⁴⁴

---

⁴⁴ Of course, reducing n in the banking scenario to include only the 5 largest banks (the RBC Financial Group, TD Bank Financial Group, Scotiabank, CIBC and BMO Financial Group) eliminates almost all difference between the co-operative scenario and the banking scenario. However, note that a) it is by no means clear that a financial services as offset marketers programme would be limited to the ‘big-5’, b) the co-operatives still enjoy significant transaction cost advantages, and c) this assumes that banks are not profit extracting. The sensitivity analysis in Section 3.3.2 makes the full-implications of these differences abundantly clear.
Finally, consider the Co-op and SDS scenarios. The demand and supply curves for the SDS are identical to the Co-op curves, transaction costs have not changed. The change is in the objective function – while the oligopolists are maximizing their respective profits, the SDS maximizes producer surplus. Given its monopoly power, the SDS is able to restrict the production of offsets by 33% more than the Co-ops, almost to the purely competitive, high transaction costs level. This drives up price by 10%. The largest effects are on the distribution statistics, with consumer surplus reduced by 56%, producer surplus increased by 29%, overall welfare falling by 16% and the producer’s share of welfare increasing to 62%. Note, however, that in the SDS scenario overall welfare is still higher than the banking scenario and more than double that of the purely competitive scenario. Relative to the Co-op scenario, however, the SDS has increased producer surplus at a cost to total welfare and unit price.

3.3.2 Policy implications

Small-scale afforestation of Canadian farmland generating temporary carbon offsets could be used to meet several policy goals, including maximizing societal welfare (Wong and Alavalapati 2003), improving the scope of sustainable forestry (Smith and Applegate 2004), minimizing the cost to industries with emission reductions requirements (Van Kooten et al. 2002) and rural investment/poverty alleviation.

---

45 Sum of producer and consumer surplus.
46 Total number of forestry based offsets produced.
47 Lowest price per C offset.
48 Maximum producer surplus.
(Sirohi 2007). The choice of which of these goals should be the primary objective of climate change mitigation policy is a question of ideology, not of objective economic rationality. The institutional frameworks here examined have been ranked in Table 3.3 as to how they have met those possible goals (1 being the best performer) based on the results from Table 3.249.

**Table 3.3 – Evaluating aggregation scenarios according to diverse policy goals**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Welfare</th>
<th>Forestry</th>
<th>Cost</th>
<th>Rural investment</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3.25</td>
</tr>
<tr>
<td>Banking</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Co-op</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>SDS</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

If the total welfare of market participants is the policy goal, the Co-op institutional framework is superior (19% greater welfare than the second best option). Interestingly, the Co-op scenario is also the most egalitarian, with a 47-53% split between producers and consumers. If environmental concerns (maximizing afforested area) are paramount, the Co-op scenario is still superior, though now tied with the banking option. The same Banking option, not surprisingly, minimizes the cost of climate change mitigation, in which category the SDS scenario fares particularly poorly. The SDS is noticeably superior, however, if rural investment is the primary consideration.

---

49 If the difference between values was < 1%, an equal rank was given.
Given the current state of uncertainty in Canadian climate change mitigation policy, it is not clear which of these policy options will be favoured. However, given a precautionary decision metric (one which selects a scenario based on its ranking over each of the possible policy goals)\textsuperscript{50}, one institutional framework does stand out. Beginning with the crude approach of simply averaging the ranking scores, the Co-op scenario has the lowest (best) score, though it does not distance itself from either the Banking or the SDS options. If a filter such as eliminating all “bad” options is applied (that is, removing any institutional framework that has a 3 or 4 ranking), the Co-op scenario is the only that remains. Similarly, choosing the option that maximizes “good” ranks (1 or 2) recommends the Co-op scenario (with the SDS second). Finally, choosing the option that has the most “best” (1) ranks again favours the Co-op (though the Banking option ties it). A precautionary approach therefore indicates that a Co-op scenario is preferable. Further, the Baseline, institution-free option is clearly a worst case scenario: a high cost, low production option with the lowest welfare, environmental and rural benefits in the comparison.

The sensitivity of these results to various model assumptions provides further clarification of this point, the results of which are in Table 3.4 (all changes are made relative to the initial model parameters, ranks are in parentheses).

\textsuperscript{50} Recommending a precautionary decision metric is itself, of course, a matter of ideology, promoting the value of “playing it safe”. That is, the information costs of identifying the policy recommendation most likely to result in a defended PhD dissertation, a published paper, or private/public sector employment are too high to identify the most efficient outcome.
Table 3.4 – Sensitivity analysis of aggregation scenarios

<table>
<thead>
<tr>
<th></th>
<th>q (Mt-CO₂e)</th>
<th>p ($/t-CO₂e)</th>
<th>CS (*10⁶ $)</th>
<th>PS (*10⁶ $)</th>
<th>CS+PS (*10⁶ $)</th>
<th>PS/(CS+PS) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>θ reduced to 25%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>16.43 (4)</td>
<td>5.42 (1)</td>
<td>8.67 (3)</td>
<td>5.53 (4)</td>
<td>14.20 (4)</td>
<td>39</td>
</tr>
<tr>
<td>Banking</td>
<td>26.28 (1)</td>
<td>5.39 (1)</td>
<td>22.18 (1)</td>
<td>9.12 (3)</td>
<td>31.30 (3)</td>
<td>29</td>
</tr>
<tr>
<td>Co-op</td>
<td>26.25 (1)</td>
<td>5.69 (2)</td>
<td>22.11 (1)</td>
<td>19.68 (2)</td>
<td>41.79 (1)</td>
<td>47</td>
</tr>
<tr>
<td>SDS</td>
<td>17.46 (3)</td>
<td>6.25 (3)</td>
<td>9.78 (2)</td>
<td>25.33 (1)</td>
<td>35.11 (2)</td>
<td>62</td>
</tr>
<tr>
<td><strong>θ increased to 75%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>16.43 (3)</td>
<td>6.27 (3)</td>
<td>8.67 (3)</td>
<td>5.53 (4)</td>
<td>14.20 (4)</td>
<td>39</td>
</tr>
<tr>
<td>Banking</td>
<td>26.28 (1)</td>
<td>5.84 (1)</td>
<td>22.18 (1)</td>
<td>9.12 (3)</td>
<td>31.30 (3)</td>
<td>29</td>
</tr>
<tr>
<td>Co-op</td>
<td>26.25 (1)</td>
<td>5.94 (2)</td>
<td>22.11 (1)</td>
<td>19.68 (2)</td>
<td>41.79 (1)</td>
<td>47</td>
</tr>
<tr>
<td>SDS</td>
<td>17.46 (3)</td>
<td>6.50 (4)</td>
<td>9.78 (2)</td>
<td>25.33 (1)</td>
<td>35.11 (2)</td>
<td>62</td>
</tr>
<tr>
<td><strong>No TAC benefits from aggregation (Banking n decreases to 185)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>16.43 (1)</td>
<td>5.85 (1)</td>
<td>8.67 (1)</td>
<td>5.53 (3)</td>
<td>14.20 (1)</td>
<td>39</td>
</tr>
<tr>
<td>Banking</td>
<td>16.43 (1)</td>
<td>5.85 (1)</td>
<td>8.67 (1)</td>
<td>5.53 (3)</td>
<td>14.20 (1)</td>
<td>39</td>
</tr>
<tr>
<td>Co-op</td>
<td>13.71 (2)</td>
<td>6.02 (2)</td>
<td>6.04 (2)</td>
<td>7.82 (2)</td>
<td>13.86 (2)</td>
<td>56</td>
</tr>
<tr>
<td>SDS</td>
<td>9.70 (3)</td>
<td>6.28 (3)</td>
<td>3.02 (3)</td>
<td>9.11 (1)</td>
<td>12.13 (3)</td>
<td>75</td>
</tr>
<tr>
<td><strong>TAC aggregation benefit reduced to 35% (Banking n = 242)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>16.43 (3)</td>
<td>5.85 (2)</td>
<td>8.67 (3)</td>
<td>5.53 (4)</td>
<td>14.20 (3)</td>
<td>39</td>
</tr>
<tr>
<td>Banking</td>
<td>21.25 (1)</td>
<td>5.74 (1)</td>
<td>14.49 (1)</td>
<td>7.27 (3)</td>
<td>21.76 (2)</td>
<td>33</td>
</tr>
<tr>
<td>Co-op</td>
<td>19.80 (2)</td>
<td>5.93 (3)</td>
<td>12.58 (2)</td>
<td>13.04 (2)</td>
<td>25.62 (1)</td>
<td>51</td>
</tr>
<tr>
<td>SDS</td>
<td>13.49 (4)</td>
<td>6.33 (4)</td>
<td>5.84 (4)</td>
<td>16.05 (1)</td>
<td>21.89 (2)</td>
<td>73</td>
</tr>
<tr>
<td><strong>Banking TAC = 0.50 $/t-CO₂e (Banking n = 364)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>16.43 (4)</td>
<td>5.42 (1)</td>
<td>8.67 (4)</td>
<td>5.53 (4)</td>
<td>14.20 (4)</td>
<td>39</td>
</tr>
<tr>
<td>Banking</td>
<td>31.49 (1)</td>
<td>5.48 (2)</td>
<td>31.83 (1)</td>
<td>11.05 (3)</td>
<td>42.88 (1)</td>
<td>26</td>
</tr>
<tr>
<td>Co-op</td>
<td>26.25 (2)</td>
<td>5.69 (3)</td>
<td>22.11 (2)</td>
<td>19.68 (2)</td>
<td>41.79 (2)</td>
<td>47</td>
</tr>
<tr>
<td>SDS</td>
<td>17.46 (3)</td>
<td>6.25 (4)</td>
<td>9.78 (3)</td>
<td>25.33 (1)</td>
<td>35.11 (3)</td>
<td>72</td>
</tr>
<tr>
<td><strong>TAC = 2.50 $/t-CO₂e (relative reductions maintained, Banking n = 242)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>7.87 (4)</td>
<td>6.00 (3)</td>
<td>1.99 (3)</td>
<td>2.54 (4)</td>
<td>4.53 (4)</td>
<td>56</td>
</tr>
</tbody>
</table>
Banks charge a service fee of 1.50 $/t-CO$_2$e.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Banking</th>
<th>Co-op</th>
<th>SDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16.43 (3)</td>
<td>8.83 (4)</td>
<td>26.25 (1)</td>
<td>17.46 (2)</td>
</tr>
<tr>
<td></td>
<td>5.85 (1)</td>
<td>5.98 (2)</td>
<td>5.82 (1)</td>
<td>6.38 (3)</td>
</tr>
<tr>
<td></td>
<td>8.67 (3)</td>
<td>2.50 (4)</td>
<td>22.11 (1)</td>
<td>9.78 (2)</td>
</tr>
<tr>
<td></td>
<td>5.53 (3)</td>
<td>2.86 (4)</td>
<td>19.68 (2)</td>
<td>25.33 (1)</td>
</tr>
<tr>
<td></td>
<td>14.20 (2)</td>
<td>5.37 (3)</td>
<td>41.79 (1)</td>
<td>35.11 (1)</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>53</td>
<td>47</td>
<td>72</td>
</tr>
</tbody>
</table>

With respect to the distribution of transaction costs ($\theta$), Equations 11 and 13 indicate that the overall share of transaction costs does not affect the optimal production level, consumer nor producer surplus in any of the policy options. However, it does change the equilibrium price depending on the magnitude of the total transaction costs, as differentiating Equation 2 shows in Equation 14.

\[
p = a - (1 - \theta)TAC - bq \rightarrow \frac{\partial p}{\partial \theta} = TAC
\]  

(14)

As a result, when the share of transaction costs borne by producers is reduced from 50% to 25%, price will fall by 0.25($TAC$), and will rise by the same amount if $\theta$ is increased to 75%. Ceteris paribus the Co-op and SDS scenarios are more robust to assumptions about transaction costs distribution than Banking or Baseline. In terms of the policy rankings, the effect is limited to changing the placement of the Baseline scenario. Lowering the share of costs borne by producers to 25% raises Baseline to a tie for first with Banking rather than a tie for second with Co-op. Increasing it to 75% drops Competitive out of a tie for second into third place. SDS maintains its role as the most expensive, Banking is always number 1 and Co-op is always number 2.
With respect to transaction costs, if there is no benefit from aggregation whatsoever (that is, $TAC = 1.70$ $$/tCO_2e$ for all scenarios) then, not surprisingly, Banking becomes indistinguishable from Baseline and the Co-op and SDS options are outperformed in terms of price, quantity, consumer surplus and total welfare. Their only advantage occurs if rural development is the primary policy goal of small-scale afforestation, and even that at a significant welfare cost and to a smaller number of producers. If a benefit to aggregation remains, yet that benefit is reduced from a 70% $TAC$ reduction to a 35% reduction, the advantages of the institutions remain, but the differences in values between all institutions and the competitive scenario and between the aggregating institutions themselves, are decreased. While this leaves the rankings for the Competitive and Banking scenarios unchanged, it results in the Co-op dropping out of a tie for number 1 in quantity of offsets produced that it had previously held with Banking and out of a tie for number 2 in price that it had previously held with Competitive. Further, SDS drops out of second for quantity produced behind the Competitive scenario. Under this new ranking, Banking and Co-op have the same (best) average rank. Banking has more best rankings, but Co-op continues to have a higher sum of best and second best rankings, as well as a lower sum of 3 and 4 rankings. At mitigated aggregation benefits then, it becomes much more difficult to choose between a Banking and Co-op institutional framework with a precautionary decision rule.

Though it is unclear how this would occur, it is worth testing the assumption that only Co-ops and SDSs would receive benefits for monitoring and verification. If it is instead
assumed that banks would be able to generate the same transaction costs reductions as Co-ops and SDSs, then Banking gains a clear advantage over the other scenarios, taking over sole possession of the first rank in the welfare, forestry and cost categories, and maintaining its third rank in rural development. Banking now has the best average rank and more best rankings, though Co-op continues to have a higher sum of best and second best rankings (scoring 2 in all four categories), as well as a lower sum of 3 and 4 rankings. These results may be particularly troubling for proponents of rural development, under which Banks, even in this generous formulation, score poorly.

A final test of changes to the $TAC$ variable is in order, increasing $TAC$ to what can safely be called a maximum level, to 2.50 $$/t\text{-CO}_2$e.$^{51}$ Since transaction costs are reduced by only part of the total for the Banking scenario, the effect of increasing total transaction costs is to increase the gap between $TAC$ in the Banking scenario and $TAC$ in the Co-op and SDS scenarios. With respect to the original rankings, those for price and producer surplus remain unchanged. In terms of quantity, significantly lower $TAC$ enables the Co-op to expand production past that of Banking, yet this high level still represents an exercise in production limiting market power to increase price. With respect to overall welfare, the gap between the transaction costs faced by the SDS and the banks enable the SDS to extract such a large producer surplus that it takes over the number 2 rank. These combined adjustments to the rankings serve to deepen the Co-op institutional framework’s advantage over the others in achieving the suite of policy options.

$^{51}$ The relative impact of reducing $TAC$ to 0 (or some other low value) would be the same as eliminating the aggregation benefits on $TAC$, which has already been addressed.
The primary effect of all the changes to TAC can be summarized simply: if the treatment of transaction costs is adjusted to decrease the advantage held by the Co-op framework over the Banks (reduced benefits to transaction costs from aggregation or overall reduced transaction costs) then it becomes difficult to distinguish the performance of Banking from the performance of Co-op. However, if the treatment of transaction costs results in an increase in the advantage held by Co-op over Banking (overall increased transaction costs) then the Co-op maintains its overall policy dominance.

The results of one final sensitivity test are displayed in Table 3.4. To this point, none of the institutions described extract profit from their role as a distribution house for afforestation generated offsets. While it is not unreasonable to assume that Canadian Co-ops or an SDS would be non-profit organizations, distributing all benefits (less costs) to producers, it is not conceivable that banks would act in a similar manner. Esuola and Weersink (2006) propose an approximately 25% mark-up by the bank on the price paid to the producer to compensate the bank for its services and regular profit. In this model, a simple increase in price by 25% can be represented by adding a new component to TAC associated only with the Banking scenario called Banking Fee, determining the model results, calculating 25% of the equilibrium price and then iteratively adjusting the Banking Fee until it is 25% of the equilibrium price.\footnote{Banking Fee is applied equally to both producers and consumers, that is, it will be applied as a component of TAC before it is multiplied by $\theta$.} In this case, this would be equivalent to charging 1.50 $/tCO_2e$ at a trading price of 5.98 $/tCO_2e$. As Table 3.4
shows, once banks begin to extract profit for their services, their performance as a policy tool weakens considerably. Further, a Banking Fee of 1.50 $/tCO₂e is greater than the original modeled transaction costs benefit of the Banking scenario (0.80 $/tCO₂e less than Baseline). To assume that banks would only charge a fee of 0.80 $/t- CO₂e is equivalent to assuming that they will only attempt a 15% mark-up. This, too, would only bring the Banking scenario’s performance into equivalence with the Baseline scenario, still poorer than the Co-op scenario for all policies and poorer than the SDS scenario for all policies but cost minimization.

Some researchers (notably Boycko et al. 1996, Carter and Loyns 1996 and Shirley and Walsh 2000) have objected that sub-private aggregating institutions such as SDSs and Co-ops are not cost efficient. While the criticisms of Boycko et al. (1996) and Shirley and Walsh (2000) are specific to SDSs whose objective functions include maximizing government revenue and Ministry profiles in less economically developed countries (and are therefore inapplicable in this case) the criticisms of Carter and Loyns (1996) are specific to the Canadian context, in particular the case of the Canadian Wheat Board (CWB). They describe a series of cost inefficiencies (relative to private multinational grain corporations) and argue that these inefficiencies lower producer welfare relative to a competitive market. Schmitz et al. (1997) and Schmitz and Furtan (2000) address these alleged inefficiencies point by point, but essentially argue that Carter and Loyns (1996) misrepresent both the Canadian grain industry (applying costs to the CWB that are not under its control) and the U.S. grain industry (by postulating savings that multinational grain corporations do not report). As a result, cost inefficiencies alleged by Carter and
Loyns (1996) exist primarily because of weakness in Canadian infrastructure or policy, and would remain even in the absence of an SDS.\textsuperscript{53} Regardless, as in the Banking Fee case examined here, Co-ops or an SDS would have to have additional inefficiencies relative to Banks of 1.20 \$/tCO\textsubscript{2}e to equal the cost performance of the Banking scenario assuming the banks would only extract 15\% of the traded value of the offset as fees (that is, a complete elimination of the transaction costs benefits of aggregation). This represents a loss of 20\% of the equilibrium value of the offset to inefficiency. It is not clear why a Co-op would be so much less efficient than a bank when membership is as large as the Co-ops under consideration here (approximately 60 members per Co-op in the original scenario).\textsuperscript{54}

### 3.4 Conclusions

Various institutional frameworks for small-scale afforestation generated temporary carbon offsets in Canada have been proposed as alternatives to a purely competitive market (including banking, cooperatives and single-desk sellers), and each can be ranked as the best Canadian option depending on the policy goal under consideration. That is, banking is the best institution for minimizing unit price, cooperatives are preferable for maximizing welfare and single-desk sellers have an advantage in maximizing producer welfare, while banks and cooperatives tie for maximizing total offset production.

\textsuperscript{53} The responses of Schmitz \textit{et al.} (1997) to the cost-inefficiency claims were explicitly accepted by Hon. Mr. Justice Muldoon in the Charter Case of 1997.

\textsuperscript{54} Furthermore, this analysis has assumed that the distribution of benefits within the Co-op, SDS and banks are themselves costless. It is not plausible to believe that the Co-ops’ distribution costs would be higher than the sum of the banks’ distribution costs and profit taking, so the advantage of the Co-op scenario remains.
However, given the uncertainty of current Canadian climate change mitigation policy, it is prudent to select a precautionary decision-rule before favouring a given institutional framework. In the modelling exercise described here, simple averages of ranks, eliminating institutions that receive ranks of 3 or 4 and selecting the option that has the highest number of 1 or 2 ranks across all policy options favour the cooperative approach. This derives from the ability of cooperatives to reduce transaction costs (specifically monitoring and approval costs) through aggregation to a greater degree than banks, while also exercising market power in limiting production so as to increase producer surplus. If the gap between the transaction costs facing cooperative members relative to banks decreases, precautionary decision-rules cannot consistently distinguish between the cooperative and banking scenarios. However, this difficulty only exists if banks act as non-profit agents – even low levels of profit extraction by the banks result in significant out performance by cooperatives across all policies considered here unless large unknown inefficiencies within cooperatives exist. Given the important role of ideology which acts in the selection of marketing institutions in society, it is not clear that competition between these various options would necessarily result in the co-operative scenario being selected over a period of competing parallel marketing institutions for afforestation generated carbon offsets. This is particularly the case given that climate change mitigation policies are largely the result of the actions of a particular subset of participants in public society: members of provincial and national government bureaucracies. The role of this group, and any particular ideologies it may possess for climate change mitigation policy, must therefore be identified. Chapters 4.0 and 5.0 will undertake that task.
A key construct... is a principle called “governmentality” – the idea that societies, economies, and government bureaucracies respond in a more or less reflexive, straightforward way to policies and plans. In this conception the state apparatus is seen as a neutral instrument for implementing plans, while the government itself tends to appear as a machine for providing social services and engineering economic growth.

James Ferguson (1994, p. 194)

Chapter 4.0: Political sustainability and the effects of modelling assumptions on the spatial distribution of afforestation for carbon sequestration in a federal context

4.1 Introduction

In the previous chapter, while identifying the various production, price and distribution effects of various institutions in the Canadian afforestation generated carbon offset market, I established that, due to transaction costs, ideology becomes a pivotal element in the choice of policy instruments: different institutions are “optimal” depending on the value system of the policy maker. In this chapter, a similar modelling exercise will be performed, but rather than focusing on the distributional differences between producers and consumers, the spatial distribution of the returns to producers will be emphasized. Not only will further questions of the distributive effects of policy options be considered, but the inherently political nature of government action will be explored. Simply put, there are no apolitical government actions. This is not to accuse government program coordinators, policy makers or researchers of corruption, it is to recognize the important distributive effects of government policy, effects that tug on the webs of power which

\[55\] A significant portion of this chapter is currently under review for publication under the same title by myself, Denys Yemshanov and Dan McKenney.

\[56\] In this paper it is assumed that all producers are selling into markets governed by the same marketing institutions, resulting in the same transaction costs for producers. As such, transaction costs themselves do not contribute to this analysis as they would not have distribution affects between producers, and so are not treated here.
pervade human society, tugs that are resisted when individual or group interests are perceived to be threatened. For, while creating climate change mitigation policies may be relatively easy, creating them such that they are timely, effective and palatable to a strong majority of citizens (and thereby politically sustainable) in a multinational federation such as Canada is much more challenging.\textsuperscript{57} In particular, the tension between provincial autonomy and federal cooperation have “darker sides” which are in evidence in Canadian climate change policy debate. Simeon (2001) outlines the risk associated with excessive emphasis on cooperation as watering down policies to the point that they are no longer effective, while similarly leading to excessive delay – ignoring the legitimate policy concerns of the citizenry. Jaccard \textit{et al.} (2006) have demonstrated ably that this is the case with regards to all federal Canadian climate change policy since before the Rio Earth Summit, including the Green Plan (1990), the National Action Program (1995), the Action Plan (2000), the Climate Change Plan (2002), Project Green (2005) and EcoENERGY (2007). Not surprisingly, this federal policy failure has resulted in several Canadian provinces pursuing a series of autonomous actions: British Columbia has introduced a much debated carbon tax, Alberta a provincial carbon offset system, while Ontario, Quebec and Manitoba have joined British Columbia in the Western Climate Initiative – a cap-and-trade system which is slowly expanding to include some of the largest regional economies in North America. This growing climate change policy autonomy among Canadian provinces is broadly reflective of the situation in the United States, though at a slower pace (Rabe 2008, Rabe 2007).

\textsuperscript{57} The authors recommend the highly readable \textit{Hot Air: Meeting Canada’s Climate Change Challenge} (Simpson \textit{et al.} 2007) for descriptions of how easy it is for federal governments to create exceedingly palatable climate change mitigation policies that are neither timely nor effective.
However, autonomy has its “darker side” as well. Particularly, when not buttressed by inter-jurisdictional cooperation, it can lead to a “narrowly focused struggle for political popularity… credit-seeking, and to an artificial heightening of regional tensions as governments seek to mobilize their voters behind them” (Simeon 2001, p. 151). Considering regional tensions in Canada exist already (particularly between Ontario and the Prairie provinces) it would be concerning if the recent move towards autonomous provincial climate change policy resulted in this scenario. Given the expansion of regionally focused climate change markets and programs (e.g. the Chicago Climate Exchange, the Western Climate Initiative, the New South Wales Greenhouse Gas Abatement Scheme and the European Union Emissions Trading Scheme) the potential for climate change policy to deepen divisions within federally oriented Canada, the United States, EU and Australia must be considered (Hamilton et al. 2008, Rabe 2008).

Furthermore, since demand for timely, effective and palatable federal climate change policy solutions continues to be strong (Rabe 2008, Jaccard and Rivers 2007), the risk that long-anticipated federal policies will be layered on top of competing autonomous solutions and further enflame division and decrease the stability and effectiveness of climate change policy in general must be considered very real.

This chapter continues my focus within this dissertation on a single element of the suite of climate change mitigation policies (afforestation generated carbon sinks) in a single country (Canada). In particular, I will show that minor variations in policy requirements (the specification of certain types of growth and yield curves, project duration and discount rates) lead to changes in the inter-regional distribution of benefits (as opposed to
the inter-sector distribution of benefits). Given the failure (to date) of federal climate change policy in Canada and the multitude of autonomous paths being pursued by Canadian provinces, it can safely be assumed that such minor variations in policies will exist throughout the federation and that they will deepen pre-existing divisions.

### 4.2 Modelling Afforestation

A few words on afforestation modelling are necessary. Afforestation generated carbon sinks have long been promoted as a cost-effective supplement to decreases in greenhouse gas emissions in Canada (Forest Sector Table 1999, Van Kooten et al. 1999). As Canada lurches towards a federal climate change mitigation plan, it has become clear that afforestation will play some role, given its popularity in various provinces (British Columbia 2004, Alberta 2007, Ontario 2007). For as long as the carbon benefits of plantations have been recognized, so has the importance of reliable models that can accurately and precisely predict the amount of carbon sequestered into various pools (Kurz and Apps 1999, Masera et al. 2003). Two different streams of model development can be identified: the first concentrates on incorporating as much of the nuance of the local biophysical and economic conditions pertinent to a carbon plantation as possible into a single model. The key variables in this integrated stream include discount rates, growth and yield (GY) curves, expansion factors, climatic variables, harvesting rules and market prices, among others. Integrated approaches have proven to be successful in establishing the benchmark costs of carbon sequestration via afforestation, but typically require large amounts of data taken from what are essentially point sources and averaged
over an entire country or region to produce their outputs, leading to misplaced concreteness in the interpretation of results, which are then used to justify various climate change mitigation policies (e.g. Biggs and Laaksonen-Craig 2006, Van Kooten et al. 2002, Nordhaus 1991, Xu 1995).

Importantly, many of the biophysical and economic variables used in integrated assessments are not spatially homogeneous and reveal significant geographical variation, including tree growing conditions (Joss et al. 2008); plantation costs (Yemshanov et al. 2005); land opportunity costs (Stephens et al. 2002) and carbon sequestration potential (Kurz and Apps 1999). At a national scale, the summation of this variability introduces spatial variation not apparent from integrated assessments. As a result, a second stream of modelling has arisen, that while largely accepting the basic elements of integrated models, has incorporated this necessary geographically variable approach. This spatial stream has focused on identifying break-even prices, opportunity costs and locating the most profitable areas for potential carbon plantations within a national or provincial context.

Unfortunately, precious little attention has been paid to a necessary third stream which requires the incorporation of the insights of the integrated and spatial streams. This third stream would study the socioeconomic distributional implications of the spatial effects of the range of values identified in integrated modelling, and may be referred to as a political stream. Within the Sustainable Forest Management paradigm, the integrated and spatial modelling approaches are adequate to support environmental and economic
sustainability, but do not provide the necessary data to promote political (or social) sustainability (Kant 2007). It is this political sustainability that is particularly affected by conflicts between autonomy and cooperation in a federal system. Specifically in Canada, with provinces possessing constitutional control over “natural resources” while the federal government maintains a large ministry and legislation dedicated to the “environment,” politically sustainable solutions to climate change are difficult to create.

Canada not only has regionally specific political interests and significant climate change mitigation commitments, but also abundant marginal farmland that would seem ideally suited for afforestation projects, a natural advantage which it recognized and pressed in Intergovernmental Panel on Climate Change (IPCC) negotiations (Lövbrand and Stripple 2006). As a result, it has invested over a long period of time in developing both its integrated and spatial modelling streams, yielding significant research fruit (e.g. Kurz et al. 2007, Yemshanov and McKenney 2008). This research has demonstrated (among other things) that the most likely regions for profitable carbon plantations are South-Central Ontario and the Prairie provinces of Alberta and Saskatchewan (Yemshanov et al. 2005). While a range of break-even price and carbon volume scenarios have been developed, at least as important must be the political ramifications of variations within modelling parameters, as it is political processes (both federal and provincial) that will decide where afforestation programs are promoted, whether they will have adequate budgets to succeed and which farmers will receive the benefit. If minor (and reasonable within the boundaries identified by integrated modelling) changes in model parameters favour one of these two regions over the other, then these distributional considerations
must be identified and federal climate change policies crafted so as to either recognize or redress these asymmetries in benefit if politically sustainable climate change mitigation policies are to be crafted.

4.3 Methodology

While not treated as a variable in this paper it is important to note that the impermanent nature of carbon credits must be considered as a key element in any modelling exercise (Locatelli and Pedroni 2006, Marland et al. 2001). This chapter treats impermanence by considering any offsets produced as a result of an afforestation project as temporary, that is, as having an expiry period (i.e., the minimum time required to store carbon in forest biomass) rather than producing a so-called “carbon graveyard” from which harvesting may never occur, as in the previous chapter. This is consistent with the long demonstrated dependency between the value of a given carbon offset and its biomass storage period (e.g. Locatelli and Pedroni 2003; Marechal and Hecq 2006). I utilize the commonly used “tonne-year” approach, providing credit for quantities of carbon in forest biomass for each year that the carbon stock is maintained. This results in a relative value of temporary offsets to permanently avoided emissions which is calculated using an equivalence factor (Moura Costa and Wilson 2000, Marechal and Hecq 2006) or discounting (Herzog et al. 2003). I use the discounting method to produce a conversion factor, \( F(t) \).

\[
F(t) = \frac{1}{1 - \left(\frac{1 + j}{1 + r}\right)^{\text{temp}}} \tag{1}
\]

where \( j \) is the rate of change of the price of a permanent offset (assumed here to equal
4\%), r is the discount rate, \( t_{\text{temp}} \) is the expiry date of the temporary carbon offset and \( t \in [1: t_{\text{temp}}] \). This technique has been widely used in the valuation of temporary carbon offsets (Locatelli and Pedroni 2003; 2006).

Sequestration of carbon in forest biomass typically demonstrates irregular annual flows, depending on the shape of the GY curve. As a result, carbon stored at the end of a commitment period has a different lifetime and permanence conversion value that that stored early on. Two observations result: first, that GY curves with delayed carbon accumulation (i.e. from poor-quality sites) will decrease the value of a proposed project relative normal growth rates even if the mean annual increment (MAI) over the lifetime of the project is identical. Second, high discount rates will have a similar effect, and will exacerbate it if delayed growth GY curves are used.

The annual values of \( F(t) \) can be aggregated into a permanence conversion factor for an entire project, \( F \):

\[
F = \sum_{t=1}^{T-1} \frac{F(t) \cdot C_t}{C_{\text{total}}} \tag{2}
\]

where \( T \) is the project lifetime; \( C_t \) is the carbon sequestered or emitted in a given project year, \( t \) and \( C_{\text{total}} \) is the total carbon sequestered over the reporting period.

The calculation of \( F \), \( C_t \) and \( C_{\text{total}} \) requires tracking carbon flows and economic factors (such as discounted and undiscounted cash flows) over the duration of the project. Here, I use the Canadian Forest Service Forest Bioeconomic Model (CFS-FBM), a spatial stream
model that combines a biophysical biomass and carbon model with economic cost-benefit analyses in a spatially explicit framework (Yemshanov et al. 2007). A series of biophysical models is implemented to calculate the growth rates and timber yields from forest plantations. A cost-benefit module uses these outputs, silvicultural costs and forest product prices to calculate net revenues from forestry activities and potential carbon sequestration costs. The model shares basic assumptions with the Afforestation Feasibility Model, CFS-AFM, described elsewhere (McKenney et al. 2004, McKenney et al. 2006, Yemshanov et al. 2005), however CFS-FBM uses a more precise carbon accounting module based on the integrated CFS-CBM2 model (Kurz and Apps 1999). Several studies based on the output of this model have been published on the cost estimates of carbon sequestration from forest plantations (Yemshanov and McKenney 2008, Yemshanov et al. 2007, McKenney et al. 2004) and assessing the impacts of exotic pest invasions (Yemshanov et al. in press).

While five live biomass pools were tracked (merchantable and non-merchantable wood, other biomass, saplings and roots) only total carbon estimates are included in these results, as the distribution among sinks is not germane to this discussion. The annual outputs from the biophysical carbon model are used to calculate the break-even carbon sequestration costs by summarizing the carbon flows from sequestration into a net annual value and then discounting the physical carbon over the planning horizon according to the “discounting levelization” technique of Richards and Stokes (2004) and adapted for irregular carbon flows in Yemshanov et al. (2007). In accordance with IPCC (2003) requirements, upon harvest of timber for wood products all of the aboveground carbon is
considered emitted into the atmosphere (though the emission is discounted just as is sequestration).

Assuming a unit carbon price, $p_c$ and a discounted carbon flow, $C_D$, we calculate the present value of carbon benefits, $PV_C$:

$$PV_C = C_D \cdot p_c$$ \hspace{1cm} [3]

Carbon benefits (or costs from CO$_2$ emissions) occur during the year the physical carbon is sequestered (or lost). The break-even value is the carbon unit price for which $NPV = 0$:

$$NPV = PV_F + PV_C - PV_{AG} - PV_{EST} = 0$$ \hspace{1cm} [4]

where $PV_F$ are revenues from fibre as would be calculated by a land owner net of any harvesting and thinning costs; $PV_C$ is the present value of carbon sequestration benefits; $PV_{EST}$ is the present value of plantation establishment and management costs and $PV_{AG}$ is the present value of agricultural land rental costs and represents the opportunity cost if land use is changed from agriculture to forestry (based on the annual rental values from the Canadian Census of Agriculture (McKenney et al. 2004)).

Rearranging Eq.4 and combining with Eq.3 produces the break-even carbon unit price, $p_{c0}$ in Eq. 5:

$$p_{c0} = \frac{(PV_{AG} + PV_{EST} - PV_F)}{C_D}$$ \hspace{1cm} [5]$

The $p_{c0}$ value is then converted into a permanent carbon offset equivalent using $F(t)$ from Eq.2. Most of the variables described in Eq. 2-5 were specified with geographical variation, and as a result the outputs of each equation also possess geographical variation.
The output maps were then summarized at the level of the particular region of interest (i.e., Ontario and the Prairie Provinces).

4.4 Data and Scenarios

The data for this study are based on those collected by the federal government’s “Forest-2020 PDA” Initiative (NRCan 2005) and include baseline spatial projections for hybrid poplar (McKenney et al. 2004, Yemshanov et al. 2005, McKenney et al. 2006). Key parameters include GY curves, wood prices, plantation and management costs, agricultural land opportunity costs and harvest costs (see Yemshanov et al. 2005 and McKenney et al. 2006 for further detail). The mapped data sources used include the site suitability models for hybrid poplar (Joss et al. 2008), agricultural land opportunity costs (McKenney et al. 2004) and the availability of agricultural land in Ontario and the Prairies based on satellite SPOT-VGT land classification (Latifovic et al. 2004).

I have estimated the distributional effects of three model parameters: (1) the discount rate; (2) the shape of the GY curve and (3) the age of plantation harvest. I assume that the harvest age also defines the expiry period for temporary carbon offsets. Separate model scenarios tested the combination of four discount rate values (4, 8, 12 and 16%, that cover most of the range identified in Richard and Stokes’ (2004) review of 36 distinct afforestation modelling studies). These values also reflect the existing return expectations ranging from low, suggested for forestry projects and governments (4%, Row 1982) to
relatively high values (12 and 16%) favoured by large corporate investors (Binkley et al. 2002). I evaluated four different shapes of the GY curve\textsuperscript{58} (Fig. 4.1).

\textsuperscript{58} These curves were developed by Denys Yemshanov of Natural Resources Canada for this project. Note that the shape (growth rate) of each census unit in Canada is different depending on its environmental characteristics. Those given in Figure 4.1 are included as representative examples to demonstrate the impact on the Default growth curve of each transformation.
Figure 4.1 – Sample Growth and Yield curves for the 16 year rotation age

Prairie

South and Central Ontario
The “Default” curve was adopted from the Forest 2020 assumptions (NRCan 2005) and had a shape close to sigmoidal. Three other idealized curves were created to fit the identical mean annual increment (MAI) for a given harvest age. These curves describe distinct plantation growth assumptions. The “Delayed” yield table resembles the Default scenario and describes a common case of plantation failures and delayed regeneration in the years following establishment. The “Logistic” scenario is characterized by a higher initial growth rate while maintaining the sigmoidal shape close to the Default scenario. The “Linear” scenario projects a linear growth rate for the entire project life and represents the “constant yield” case (Oliver and Larson 1996, Garcia 1989). A simple sigmoid equation was used to generate the Delayed, Logistic and Linear yield curves:

\[ Y(\tau) = \frac{1}{1 + e^{-\tau}} \]  \hspace{1cm} [6]

where

\[ \tau = \alpha \left( \frac{t}{T} - \sigma \right) - \frac{\alpha}{2} \]  \hspace{1cm} [7]

where \( T \) is the age of harvest, \( t \) is the given growth year, \( t \in [1; T] \) and \( \alpha \) and \( \sigma \) are coefficients. For Delayed, \( \alpha = 5 \) and \( \sigma = 0.3 \); for Logistic, \( \alpha = 7 \) and \( \sigma = 0 \); and \( \alpha = 0.0001 \) and \( \sigma = 0 \) for Linear. \( Y(\tau) \) was then rescaled to fit the regional mean annual increment prescribed by the Default yield curve.

I also assume that at least 25% of farmers would refuse to participate in afforestation regardless of the level of economic incentives (Van Kooten et al. 2002). This particular assumption was applied as a spatially uniform random mask eliminating 25% of the total agricultural land eligible for afforestation.
The harvest age assumptions include three possible ages of 16, 22 and 28 years, representing a range of hybrid poplar options in Canada (Yemshanov and McKenney 2008, Thomas et al. 2000). The combination of these three variables resulted in 96 distinct scenarios. Break-even prices were divided into six value ranges 0-5, 5-10, 10-15, 15-20, 20-25 and >25 $/tCO$_2$e. The final range is left open to represent “unfeasible” prices for afforestation generated carbon offsets. Given that these assets currently trade at approximately 50% the value of more permanent carbon assets a value of 50 $/tCO$_2$e emissions credits would be necessary for such a price to be feasible. Given prices for project based emissions reductions units (ERUs) averaged $8.70/tCO$_2$e$ for 2006 (Capoor and Ambrosi 2007), it would take an almost 8% annual increase in price to reach 50 $/tCO$_2$e$ by, for instance, 2030. Recall that here we assumed that $j = 4\%$. While I believe that this upper bound for competitive pricing is reasonable, this question is, of course, open for debate. Model outputs were converted into raster files to build a spatial representation of the results for the regions under consideration. These were post-processed and analyzed using the Geographical Information System software ArcView GIS 3.2.

4.5 Results

The outputs of the 96 scenarios are found in Table 4.1.
Table 4.1 – % of farmland available for afforestation but unattractive as a result of high production costs

<table>
<thead>
<tr>
<th>GY Curve</th>
<th>Region</th>
<th>Rotation Age</th>
<th>% of total farmland unattractive (&gt;25 $/tCO₂e)</th>
<th>Discount Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Default (0)</td>
<td>Ontario</td>
<td>16</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Prairie</td>
<td>16</td>
<td>64</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>40</td>
<td>56</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>Ontario</td>
<td>22</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Prairie</td>
<td>22</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-4</td>
<td>24</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Ontario</td>
<td>28</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Prairie</td>
<td>28</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>0</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>Linear (2)</td>
<td>Ontario</td>
<td>16</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Prairie</td>
<td>16</td>
<td>39</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>26</td>
<td>31</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Ontario</td>
<td>22</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Prairie</td>
<td>22</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Ontario</td>
<td>28</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Prairie</td>
<td>28</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

To interpret these data, I used a simple model to identify the impact of the three variables of interest on the break-even carbon values and the total carbon sequestration potential following Equation 8.

$$\lambda = \beta_0 + \beta_1(GY) + \beta_2(\delta) + \beta_3(H) + \varepsilon$$  [8]
Since only 3-4 distinct values were studied for each variable, I chose a linear model. The difference in the % total farmland unavailable (unavailable land has a > 25 $/tCO\textsubscript{2\text{e}} break-even price) was the dependent variable ($\lambda$). The type of GY curve ($GY$), the discount rate ($\delta$) and the harvest age ($H$) were used as the explanatory variables, and the discount rates and harvest ages took the values already identified. $GY$ was described by a dummy variable which was set to 0 for the Default “Forest 2020” GY curve, and 1 for the other growth curves, iteratively. As a result, three slightly different specifications were produced, depending on which alternative GY curve was being considered. A random error has been included to explain the variation in the project acceptance among landowners and other potential factors not incorporated in this study. The linear model is advantageous because of its simplicity and the ease of interpretability for the distributional implications. Ordinary least-squares regression was used to determine the significance and size of the coefficients, as well as the explanatory power of the model.

The difference between the % of total farmland unattractive for afforestation in each region was chosen as the dependent variable for multiple reasons. First, and particularly in the Canadian context, if the pursuit of a given policy results in individuals or communities completely excluded from benefits, this is potentially more significant for public debate than effects of the distribution of “prime” land. That is, as has long been recognized in welfare economics, the loss of an opportunity is valued more than its gain (Tversky and Kahneman 1981). Of at least as much importance, however, is that there is simply not enough land available in the best category (break-even price < 5 $/tCO\textsubscript{2\text{e}}) to which to fit a model of, for instance, the difference between the % of total land in the
prime category between each region. Even if the second best land (price between 5 and 10 $/tCO_2e) is also included with a dummy variable for location, the other explanatory variables and the dependent variable is set to % land available in the best two classes (rather than the difference) a model with explanatory power ($R^2=0.64$, results not shown) can be described but neither the regional dummy nor the intercept is significant (while the other variables are). These results would give comfort to those who would argue that distributional concerns are either unimportant or non-existent, and masks the important distributional concerns that further analysis reveal. Tables 4.2-4.4 display the results of the model described by Equation 8 with each successive Table displaying the $\beta$ values as well as their individual and group significance, and the explanatory power of the model, for a comparison between the Default GY curve and Delayed, Linear and Logistic, respectively. Note that the $p$-values are significant to $p < 0.01$ for each variable in all three formulations.

**Table 4.2 – Model results including Delayed GY curve alternative**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T Statistic (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>48.5</td>
<td>13.6</td>
<td>3.56 (1.94*10^{-3})</td>
</tr>
<tr>
<td>Discount rate</td>
<td>2.92</td>
<td>0.584</td>
<td>4.99 (6.95*10^{-5})</td>
</tr>
<tr>
<td>GY Dummy</td>
<td>-18.0</td>
<td>5.23</td>
<td>-3.44 (2.55*10^{-3})</td>
</tr>
<tr>
<td>Rotation Age</td>
<td>-1.81</td>
<td>0.533</td>
<td>-3.40 (2.87*10^{-3})</td>
</tr>
</tbody>
</table>

F statistic (significance): 16.1 (1.45*10^{-5})

Adjusted $R^2$: 0.664
Table 4.3 – Model results including Linear GY Curve alternative

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t Statistic (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>67.0</td>
<td>12.4</td>
<td>5.41 (2.68*10^{-5})</td>
</tr>
<tr>
<td>Discount rate</td>
<td>2.52</td>
<td>0.531</td>
<td>4.74 (1.25*10^{-4})</td>
</tr>
<tr>
<td>GY Dummy</td>
<td>-24.7</td>
<td>4.75</td>
<td>-5.20 (4.33*10^{-5})</td>
</tr>
<tr>
<td>Rotation Age</td>
<td>-2.47</td>
<td>0.485</td>
<td>-5.09 (5.55*10^{-5})</td>
</tr>
<tr>
<td>F statistic (significance):</td>
<td>25.2 (5.42*10^{-7})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R^2:</td>
<td>0.759</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4 – Model results including Logistic GY Curve alternative

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T Statistic (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>55.8</td>
<td>12.5</td>
<td>4.46 (2.43*10^{-4})</td>
</tr>
<tr>
<td>Discount rate</td>
<td>2.89</td>
<td>0.537</td>
<td>5.38 (2.92*10^{-5})</td>
</tr>
<tr>
<td>GY Dummy</td>
<td>-22.0</td>
<td>4.81</td>
<td>-4.58 (1.81*10^{-4})</td>
</tr>
<tr>
<td>Rotation Age</td>
<td>-2.13</td>
<td>0.491</td>
<td>-4.34 (3.17*10^{-4})</td>
</tr>
<tr>
<td>F statistic (significance):</td>
<td>22.9 (1.12*10^{-6})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R^2:</td>
<td>0.741</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Consider first the value of the intercepts ($\beta_0$) in Tables 4.2-4.4. Given that the difference being modeled is % of Prairie farmland unattractive - % of Ontario farmland unattractive, the large intercepts (> 50% in each case) demonstrate a relative advantage of South and Central Ontario over the Prairies. That is, while the Prairies have a larger area of farmland available for afforestation, the vast majority of it is unattractive (it has high break-even prices). Note further the R$^2$ and F statistics. Between two-thirds and three-quarters of all variation in the models are explained by linear sums of these three modelling parameters. This alone is enough to justify a demand for further effort into research in the “classic” elements of forest management (GY curves, rotation age and discount rate).
It is necessary to explain the difference of almost 10% between the $R^2$ that results from comparing the Default to the Delayed GY curve and those associated with the Linear or Logistic curves. A casual inspection of Figure 4.1 explains this discrepancy, however, as well as the difference between the influence of the GY dummy across all three models. That is, the Default and Delayed curves are very similar (in particular in the Prairie case) while the Linear and Logistic curves are separated from the Default curve and, though distinct, closer to each other than they are to the others. As a result, there is more variation between the Linear and Logistic curves and the Default than between the Delayed and the Default, and so ordinary least squares is able to formulate a model with greater explanatory power. Regardless, however, a shift from the Default Forest 2020 curve to any other shaped curve considered here results in between an 18 and 25% decrease in the difference of land unattractive for afforestation between the Prairies and Ontario. This is particularly significant when one considers the wide variation of GY curves that reasonable, responsible professionals can identify from the same, high quality dataset. Consider Penner (2008) in which she presents GY curves for Ontario mixed-wood stands – the spread of the data is impressive, and it does not require much in the way of imagination to fit any of the GY curve shapes considered here to her data. Furthermore, consider the range of possible shapes of environmental growth curves treated in Garcia (2005) and Garcia (2008) in which the precious little separating Richards, logistic, exponential or linear growth curves is made explicit. Finally, note that while texts continue to provide examples of a wide range of sigmoid curves to describe volume/area growth over time, a significant body of research indicates that perhaps a
linear model is best after all (e.g. Oliver and Larson 1996, Garcia 1989)! In the end we must return to the insight of Vanclay and Skovsgaard (1997) that, “the only truth that can be established in a growth model is that the model is a faithful representation of what the modeller intended (p.2).” That is, reasonable scientists can come up with reasonable but different GY curve shapes, depending on their purpose. It is those differences of purpose and their effects that policy researchers must carefully evaluate according to their contribution (or otherwise) to policy sustainability.

Other than this difference, the other two variables have comfortingly similar and highly significant values. An additional 1% in discount rate results in an additional 2.5-2.9% in the relative advantage of Ontario over the Prairies. A lengthening in rotation age by 1 year decreases the gap by another 1.8-2.5%.

4.6 Discussion

When considering the political sustainability of a given policy (or suite of policies), especially a contentious one, the distributional effects of said policy, particularly when these effects favour one set of influential stakeholders over another (e.g. Ontario vs. the Prairies) must be paid very close attention. Consider adjusting the discount rate: as opposed to being a matter of solely technical interest, it has significant social ramifications. A low discount rate (e.g. 4%) such as may characterize that applied in a
public investment\textsuperscript{59} or forestry context, will favour Prairie farmers relative to Ontario farmers. This implies that climate change mitigation policies including a component of afforestation for carbon sequestration that is heavily influenced by federal investment would distribute benefits towards the Prairie provinces. Increasing that discount rate to a higher level (e.g. 12-16\%) will increase the area potentially benefited by the policy in favour of Ontario. That is, afforestation for carbon sequestration policies which favour investment by large market actors (characterizing the major emitting fossil fuel extraction, energy generating and manufacturing firms) will shift benefits east. High discount rates usually decrease the value of delayed growth in hybrid poplar projects, for which the larger early growth rates in Ontario (compared to the Prairies) are able to compensate, resulting in a significant impact on the geographic distribution of carbon benefits. With this in mind, the choice between one carbon offset producing or marketing institution and another now has significant national benefit distribution implications, as the choice of a public (low discount rate), private (high-discount rate) or public-private partnership (intermediate discount rate) may enjoy regionally divergent support irrespective of its fulfillment of federal policy goals that put its longterm political sustainability at risk. For instance, the demise of the 1996 Softwood Lumber Agreement in 2001 was directly the result of disputes based on the regional distribution of benefits, despite the fact that it was highly profitable for each Canadian region involved in the dispute and despite the (realized) risk that the resultant countervailing action by the United States and new treaties would not be as profitable (Biggs \textit{et al.} 2006). Any

\textsuperscript{59} I take no position on the argument as to whether or not public investments \textit{should} be discounted at a lower rate than private investments as a result of the existence distortionary taxation, incomplete markets, etc. (see Arrow and Lind 1970, Baumol 1968, Grout 2003).
modelling exercise which could be foreseen to influence the creation of public policy must therefore recognize the political nature of selecting the discount rate.

The political sustainability implications of the choice of GY curve shape are similar to those of the discount rate. The Forest 2020 Default curves include a noticeably delayed distribution of growth which favours Ontario in the presence of discounting. The other formulations discussed here (even with constant MAI) distribute more benefits towards the Prairies. Ideally, the determination of tree growth dynamics for an individual project should be based on purely biophysical and silvicultural considerations and be a matter of a rather technical discussion among experts (see Vanclay and Skovsgaard 1997). However, the perception of that choice (which often starts from certain management considerations in a particular geographical location), and the fact that the distributional effects would be publicly discussed in the event of the planning of a major federal carbon policy package, makes this seemingly technical issue a critical point that could define the long-term sustainability of afforestation policies. The legislation governing the operations of Canadian Wheat Board, for instance, has repeatedly been demonstrated to provide important benefits to Prairie wheat farmers in terms of price premia, international reputation and overall product quality, without increasing inefficiency in marketing, matters which should in principle be identifiable more-or-less objectively, and have been ruled as such by the Hon. Mr. Justice Muldoon in the Charter Case of 1997 (Schmitz and Furtan 2000, Furtan et al. 1999, Lavoie 2002). However, this legislation has been under pressure for reform (and has repeatedly been reformed) for over 20 years in part because of the distribution of those benefits between Saskatchewan and Alberta farmers (Skogstad
Specialists are therefore forced to recognize that even when their decisions on the selection of the GY curve are ostensibly determined by the data alone that the political ramifications of this choice may have a profound impact on the longterm sustainability of policies incorporating their results.

Once the effect of discounting has been removed, longer harvest ages favour Prairie farmers because of their lower land opportunity costs (higher land opportunity costs in Ontario negate the higher growth rates). In real-life project applications, the harvest age is more to be influenced by the harvest choices of individual land managers. However, on the national scale, the choice of harvest age has an important institutional consideration that must be considered. The harvest age is strongly influenced by the expiry date for the carbon in the project, and that expiry date could either be institutionally set or negotiated in the event of a private transaction. If the former, the longer the expiry date the greater the pressure towards a longer harvest age, and the greater the share of the benefits captured by Prairie farmers. As a result, if the expiry date is institutionally determined at a federal level, this would have serious implications for the long-term sustainability of carbon sequestration policies in Canada.

4.7 Conclusions

One of the primary arguments in favour of a vigorous climate change mitigation policy is that of “sustainability”: that if human societies cannot achieve medium-term stability in the concentration of greenhouse gases in the atmosphere then our collective future in a
world recognizable as the one in which our cultures evolved is in jeopardy. Sustainability itself, however, is not monolithic, but requires sustainable activities in three separate spheres: the ecological, economic and political. Afforestation for carbon sequestration modelling, as a key element of Canada’s climate change mitigation policy, has produced significant fruit in establishing the expectations and the boundaries for both ecological and economic sustainability. It has, however, yet to fully contribute to discussions of the political sustainability of climate change policy. By examining the distributional effects of adjusting seemingly technical modelling assumptions (such as the discount rate, growth and yield curve shape and harvest age) I have demonstrated the potential consequences to policy sustainability in a federal context. In the Canadian federation, Ontario and the Prairies are not the only political cleavages that distributional effects could inflame. In the context of the United States, for instance, poorly designed federal policies that fail to recognize the autonomous actions of individual states could deepen already existing divides between North and South, or Blue and Red states. Furthermore, this analysis has not even touched on the wide variety of other technical elements associated with afforestation, such as permanence, baseline, monitoring and planning requirements that would presumably have noticeable distributional effects, and afforestation remains only one relatively small element of climate change policy. It is clear that given the rise of autonomous regional climate change policies, the necessary task of crafting politically sustainable federal climate policies has become much more challenging. A possible response in the Canadian and United States context to the problems outlined in this paper would be to abandon federal level climate change policy altogether, allowing states and provinces to pursue completely autonomous and
asymmetric climate change policies. While this may avoid the distributional concerns associated with federal policy outlined here it is also tantamount to recommending a complete abandonment of the federal project. Furthermore, though not a focus of this paper, geographically asymmetric distribution exists within provinces and states as well, particularly those as large as many found in Canada and the United States (e.g. Ontario and California). Further research in modelling the distributive effects of climate change policies, be they federal or provincial, is clearly necessary to ensure the long-term political sustainability of such policies.

It is clear from this analysis that regardless of the intent of federal researchers and policy makers, and irrespective of the degree of objectivity placed into their establishment, that the choice of modelling parameters such as GY curve, discount rate and rotation age has inter-provincial distribution effects with powerful implications for policy sustainability. In particular, given that little in the data “objectively” support the choice of a sigmoidal as opposed to a linear GY curve, or a 4% versus an 8% discount rate, choices in this regard will be largely based on the shared frameworks and mental models of the policy makers, that is, their ideology. Identifying some aspects of that ideology with respect to afforestation generated carbon offset projects is the task of Chapter 5.0.
I]t is the characteristic of man [sic] to do something, not simply to suffer pleasures and pains through the impact of suitable forces. He is not simply a bundle of desires that are to be saturated by being placed in the path of the forces of the environment, but rather a coherent structure of propensities and habits which seeks realization and expression in an unfolding activity. According to this view, human activity, and economic activity among the rest, is not apprehended as something incidental to the process of saturating given desires. The activity is itself the substantial fact of the process, and the desires under whose guidance the action takes place are circumstances of temperament which determine the specific direction in which the activity will unfold itself in the given case.... Economic action is teleological, in the sense that men [sic] always and everywhere seek to do something. What, in specific detail, they seek, is not to be answered except by a scrutiny of the details of their activity; but, so long as we have to do with their life as members of the economic community, there remains the generic fact that their life is an unfolding activity of a teleological kind.

Thorstein Veblen (1898a)

Chapter 5.0: Ideologies of policy makers in the attractiveness of carbon offset generating afforestation projects

5.1 Introduction

In the previous chapter I demonstrated that the action of establishing the basic values of variables in a modelling exercise for the development of guidelines to govern the production of afforestation generated carbon offsets in the service of a larger climate change mitigation policy is an inherently political act. That is, it is an act dependent upon and reinforcing systems of power, control and resistance. This is not to impute some ill-will, Machiavellianism, or other form of conspiracy onto the hearts of government researchers and policy makers, rather it is to recognize, as has been so difficult for many in the economics community, Foucault’s fundamental observation that exercises in power are actions which “structure the field of other possible actions” (Foucault 1982). Given the sectoral and spatial cleavages that subtle differences in marketing institutions (Chapter 3.0) and modelling parameters (Chapter 4.0) would have on the distributional
and production outcomes of the Canadian afforestation generated carbon offset market, and that the ultimate implementers (government employed researchers and policy makers) of these actions are largely immune to these effects, I take this point to be well established.

However, given the equally well established point that the “shared frameworks of mental models” (that is, the ideologies) of researchers and policy makers are the foundations upon which the choices of marketing institutions and modelling parameters are built, it is necessary to follow the advice of Veblen which introduces this chapter and examine these ideologies in “specific detail” (North 1994). In keeping with the stated goal of this dissertation to examine the role of institutions in the Canadian afforestation generated carbon offset market, ideologies associated with the ideal design of such afforestation generated carbon offset projects will be examined. The tool that will be used to identify these ideologies (and their spatial variation) is multi-criteria analysis as practiced in a survey of provincial government researchers and policy analysts (hereafter referred to as “policy makers”) employed in ministries focused on what can loosely be called “environmental” matters. The analysis will respond to several matters critical to climate change mitigation policy, identifying variations in ideology relating to offset permanence, market clarity, the role of the Kyoto Protocol, opportunities for profit and region as foundational to informing what sorts of afforestation generated carbon offset projects policy makers prefer. Simultaneously questions of biodiversity, asset flexibility, national policy and monitoring will be shown to be much less influential in decision making, while planning requirements, market facilitating institutions and, importantly, transaction
costs, will be shown to be nearly completely unimportant in informing policy makers as to what sort of carbon offset generating projects are preferable.

5.2 Multi-criteria analysis

Given the SFM framework elaborated in Chapter 4.0, the complexity of influences informing the ideology of an individual (or group of) policy maker(s), and the detailed analysis in which I desire to engage, a flexible tool capable of both identifying the breadth of potential values and providing the level of quantification necessary to engage in a statistically relevant analysis is necessary. In the context of SFM, multi-criteria analysis provides such a framework, through value identification in surveys and interviews, rather than through other stated preference techniques, such as contingent valuation (CV) approaches which aim to identify willingness-to-pay. While CV techniques in eliciting non-marketed forest values have become standard, they have increasingly been subject to critique (Carlsson and Martinsson 2001).\(^{60}\) First, non-marketed forest goods are multi-dimensional and complex, making large computational requirements on individuals when they are asked to value them, computational requirements that have repeatedly been demonstrated to be beyond the scope of most survey respondents (Tversky and Kahneman 1981, Mazotta and Opaluch 1995). Multi-criteria analysis, on the other hand, allows informants to identify different values for many parts of the good in question, before making a combination of those parts (Gregory and Slovic 1997). Second, the question as to whether all goods can be translated into

\(^{60}\) Only certain problems associated with CV that are germane to this paper will be discussed here. Readers are recommended to Gregory and Slovic (1997) or Kant and Lee (2004) for a more thorough critique.
monetary terms and integrated into a single willingness-to-pay value remains no less valid for its repetition (e.g. Kant and Lee 2004). Multi-criteria methods, on the other hand, allow the expression of preference, on common scales, without requiring conversion to monetary terms (e.g. Ananda and Herath 2003). Finally, whether preferences for unfamiliar or hypothetical choices actually exist is open to significant debate. Gregory and Slovic (1997) review a number of cases which demonstrate that in these types of situations, preferences are established during the process of filling out the survey, as a response to cues within the value eliciting instrument itself. By providing a relatively large number of potential values, multi-criteria approaches allow informants to construct their preferences while reflecting on all the elements that inform their ideology, rather than a small subset (i.e. money).

In this study, therefore, multi-criteria analysis was used. Specifically, the preferences of policy makers were identified through the use of a survey which aimed to answer the following questions:

1. Which criteria for afforestation generated carbon offset projects are more important for policy makers in informing their preferences for certain types of projects? That is, what is the basic ideology informing how such projects should be designed?

2. Is spatial variation present in these criteria? That is, are ideological differences between policy makers partially explained by location?

3. Does the method of analysis in analyzing the data reveal different preferences? If so, which methods provide the “best” description of preference?
The following section describes the survey itself, and the analytical techniques applied, in detail.

5.3 Methodology

5.3.1 The survey

The survey was distributed by email to informants in August and September 2008. The contact information for informants was collected from those published online from websites operated by various provincial ministries oriented to “environmental” foci. Given that (as discussed in Chapter 4.0) the regions most likely to host afforestation generated carbon offset projects in Canada are Alberta, Saskatchewan and Ontario, informants were limited to these regions. Managers, researchers, economists, policy analysts and policy advisors from the Ontario Ministry of the Environment; Ontario Ministry of Natural Resources; Ontario Ministry of Agriculture, Food and Rural Affairs; Alberta Ministry of the Environment; Alberta Ministry of Sustainable Resource Development; Alberta Ministry of Agriculture and Rural Development; Saskatchewan Ministry of the Environment; and Saskatchewan Ministry of Agriculture were invited to participate. Not including invalid email addresses, 453 policy makers were invited to participate, and 61 completed the survey, for a response rate of 13.5%. The survey was

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61 The methodology in this study is based on that of Sell et al. (2007) in their study of payments for ecosystem services based tropical forestry projects, with minor variations.

62 While this rate is relatively low (compare to the 20% response rate of Sell et al.) the primary problem this would create would occur if the analysis was unable to detect significant differences between groups and ideologies. The succeeding analysis and discussion indicates quite clearly that significant differences do
filled out on the computer and required an average of 10 minutes, 30 seconds to complete. Participants were informed that their responses would be treated anonymously and were given an opportunity to contact the lead researcher (via email) to ask clarifying questions – none of the informants did so.

After a series of questions soliciting personal information\textsuperscript{63}, preferences for afforestation generated carbon offset projects were identified in two sections. In the first, two hypothetical projects were described according to a set of 11 criteria, which had been identified from the wide academic literature on afforestation generated carbon offsets as important elements in project design (see Table 1). The projects were described such that one of them performed well in 5 of the criteria\textsuperscript{64} (which I associate with “environmental integrity”), and poorly in another 5 criteria\textsuperscript{65} (which I associate with a “business opportunity”), while the other project performed well in the business opportunity criteria, and poorly in the environmental integrity opportunity. The former project will hereafter be referred to as “environmental integrity” and the latter as “business opportunity”, though it should be noted that the projects did not bear these appellations in the survey, they were simply labeled “Project 1” and “Project 2”. I was uncertain which element of the remaining criterion (type of market facilitating institution) would be perceived as

\textsuperscript{63} These included age, sex and whether the informant considered him- or herself informed on climate change, none of which had a significant effect on the results. This was potentially because of a lack of variation in the responses: respondents were overwhelmingly male, between the age of 40 and 60 and considered themselves well informed.

\textsuperscript{64} Permanence, monitoring, biodiversity and pre-project planning requirements, as well as Kyoto Protocol compliance.

\textsuperscript{65} The clarity of market for carbon offsets, the existence of the national policy of which carbon offsets are a component, the level of profit the project would generate, the flexibility of rules governing harvest of the resultant trees, and the level of transaction costs.
positive and which negative, so those values were arbitrarily assigned between the two projects. A key element of this technique was to ensure that though the performances of the criteria were distinct between the two projects, they were at the same time realistic projects. That is, the pre-project planning criterion could have been described in environmental integrity as “requiring five years of planning and an environmental impact assessment” and in business opportunity as “requiring no planning whatsoever” in order to communicate the difference between the two projects, but neither reflects a reasonable project. Informants were then asked (ignoring their opinion as to their relative importance) to assess the performance of each criterion, for each project, on a scale of 1 to 7, where 1 was identified as “very bad performance” and 7 as “very good performance”. See Table 5.1 for a description of each criterion for each project, as it appeared in the survey.  

Table 5.1 – Description of project design criteria for the two projects

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Environmental Integrity</th>
<th>Business Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanence of environmental benefits</td>
<td>Land-use is permanently changed from agricultural to forest land.</td>
<td>Land-use is changed from agricultural to forest land temporarily, but for at least 15 years.</td>
</tr>
<tr>
<td>Monitoring stringency</td>
<td>Several aspects of the growing trees are monitored, on an annual basis, according to randomly identified permanent study areas.</td>
<td>Monitoring takes place every 5 years to ensure that tree growth and density accord with what was initially predicted.</td>
</tr>
<tr>
<td>Promotion of biological diversity</td>
<td>A variety of native species are used for planting, promoting a higher level of biological diversity than the original farmland.</td>
<td>A monoculture plantation of non-native or hybrid species are used in planting. Genetically modified organisms are not permitted.</td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>The project adheres to the</td>
<td>The project is not designed with the</td>
</tr>
</tbody>
</table>

66 Note that while these are how the criteria were described in the survey, the lay-out of the description was quite different, with Project 1 described (with a column to evaluate each criteria) above Project 2. There is no indication in the data that the order of the projects affected the results.
| compliance | guidelines laid out in the Kyoto Protocol for such projects – verifying this compliance by an arms-length body is part of the planning and monitoring process. | restrictions of the Kyoto Protocol in mind, but independent rules to determine its legitimacy do exist – verifying this compliance by an arms-length body is part of the planning and monitoring process. |
| Planning requirements | Project design documents including approval by a licensing body, calculations of production for the life of the project, delineating of the project territory and identification of activities displaced by the project are required. Approval could take up to a year. | Project design documents including approval by a licensing body and fulfilling guidelines designed to simplify the planning process are required. Approval could take several months. |
| Marketing facilitation | Advice on production and sales is provided through the extension services of ministries responsible for agriculture, natural resources, forests, or the environment. | Mandatory membership by farmers engaging in this project in a marketing co-operative or government sponsored marketing institution. This organization provides advice on project planning and management as well as acting as a trading bloc to promote farmer welfare. |
| Market clarity | Market situation lacks clarity, specifically as to whether private sector demand for tree-planting offsets exists, whether they will be marketed internationally and whether they have government support. | Market analysis reveals a clear and growing demand in the private sector for afforestation offsets. Government is and has been engaging in efforts to develop such markets. |
| Comprehensive national policy | National plans to combat climate change are unclear, as is the role of tree planting offsets within them. | Afforestation offsets are part of a comprehensive national plan to combat climate change. |
| Profitability | Based on calculations, project should be profitable and financial returns positive. However, the return on investment will be lower than most project (below 3%). | Based on calculations, project will clearly be profitable and financial returns positive. Return on investment is average (between 5 and 7%). |
| Contract flexibility | Penalties accrue to farmers when they harvest the trees by reducing the number of offsets | No penalties exist for harvesting activity as long as a minimum contract length of 15-25 years is met. |
| Transaction costs | The costs associated with marketing the offsets (finding a buyer, negotiating a contract, etc.) are relatively high, accounting for 25-35% of the total sale price of the offset. | The costs associated with marketing the offsets (finding a buyer, negotiating a contract, etc.) are relatively low, accounting for 8-10% of the total sale price of the offset. |

Informants were then asked to evaluate, on the same 1 to 7 scale, the overall attractiveness of the two projects. This dataset was sought such that the ultimate preference between one or the other project could be tested to identify which of the criteria were more influential on the decision, according to two different modelling techniques: discriminant analysis and linear regression. By asking informants to evaluate the project attractiveness directly (rather than simply selecting one) additional data were generated: if proponents gave one project a higher overall score than another they have communicated that they prefer it (providing data for the discriminant analysis), while simultaneously providing data for the linear regression (overall score).

The next section of the survey asked informants to directly evaluate the importance of the same 11 criteria, ignoring the hypothetical projects already described. Informants were asked to refer to projects in which they have participated in the past, or in which they would consider participating in the future. This was done to test whether the overall importance of a given criterion (hereafter referred to as its “weight”) was important in influencing the preference between the two types of projects. The direct weights also provide valuable insight into the stated preferences of policy makers.
5.3.2 Analysis

The data generated by the survey were analyzed primarily by commonplace statistical methods. Difference of means tests of criteria performance between projects and between criteria were performed. The effect of region was tested in an ANOVA with a dummy for Ontario (0) or Prairie (1). Factor analysis (principle components, rotation by varimax) was employed to verify whether informants identified the environmental integrity and business opportunity criteria as members of the same group that I postulated they would, and to identify which of the market facilitation options was associated with which group. Linear Discriminant Analysis (LDA) was used to model the linear relationship between criteria performance and project attractiveness (Huberty 1994). These analyses were executed using the Intercooled STATA 8 software package.

5.4 Results

Informant evaluation of criteria performance was largely as expected given the manner in which the survey was constructed (see Table 5.2).
Table 5.2 – Evaluation of project design criteria performance

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Project “Environmental Integrity” (EI)</th>
<th>Project “Business Opportunity” (BO)</th>
<th>Expected result</th>
<th>p-value (H₀ equal means)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean score (standard deviation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>5.83 (0.86)</td>
<td>2.93 (1.69)</td>
<td>EI &gt; BO</td>
<td>0.00</td>
</tr>
<tr>
<td>Monitoring</td>
<td>5.00 (1.44)</td>
<td>4.59 (1.53)</td>
<td>EI &gt; BO</td>
<td>0.05</td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>4.93 (1.71)</td>
<td>4.00 (1.70)</td>
<td>EI &gt; BO</td>
<td>0.00</td>
</tr>
<tr>
<td>Facilitation</td>
<td>4.80 (1.50)</td>
<td>4.41 (1.85)</td>
<td>EI ≠ BO</td>
<td>0.11</td>
</tr>
<tr>
<td>Permanence</td>
<td>4.54 (1.92)</td>
<td>4.13 (1.51)</td>
<td>EI &gt; BO</td>
<td>0.11</td>
</tr>
<tr>
<td>Planning</td>
<td>4.49 (1.48)</td>
<td>4.69 (1.59)</td>
<td>EI &gt; BO</td>
<td>0.77</td>
</tr>
<tr>
<td>Flexibility</td>
<td>3.95 (1.69)</td>
<td>4.02 (1.43)</td>
<td>BO &gt; EI</td>
<td>0.41</td>
</tr>
<tr>
<td>Profitability</td>
<td>3.75 (1.51)</td>
<td>5.23 (1.50)</td>
<td>BO &gt; EI</td>
<td>0.00</td>
</tr>
<tr>
<td>Market Clarity</td>
<td>3.22 (1.36)</td>
<td>5.38 (1.33)</td>
<td>BO &gt; EI</td>
<td>0.00</td>
</tr>
<tr>
<td>National Policy</td>
<td>2.87 (1.66)</td>
<td>5.20 (1.44)</td>
<td>BO &gt; EI</td>
<td>0.00</td>
</tr>
<tr>
<td>Transaction Costs</td>
<td>2.75 (1.29)</td>
<td>5.15 (1.25)</td>
<td>BO &gt; EI</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The expected results were achieved at 95% confidence levels for the Biodiversity, Monitoring, Kyoto Protocol, Profitability, Market Clarity, National Policy, Transaction Costs criteria. For Market Facilitation, the two-sided difference of means test was insignificant, but a one sided test (assuming that policy makers prefer government extension to mandatory co-operative or SDS membership) was significant at the 94% confidence level. This leaves three unexpected results, for the Permanence, Planning and Flexibility criteria. While the Permanence and Flexibility criteria had the expected sign, they were not sufficiently different to establish statistical confidence. With respect to Project Planning, the sign was opposite to what was expected, though the difference was not large. Returning to the criteria themselves, it is perhaps not surprising that informants could not choose between penalties at harvest as opposed to no penalties but lower prices. Extending this survey to farmers (as is expected in a separate phase of this research) would hopefully shed further light on this issue. Similarly, a long, complex planning
process (yet ensuring environmental integrity) as opposed to a short, relatively simple planning process (yet risking environmental integrity) may leave too little difference for informants to choose between. The lack of statistical significance in the question of permanence is more surprising, as it seems intuitive that, all else being equal, permanent environmental benefits would be preferable to impermanent. I will defer discussion of the source of this anomaly until the next section. Further note that, on a 7-point scale, a score of 4 is the middle, average, score, and could be taken to communicate an “acceptable” level of performance. Note that Environmental Integrity has six criteria that score > 4, and five that score < 4, not surprising given the design of the project. For Business Opportunity, however, only one criterion (Biodiversity) scores below 4, potentially indicating that such projects are more acceptable to policy makers. I will return to this question shortly.

In order to further test whether informants identified the environmental integrity and business opportunity criteria as members of a similar group, a factor analysis, principal components, rotation by varimax, was performed, one for each project. The Kaiser test indicated that 3 factors should be retained because their Eigenvalues were greater than 1, together they explained 60 and 66% of variation in the criteria (in Environmental Integrity and Business Opportunity, respectively), while the fourth factor in each case explained less than 10% of the variation.

The factor loadings for each criterion are displayed in Table 5.3, while 3-dimensional scatterplot of the loadings are displayed graphically in Figures 5.1 and 5.2. The
proportion of variation explained by each factor is provided in brackets, and tentative titles for each factor are also given. Where the factor loadings are greater than 0.50 (or less than -0.50) they have been highlighted.

**Table 5.3 – Factor loadings for both projects for project design criteria**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Environmental Integrity</th>
<th></th>
<th>Business Opportunity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1 (0.33)</td>
<td>Factor 2 (0.16)</td>
<td>Factor 3 (0.11)</td>
<td>Factor 1 (0.42)</td>
<td>Factor 2 (0.14)</td>
</tr>
<tr>
<td>Finance</td>
<td>0.11</td>
<td>0.00</td>
<td><strong>0.72</strong></td>
<td>0.24</td>
<td>0.09</td>
</tr>
<tr>
<td>Enabling Environment</td>
<td>0.00</td>
<td>0.2</td>
<td><strong>0.73</strong></td>
<td>0.08</td>
<td><strong>0.61</strong></td>
</tr>
<tr>
<td>Green</td>
<td>0.65</td>
<td>0.14</td>
<td>0.65</td>
<td>0.27</td>
<td><strong>0.51</strong></td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>-0.29</td>
<td>0.44</td>
<td>0.45</td>
<td>0.01</td>
<td><strong>0.78</strong></td>
</tr>
<tr>
<td>Flexibility</td>
<td>0.25</td>
<td><strong>0.79</strong></td>
<td>-0.04</td>
<td>0.27</td>
<td>0.45</td>
</tr>
<tr>
<td>Facilitation</td>
<td>0.05</td>
<td><strong>0.63</strong></td>
<td>0.28</td>
<td><strong>0.65</strong></td>
<td>0.38</td>
</tr>
<tr>
<td>Planning</td>
<td>0.07</td>
<td><strong>0.66</strong></td>
<td>0.34</td>
<td><strong>0.54</strong></td>
<td><strong>0.54</strong></td>
</tr>
<tr>
<td>Profitability</td>
<td><strong>0.58</strong></td>
<td><strong>0.51</strong></td>
<td>0.16</td>
<td><strong>0.80</strong></td>
<td>0.01</td>
</tr>
<tr>
<td>Market Clarity</td>
<td><strong>0.71</strong></td>
<td>0.1</td>
<td>0.38</td>
<td><strong>0.86</strong></td>
<td>0.02</td>
</tr>
<tr>
<td>National Policy</td>
<td><strong>0.89</strong></td>
<td>-0.02</td>
<td>0.06</td>
<td><strong>0.88</strong></td>
<td>0.11</td>
</tr>
<tr>
<td>Transaction Costs</td>
<td><strong>0.75</strong></td>
<td>0.34</td>
<td>-0.12</td>
<td><strong>0.86</strong></td>
<td>0.16</td>
</tr>
</tbody>
</table>
Figure 5.1 – Factor loadings of criteria performance for Environmental Integrity

Figure 5.2 – Factor loadings of criteria performance for Business Opportunity
The principal components of the factor analysis divide the criteria into three well defined groups. The factor explaining the greatest component of variation can be quite confidently labeled “finance”: factor loadings are quite high for Profit, Transaction Costs, Market Clarity and a National Policy for carbon offsets. Note, however, that in Environmental Integrity these elements perform very poorly (they have the lowest average scores in Table 5.2). That is, the financial elements of Environmental Integrity score poorly, and score poorly together as a well defined group, as expected. The second factor I have slightly less confidently labeled “enabling environment”. These criteria (market Facilitation, contract Flexibility and Planning requirements) seem to be those associated with “greasing the wheels” of the market, that is, with keeping transaction costs low. Profitability is associated with this group, as well (though as Figure 5.1 indicates, it is more closely grouped with the finance set). The third factor can confidently be labeled “green” as those criteria are the ones with the clearest influence on achieving real environmental benefits: permanence, biodiversity, and close monitoring of the project. Kyoto Protocol is the only criterion that does not have at least one factor loading > 0.50, but an inspection of Figure 5.1 shows a clear membership in the green group, which conforms to expectations.

The factor analysis of Business Opportunity gives less clear-cut, but still interesting results. The most explanatory factor has lumped both the finance and enabling environment criteria together into a single group which all perform well (see Figure 5.2 and Table 5.2). As in Environmental Integrity, Biodiversity, Monitoring and Kyoto Protocol (with the addition of Flexibility) are in a well-defined group themselves, each of
which has middling average scores in Table 5.2, and can be thought of as poorly-performing green criteria. The aberration is the third factor, which only explains a significant amount of variation in Permanence and Flexibility, and (as can be seen in Figure 2) sets Permanence off into a group of its own, strongly separated from the others. Given that the Permanence and Flexibility criteria are two of the three which fail their significance tests in Table 5.2 (along with Planning, which also stands out in the factor analysis of Business Opportunity, seemingly having membership in both the well-performing group, and the poor-performing group), the nature of this factor becomes even more murky. As mentioned already, it is not unreasonable to conclude that the policy makers simply could not draw a consistent distinction between the performance of Flexibility and Planning in the two different projects, however, the Permanence options between the two were quite distinct. ANOVA sheds significant light on this factor, to which I turn presently. However, broadly speaking, the factor analysis confirms that respondents are separating the criteria into groups based on their contribution to environmental integrity or contribution to business opportunities.

The results for the overall project attractiveness are given in Table 5.4.

<table>
<thead>
<tr>
<th>Project</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Integrity</td>
<td>4.15</td>
<td>1.53</td>
<td>3.76 – 4.54</td>
</tr>
<tr>
<td>Business Opportunity</td>
<td>4.57</td>
<td>1.53</td>
<td>4.18 – 4.97</td>
</tr>
<tr>
<td>Difference</td>
<td>-0.42</td>
<td>2.38</td>
<td>-1.03 – 0.18</td>
</tr>
</tbody>
</table>
Overall project attractiveness favours the Business Opportunity over Environmental Integrity, however, the margin is not large enough for this difference in means to be statistically significant at the 95% confident level (p = 0.08). However, given the well established groups in Table 5.3 and Figures 5.1 and 5.2, as well as the seemingly strong performance for Business Opportunity over Environmental Integrity indicated by the overall scores in Table 5.2, it is necessary to examine this result in greater detail, so I have performed an ANOVA with the region of employment (Ontario = 0, Prairie = 1) on these data, the results of which are found in Table 5.5.

Table 5.5 – ANOVA of overall project attractiveness and region of employment

| Model | Elements  | Coefficient | t value | P >|t|   | F     | P > F |
|-------|-----------|-------------|---------|------|-------|-------|-------|
| EI, Region | Constant  | 4.05        | 16.71   | 0.00 | 0.47  | 0.50  |
|        | Region    | 0.28        | 0.69    | 0.50 |       |       |
| BO, Region | Constant  | 5.00        | 22.19   | 0.00 | 10.39 | 0.00  |
|        | Region    | -1.24       | -3.22   | 0.00 |       |       |
| EI – BO | Constant  | -0.95       | -2.63   | 0.01 | 6.12  | 0.02  |
|        | Region    | 1.52        | 2.47    | 0.02 |       |       |

As may be expected from the criteria performance values in Table 5.2 for Environmental Integrity, there is little impact of Region on the results: they conform to expectations. However, and confirming the results of the factor analysis, Region has a statistically significant, and large, effect on the evaluation of project Business Opportunity. Specifically (and as shown in Table 5.6) policy makers from the Prairies (n=40) favour Business Opportunity while policy makers from Ontario (n=21) favour Environmental Integrity: the larger number of respondents from the Prairies was obscuring this result.
Table 5.6 – Influence of employment region on overall project attractiveness

<table>
<thead>
<tr>
<th>Region</th>
<th>Environmental Integrity</th>
<th>Business Opportunity</th>
<th>P-value (one sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>4.33</td>
<td>3.76</td>
<td>0.16</td>
</tr>
<tr>
<td>Prairies</td>
<td>4.05</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>P-value (one sided)</td>
<td>0.25</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

While policy makers from each region find Environmental Integrity passable (if mediocre) they are divided (significantly) when it comes to Business Opportunity. Policy makers from Ontario find it less appealing than Environmental Integrity, and less appealing than 4 (though not significantly due to the relatively small sample from Ontario) while Policy makers from the Prairies find it significantly more appealing than Environmental Integrity. Inspecting the criteria performance via ANOVA for a clue as to this disagreement results in only one criterion for which region is a significant factor: Permanence (see Tables 5.7 and 5.8).

Table 5.7 – Influence of region on performance of permanence criterion

<table>
<thead>
<tr>
<th>Region</th>
<th>Permanence EI</th>
<th>Permanence BO</th>
<th>P-value (one sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>5.25</td>
<td>3.80</td>
<td>0.01</td>
</tr>
<tr>
<td>Prairies</td>
<td>4.18</td>
<td>4.40</td>
<td>0.28</td>
</tr>
<tr>
<td>P-value (one sided)</td>
<td>0.02</td>
<td>0.06</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 – ANOVA on region and performance of permanence criterion

| Model          | Elements     | Coefficient | t value | P>|t| | F    | P > F |
|----------------|--------------|-------------|---------|-----|-----|------|
| PermEI, Region | Constant     | 4.18        | 14.15   | 0.00| 4.47| 0.04 |
|                | Region       | 1.06        | 2.11    | 0.04|     |      |
| PermBO, Region | Constant     | 4.40        | 18.85   | 0.00| 3.85| 0.05 |
|                | Region       | -0.78       | -1.96   | 0.05|     |      |
| PermEI-PermBO, | Constant     | -0.22       | -0.57   | 0.57| 7.59| 0.01 |
| Region         | Region       | 1.84        | 2.76    | 0.01|     |      |
This result tidily explains the aberration found in Factor 3 of project Business Opportunity: Prairie policy makers preferred (slightly) impermanent offsets to permanent offsets, while policy makers from Ontario preferred (strongly) permanent offsets to impermanent offsets. While to Prairie policy makers Permanence is acceptable (though mediocre) in each project, in Ontario, policy makers would require permanent offsets rather than impermanent. As was discussed at length in Chapter 4.0, a regional disparity in preferences exists for the question of permanence, and this disparity influences which type of project (overall) would be preferred.

The importance of the project criteria assessed directly by informants can be found in Table 5.9, including both overall and divided by region.
Table 5.9 – Directly assessed values of the importance of criteria to project attractiveness

<table>
<thead>
<tr>
<th>Overall Rank</th>
<th>Overall Weight</th>
<th>Ontario Rank</th>
<th>Ontario Weight</th>
<th>Prairie Rank</th>
<th>Prairie Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanence</td>
<td>5.88</td>
<td>Permanence</td>
<td>6.10</td>
<td>Biodiversity</td>
<td>5.79</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>5.68</td>
<td>Biodiversity</td>
<td>5.50</td>
<td>Permanence</td>
<td>5.77</td>
</tr>
<tr>
<td>Market Clarity</td>
<td>5.28</td>
<td>Monitoring</td>
<td>5.45</td>
<td>Profit</td>
<td>5.53</td>
</tr>
<tr>
<td>Planning</td>
<td>5.25</td>
<td>Market Clarity</td>
<td>5.40</td>
<td>Market Clarity</td>
<td>5.23</td>
</tr>
<tr>
<td>Profit</td>
<td>5.23</td>
<td>National Policy</td>
<td>5.30</td>
<td>Planning</td>
<td>5.23</td>
</tr>
<tr>
<td>National Policy</td>
<td>5.23</td>
<td>Planning</td>
<td>5.30</td>
<td>National Policy</td>
<td>5.21</td>
</tr>
<tr>
<td>Monitoring</td>
<td>5.20</td>
<td>Flexibility</td>
<td>4.90</td>
<td>Transaction Costs</td>
<td>5.18</td>
</tr>
<tr>
<td>Flexibility</td>
<td>5.07</td>
<td>Transaction Costs</td>
<td>4.75</td>
<td>Flexibility</td>
<td>5.15</td>
</tr>
<tr>
<td>Transaction Costs</td>
<td>5.02</td>
<td>Profit</td>
<td>4.65</td>
<td>Monitoring</td>
<td>5.15</td>
</tr>
<tr>
<td>Market Facilitation</td>
<td>4.75</td>
<td>Market Facilitation</td>
<td>4.45</td>
<td>Market Facilitation</td>
<td>4.90</td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>4.07</td>
<td>Kyoto Protocol</td>
<td>4.20</td>
<td>Kyoto Protocol</td>
<td>4.15</td>
</tr>
</tbody>
</table>

Comparing the final four columns of Table 5.9 to each other reveals that only two criteria are given noticeably different evaluations between Ontario and the Prairies: Monitoring and Profit. Looking closer, ANOVAs reveal that only for Profit is region a significant influence on the overall importance of the criteria (see Table 5.10).

Table 5.10 – ANOVA of the importance of profit and region

| Model                | Elements  | Coefficient | t value | P>|t| | F   | P>|F| |
|----------------------|-----------|-------------|---------|------|------|------|
| Profit, Region       | Constant  | 5.53        | 34.21   | 0.00 | 9.78 | 0.00 |
|                      | Region    | -0.88       | -3.13   | 0.00 |      |      |
While this result confirms the pattern seen in Table 5.6, that Prairie policy makers prefer
the project which offers greater business opportunities, the fact that there is no dispute
between the two groups of policy makers on the importance of Permanence is perhaps
surprising given its already demonstrated influence on project attractiveness. This raises a
point to which I will now turn in presenting the results from the discriminant analysis:
there is a very real and influential difference between the performance of a criteria in a
project and the importance of a criteria as directly stated by a policy maker, and each play
a role in the ultimate choice of which project is most attractive.

Discriminant analysis is a common statistical tool for the development of classification
rules (Hand 1997). That is, assuming normally distributed data with a demonstration of
equal covariances between the groups under consideration, discriminant analysis
maximizes the linear classification function (LCF): assigning a given unit to the group of
whose centroid it is “closest”. Two groups are indicated in these data: those who prefer
Environmental Integrity \((n = 20)\) and those who prefer Business Opportunity \((n = 36)\)\(^{67}\).
The \(\chi^2\) approximation to Bartlett’s test for equal variances fails to reject the null
hypothesis of homoscedasticity in each LCF considered here – so the modelling
 technique employed can be considered adequate to the data. There are an infinite number
of LCFs that can be approximated to any given dataset, and the choice between them
must be made balancing two criteria which pull in opposite directions: goodness-of-fit
(which improves with additional variables) and simplicity (which decreases with
additional variables). The former is most readily communicated by a confusion matrix,

\(^{67}\) Only 4 respondents were indifferent between the projects, so their results were excluded from the
discriminant analysis.
showing actual and predicted group membership, while the latter, in this case, will be communicated through a discussion of the retained variables (Hand 1997). A minimum requirement of a meaningful LCF is an eigenvalue > 1 and canonical correlation > 0.60. Four LCFs were tested: the first evaluated preference for Environmental Integrity versus Business Opportunity as explained solely by the criteria performance evaluations (LCF CP), the second evaluated group membership based on the directly assessed criteria weights (LCF CW), the third used the difference between how respondents evaluated criteria performance between Environmental Integrity and Business Opportunity (LCF DP) and the fourth a combination of the first three by using the directly assessed weights on the difference between criteria performance between the projects (LCF DW). Each model included a dummy variable for Region (in keeping with the preceding results) and a constant. The results of each are reported in Tables 5.11-5.18.
Table 5.11 – Discriminant function for model LCF CP

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discriminant Function Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity EI</td>
<td>1.52</td>
</tr>
<tr>
<td>Market Clarity EI</td>
<td>-1.49</td>
</tr>
<tr>
<td>Profit BO</td>
<td>-1.40</td>
</tr>
<tr>
<td>Profit EI</td>
<td>1.31</td>
</tr>
<tr>
<td>Kyoto Protocol BO</td>
<td>-1.19</td>
</tr>
<tr>
<td>Market Clarity BO</td>
<td>1.15</td>
</tr>
<tr>
<td>Flexibility BO</td>
<td>-1.00</td>
</tr>
<tr>
<td>National Policy EI</td>
<td>0.80</td>
</tr>
<tr>
<td>Monitoring BO</td>
<td>-0.58</td>
</tr>
<tr>
<td>Transaction Costs BO</td>
<td>-0.51</td>
</tr>
<tr>
<td>Permanence BO</td>
<td>-0.50</td>
</tr>
<tr>
<td>Permanence EI</td>
<td>0.36</td>
</tr>
<tr>
<td>Biodiversity BO</td>
<td>0.34</td>
</tr>
<tr>
<td>Market Facilitation EI</td>
<td>-0.30</td>
</tr>
<tr>
<td>Planning Requirements EI</td>
<td>0.30</td>
</tr>
<tr>
<td>Flexibility EI</td>
<td>-0.27</td>
</tr>
<tr>
<td>National Policy BO</td>
<td>0.26</td>
</tr>
<tr>
<td>Monitoring EI</td>
<td>0.20</td>
</tr>
<tr>
<td>Kyoto Protocol EI</td>
<td>-0.16</td>
</tr>
<tr>
<td>Planning Requirements BO</td>
<td>0.09</td>
</tr>
<tr>
<td>Market Facilitation BO</td>
<td>-0.02</td>
</tr>
<tr>
<td>Transaction Costs EI</td>
<td>0.00</td>
</tr>
<tr>
<td>Region</td>
<td>-2.93</td>
</tr>
<tr>
<td>Constant</td>
<td>3.77</td>
</tr>
</tbody>
</table>

Eigenvalue  1.75  
Wilk’s $\lambda = 0.36$
Canonical Correlation 0.80  
$\chi^2$ approximation = 43.00
$R^2$ 0.64  
Significance $\chi^2 = 0.01$

Table 5.12 – Confusion matrix for model LCF CP

<table>
<thead>
<tr>
<th>Actual</th>
<th>Predicted</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Environmental Integrity</td>
<td>Business Opportunity</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Environmental Integrity</td>
<td>18</td>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Business Opportunity</td>
<td>3</td>
<td>33</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>35</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>
Correctly predicted: 91% - False Classification as BO: 10% - False Classification as EI: 8.3%
Considering the results of LCF CP found in Tables 5.11 and 5.12, the model performs quite well, correctly predicting 91% of project preferences based on the criteria performance evaluations. In Table 5.11 (as in Table 5.15 and 5.17) criteria coefficients with values greater than the mean of all of the coefficients have been highlighted as being of particular interest. In general, LCF CP confirms much of the foregoing analysis that Biodiversity, Market Clarity and Profit are among the most important factors influencing policy makers as to which project they prefer. However, the results also introduce (by including opposite sign coefficient values for both Market Clarity and Profit depending on which project’s criteria are being evaluation) the idea that not only the performance of criteria in the two projects is of value, but also the difference between the performance of the criteria in each project. That is, it is not only the case that, the more a policy maker appreciates the Biodiversity requirements of Environmental Integrity the more likely they are to prefer Environmental Integrity over Business Opportunity, but also, that the more they appreciate the high Profit opportunities in Business Opportunity relative to the low Profit opportunities in Environmental Integrity the more likely the are to prefer Business Opportunity. An LCF that incorporate the difference between the criteria performance between the projects is therefore clearly called for.

In addition, given that the results in Table 5.11 replicate at least in some degree the overall priorities expressed in Table 5.9 (the direct weights) it is reasonable to attempt to formulate an LCF (LCF CW) from the directly evaluated weights found in Table 5.9 alone: perhaps the choice of project is not determined by criteria performance as much as it is from the overall priority of individual criteria (see Tables 5.13 and 5.14).
Table 5.13 – Discriminant function for model LCF CW

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discriminant Function Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td>-0.81</td>
</tr>
<tr>
<td>Permanence</td>
<td>0.57</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>0.32</td>
</tr>
<tr>
<td>Monitoring</td>
<td>-0.31</td>
</tr>
<tr>
<td>Market Facilitation</td>
<td>-0.18</td>
</tr>
<tr>
<td>Transaction Costs</td>
<td>0.15</td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>0.15</td>
</tr>
<tr>
<td>Market Clarity</td>
<td>0.13</td>
</tr>
<tr>
<td>Flexibility</td>
<td>-0.09</td>
</tr>
<tr>
<td>National Policy</td>
<td>-0.08</td>
</tr>
<tr>
<td>Planning Requirements</td>
<td>0.02</td>
</tr>
<tr>
<td>Region</td>
<td>-0.67</td>
</tr>
<tr>
<td>Constant</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Eigenvalue 0.40  Wilk’s λ = 0.71  Canonical Correlation 0.53  $\chi^2$ approximation = 16.09  R² 0.28  Significance $\chi^2 = 0.19$

Table 5.14 – Confusion matrix for model LCF CW

<table>
<thead>
<tr>
<th>Actual</th>
<th>Predicted</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Environmental Integrity</td>
<td>Business Opportunity</td>
<td>Total</td>
</tr>
<tr>
<td>Environmental Integrity</td>
<td>14</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Business Opportunity</td>
<td>10</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>32</td>
<td>56</td>
</tr>
</tbody>
</table>

Correctly predicted: 71% - False Classification as BO: 30% - False Classification as EI: 28%

As can be seen from the high Wilk’s λ score (resulting in low overall statistical significance of the model), the Eigenvalue < 1.0 and the Canonical Correlation < 0.60, the directly assessed weights on their own are not particularly indicative of group membership. Given that both Prairie and Ontario policy makers can agree on a high priority for Permanence (see Table 5.9) while at the same time considering it to have completely opposite meaning (see Table 5.7) makes this result unsurprising. Further consider from Table 5.14 that the using direct weights alone leads to a very large over-
prediction of Environmental Integrity projects – LCF CW makes almost as many false Environmental Integrity preference predictions (10) as it does correct ones (14)! This should remind the analyst to treat polling data purporting that a high priority for “environment” relative to other values implies heralds a new era of environmentally sustainable development: placing a directly stated high weight on “environment” does not necessarily translate into preferring development emphasizing environment over business.

Returning to the question of the importance of the difference between criteria performance between projects, the results of LCF DP are provided in Tables 5.15 and 5.16.

Table 5.15 – Discriminant function for model LCF DP

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discriminant Function Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td>0.87</td>
</tr>
<tr>
<td>Market Clarity</td>
<td>-0.74</td>
</tr>
<tr>
<td>Monitoring</td>
<td>0.55</td>
</tr>
<tr>
<td>Permanence</td>
<td>0.41</td>
</tr>
<tr>
<td>National Policy</td>
<td>0.39</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>0.36</td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>0.35</td>
</tr>
<tr>
<td>Market Facilitation</td>
<td>-0.29</td>
</tr>
<tr>
<td>Planning Requirements</td>
<td>0.21</td>
</tr>
<tr>
<td>Flexibility</td>
<td>0.18</td>
</tr>
<tr>
<td>Transaction Costs</td>
<td>0.11</td>
</tr>
<tr>
<td>Region</td>
<td>-1.69</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

| Eigenvalue | 1.17                      | Wilk’s $\lambda = 0.46$ |
| Canonical Correlation | 0.73                      | $\chi^2$ approximation = 37.10 |
| $R^2$       | 0.54                      | Significance $\chi^2 = 0.00$ |
Table 5.16 – Confusion matrix for model LCF DP

<table>
<thead>
<tr>
<th></th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Environmental Integrity</td>
</tr>
<tr>
<td>Actual</td>
<td></td>
</tr>
<tr>
<td>Environmental Integrity</td>
<td>18</td>
</tr>
<tr>
<td>Business Opportunity</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

Correctly predicted: 86% - False Classification as BO: 10% - False Classification as EI: 17%

While not as accurate nor as well-formulated as LCF CP, LCF DP still performs well, correctly predicting 86% of group membership. Like LCF CP, Profit and Market Clarity come through as very important factors in explaining project preference, and Biodiversity, Kyoto Protocol and National Policy also contribute. Comfortingly (given the results in Tables 5.7 and 5.9), this formulation re-establishes Permanence as a critical consideration, while Flexibility has decreased in relevance. Like LCF CW, false preferences for Environmental Integrity are an important share of the total identified preferences, though to a lesser degree.

Despite the failure of LCF CW to accurately indicate group membership, it is worth considering another discriminant function which includes the directly stated weights, which are this time applied to the differences used in LCF DP. The results for this final discriminant function are given in Tables 5.17 and 5.18.
Table 5.17 – Discriminant function for model LCF DW

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discriminant Function Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td>0.17</td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>0.12</td>
</tr>
<tr>
<td>Market Clarity</td>
<td>-0.11</td>
</tr>
<tr>
<td>Permanence</td>
<td>0.11</td>
</tr>
<tr>
<td>Monitoring</td>
<td>0.11</td>
</tr>
<tr>
<td>Transaction Costs</td>
<td>0.07</td>
</tr>
<tr>
<td>National Policy</td>
<td>0.05</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>0.04</td>
</tr>
<tr>
<td>Market Facilitation</td>
<td>-0.03</td>
</tr>
<tr>
<td>Planning Requirements</td>
<td>0.02</td>
</tr>
<tr>
<td>Flexibility</td>
<td>0.01</td>
</tr>
<tr>
<td>Region</td>
<td>-0.91</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.48</td>
</tr>
</tbody>
</table>

| Eigenvalue | 1.39 |
| Wilk’s λ   | 0.41 |
| Canonical Correlation | 0.76 |
| χ² approximation | 41.79 |
| R²         | 0.58 |
| Significance | χ² = 0.00 |

Table 5.18 – Confusion matrix for model LCF DW

<table>
<thead>
<tr>
<th>Actual</th>
<th>Predicted</th>
<th>Environmental Integrity</th>
<th>Business Opportunity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Integrity</td>
<td>18</td>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Business Opportunity</td>
<td>3</td>
<td>33</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>35</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

Correctly predicted: 91% - False Classification as BO: 10% - False Classification as EI: 8.3%

Though the Eigenvalue, Canonical Correlation and R² are slightly lower than those of LCF CP, LCF DW is just as accurate, correctly classifying 91% of informants, with the same misclassification percentages. Again, Profit, Market Clarity, Permanence and the Kyoto Protocol are highlighted as of particular importance, in addition this time to Monitoring requirements. The simple fact that discriminant analysis can identify groups (those that prefer Environmental Integrity and those that prefer Business Opportunity) based either solely on the performance of criteria in these projects, or on a mixture of
differences between criteria performance in the two projects and directly assessed weights is an important result completely outside all consideration of which criteria are most important. That is, it demonstrates that statistically relevant differences in values lead to different levels of project attractiveness distinct enough to change which project is considered preferable overall. In short, ideology matters, and is central to identifying what is ‘best’ in the minds of policy makers.

One final analysis of these data was performed, as a final check on the results from the discriminant analysis. Since the informants were asked to evaluate the attractiveness of Environmental Integrity and Business Opportunity directly (rather than making a choice between the two) the difference between the values of their indicated attractiveness can be used to formulate a multivariate regression model using ordinary least squares. Such an exercise allows identification not only of which criteria contribute the most to preference for one project over the other, but also which variables are statistically significant. This exercise could potentially clarify the choice between LCF CP and LCF DW. As a result two multivariate models were formulated, MV CP and MV DW (which correspond to the variables used in the respective LCFs). The least significant variable was then removed and the model reformulated until only variables with t-values significant to 0.05 remained. The results are found in Tables 5.19 and 5.20.
Table 5.19 – Coefficients and t-values for model MV CP

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-value</th>
<th>P &gt;</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanence EI</td>
<td>0.44</td>
<td>3.68</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Market Clarity EI</td>
<td>-0.40</td>
<td>-2.15</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Profit EI</td>
<td>0.63</td>
<td>3.48</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Profit BO</td>
<td>-0.60</td>
<td>-3.51</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Flexibility BO</td>
<td>-0.67</td>
<td>-4.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td>-1.32</td>
<td>-2.70</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>3.26</td>
<td>2.53</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

F (6, 53) = 10.97  P > F = 0.00  R² = 0.55  Adj R² = 0.50

Table 5.20 – Coefficients and t-values for model MV DW

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-values</th>
<th>P &gt;</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanence</td>
<td>0.079</td>
<td>5.64</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Kyoto Protocol</td>
<td>0.079</td>
<td>3.53</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>National Policy</td>
<td>0.042</td>
<td>2.21</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>0.067</td>
<td>2.86</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

F (4, 56) = 18.30  P > F = 0.00  R² = 0.57  Adj R² = 0.54

The results of MV CP are broadly similar to those of LCF CP, emphasizing that Market Clarity EI, Profit EI, Profit BO, Flexibility BO and Region are important in influencing project preference, but adding Permanence EI while omitting Biodviersity EI and National Policy EI (Kyoto Protocol BO is also omitted, though its p value was 0.06). MV DW was also similar to LCF DW, emphasizing Permanence, the Kyoto Protocol and Profit, though it adds National Policy and omitted Monitoring and Market Clarity. While MV DW slightly outperforms MV CP in terms of R² and Adjusted R², it does not do so to a degree that would clarify which of the LCFs may be preferable.
5.5 Discussion

The results presented in Tables 5.2 through 5.20 ultimately provide a great deal of insight into what drives the preferences of policy makers with respect to the characteristics of afforestation generated carbon offset projects. With particular reference to Table 5.2, there is a clear and significant preference for projects which employ diverse, native species over non-native plantations; more strict monitoring over more relaxed monitoring, Kyoto Protocol compliance over non-Kyoto Protocol compliant standards; average levels of profit over low levels of profit; market clarity as to the role of carbon offsets over confusion; well-established national policy over a lack of the same and low transaction costs over high. These results are to be expected and conform to commonly held view of economic and environmental rationality: thus far, there are no results which would suggest the presence of anything resembling an ideologically driven set of preferences which would introduce conflict or lower the sustainability of a given suite of climate change mitigation policies. This rather comfortable situation is overturned by the evaluation of the performance of the Permanence criteria and overall project attractiveness reported in Tables 5.4 though 5.8. It is clear from these results that a preference for shorter term, that is, impermanent projects is strong in policy makers in the Prairies. This outcome (see Table 5.7) would be unacceptable for Ontario policy makers, who have a strong preference for permanent conversions of farmland to forest. This, despite the analysis in Chapter 4.0 which demonstrates that increased permanence would, in fact, relatively favour Prairie farmers over Ontario farmers. While many justifications for either of these preferences exist, the point is not that this difference is rational, the point is that this difference exists, and represents a fundamental difference in ideology.
which contributes, to some degree, in different preferences as to the overall attractiveness of afforestation generated carbon offset projects. Since it is, I hope, clear, that a project which is Kyoto Protocol compliant, uses a mix of native species and has strict monitoring procedures cannot simultaneously occur with one that has high profit and low transaction costs, some tradeoff is necessary. When that tradeoff occurs, policy makers from the Prairies will be more willing (if not eager) to sacrifice permanence for the sake of business opportunities, while policy makers from Ontario will lean the other direction. The implications for the sustainability of federally crafted climate change mitigation policy (or competing provincial policies) as discussed in Chapter 4.0 are clear.

When the directly evaluated importance of project criteria are included, this distinction becomes even more clear (see Table 5.9). Though Permanence as a criterion is equally important despite region, the foregoing discussion clarifies that it is important for different reasons depending on whether a policy maker is from Ontario or the Prairies: to the former it is a necessity, to the latter, an impediment. The only significantly different directly assessed criterion is Profit, which is ranked much more important for Prairie policy makers than their Ontario compatriots. While the performance of Profit between the two projects is not significantly different (Table 5.2), its overall importance is, leading again to the preference of Prairie policy makers for project Business Opportunity. In examining the two best performing discriminant functions (LCF CP and LCF DW) and their corresponding multivariate regressions (MV CP and MV DW), distinct groups with distinct ideologies over a variety of criteria are clearly and statistically significantly apparent. Profit (either directly assessed or evaluated for each project) appears
prominently all four. Permanence appears prominently in three (LCF DW, MV DW, MV CP). These criteria appear more often in the models explaining project attractiveness (Tables 5.11, 5.17, 5.19 and 5.20) than any other, even when the regional disparity has been taken into consideration (recall that a regional dummy is included for each of these models except MC DW, for which it was not significant), emphasizing that an ideological difference on these criteria exists which transcends regionalization (though it certainly exists there). Underlining this point, two other criteria also appear three times: Market Clarity (LCF DW, LCF CP, MV CP) and Kyoto Protocol\textsuperscript{68} compliance (LCF DW, LCF CP, MV DW), for which there is no regional dispute in performance (directly assessed or otherwise). As noted by Jasanoff (1990), “science in the policy setting is always colored \textit{sic} by values,” (p. 7). If public policy was simply a matter of minimizing costs in the production of certain goods, as implied by Alchian and Demsetz (1972) and Zhang (2000) (see Chapter 1.0) then one would expect Profit and Market Clarity to appear\textsuperscript{69} (in addition to Transaction Costs, though more on it below), but not Permanence, and certainly not Kyoto Protocol compliance.

Of course, corollary to the observation that the most important criteria in determining how attractive a given afforestation generated carbon offset project is to a policy maker are what province they work for, permanence, profit opportunity, market clarity and Kyoto Protocol compliance, is that certain factors, in spite of the ink dispensed upon

\textsuperscript{68} The large influence of Kyoto Protocol compliance on project attractiveness is particularly interesting given that it was evaluated as, by far, the least important criteria in the direct weights. It seems that, for policy makers who value projects primarily for their environmental characteristics, Kyoto Protocol compliance is key in spite of its Canadian obsolescence.

\textsuperscript{69} Of course, the relevance of the Profit and Market Clarity criteria in the discriminant analysis reveals at least two distinct ideologies with respect to their importance, so their inclusion is not particularly comforting to the prevailing economic theory, after all.
them, do not matter. Specifically, planning requirements, transaction costs and market facilitating institutions appear in none of the best four performing models which describe (quite accurately) project attractiveness. This is not to say that policy makers did not evaluate these criteria as having some importance (they were evaluated, respectively, as having an importance of 5.25, 5.02 and 4.75 on a scale of 1 to 7, or 4th, 9th and 10th overall in Table 5.9), but that they did not consider them when deciding project attractiveness.\(^{70}\) Given the emphasis of Chapters 2.0 and 3.0 on transaction costs (and the importance of planning requirements to them) and marketing institutions, I must confess that their irrelevance to policy makers is disappointing, though not surprising. A primary result of this analysis is that, when it comes to the elements of project design directly informed by public policy, neither marketing institutions nor transaction costs matter to policy makers. While the large volume of economic theory embodied in the New Institutional Economics (see Chapter 1.0) would argue that they very much should matter, as it is transaction costs which control institutional evolution – when it comes to the actual crafters of public policy (according to these results) they do not. Rather, as the Old Institutional Economics and the Institutionalism of Knight (e.g. 1992) and North (1988, 1992) contend, ideology maintains a dominant position.

In between the dominant (profit, permanence, market clarity and the Kyoto Protocol) and irrelevant (market facilitating institutions, transaction costs and planning requirements) are the criteria of some, though limited, importance. These include biodiversity, asset

\(^{70}\) While it is possible that the relevance of Transaction Costs was conflated with that of Profit, given that transaction costs, planning requirements and marketing facilitation are the three variables most closely associated with transaction costs \textit{per se} (see Chapter II) and that these three were resoundingly non-influential, I believe that it is reasonable to conclude that policy makers were able to draw the distinction.
flexibility, monitoring and national policy. Biodiversity (specifically, its promotion in offset generating projects), though given very high evaluations in its importance in Table 5.9, enjoys such near universal agreement that it plays very little role in actually informing project preference. Note, however, that though it is expressed as important, it is not a ‘kick-out’ criteria whose absence would produce an immediate rejection of the project: in spite of non-native monocultures in project Business Opportunity, it is still preferred by a majority of policy makers. Asset flexibility only appears as relevant in a single model (LCF CP) and in that only because of my arbitrary decision rule to identify as relevant those criteria which had above average coefficients. A slightly modified decision rule would have removed it (and the presence of national policy) from relevance. National Policy, while identified as of middling importance in Table 5.9, only appears to be significant in MV DW (see Table 5.20), but even there it as a relatively small coefficient, and correlates with preferences for projects with higher environmental benefits. Finally, monitoring appears as relevant in one model (LCF DW) but was evaluated with a score above 4.00 in both projects: while more monitoring was thought to be better than less, any professional monitoring seemed to result in general approval from policy makers. 71

These results demonstrating the central role played by ideology in informing policy makers should not be interpreted as surprising, particularly in light of Liora Salter’s (1988) book Mandated Science. This work, focusing on the Canadian public policy

71 In fact, 5 criteria score above 4.00 for both projects. The others are Market Facilitation, Planning requirements, Kyoto Protocol compliance and Permanence. The first two have already been identified as irrelevant, the third is thought to be quite unimportant (in Table 9) though its legacy in the minds of policy makers who support environmentally focused projects is strong, while the fourth was shown to include significant disagreement as to why it was important.
environment, discusses the role of science that is undertaken for the sake of establishing public policy (“mandated science”) and identifies distinct differences from non-mandated science. She notes four specific ways it diverges from science *per se*: it is idealized (the value free, public, unequivocal nature of its results is emphasized), imbued with legal considerations (given has often come to be used as a foundation for law itself), has a distinct form of debate (its “bottom-line” implications are emphasized and discussion of uncertainty is limited or excluded) and is explicitly moral (it responds largely to normative questions, i.e. what “should” be done). Each of these elements is highly applicable to the respondents in this case, and each opens the door wider for the role of ideology to influence public policy. I wholeheartedly agree with Jasanoﬀ (1990) that “although political conﬂict may be promoted and sustained by scientiﬁc uncertainty, it is by no means safe to assume that reducing uncertainty automatically reduces conﬂict,” (p. 8). That is, I am in no way calling for a purge of ideology from the creation of public policy, one of the primary points of this dissertation is that such a purge would be, and is, impossible, given the ultimately institutional nature of human behaviour. Rather, my argument, demonstrated here, is that given the enormity and imminence of climate change as a national and global problem, it is necessary to identify the ideological roots of the characteristics of afforestation generated carbon offset projects which policy makers find attractive, such that sustainable climate change mitigation policies can be crafted in an effective and timely manner.
5.6 Conclusions

This chapter has demonstrated several elements of afforestation generated carbon offset projects critical to the creation of a politically sustainable suite of climate change mitigation policies. First, the key criteria of such projects which contribute to their attractiveness to policy makers are their opportunities for profit, treatment of permanence and Kyoto Protocol compliance within a context of market clarity, with the existence of distinct groups (which prefer projects promoting Environmental Integrity or Business Opportunities) with a distinct set of preferences over the performance of these criteria, their difference between projects and the overall weight placed upon them. Other criteria (biodiversity, asset flexibility, monitoring requirements and national policy) have some level of influence, but noticeably less than the aforementioned four. Second, certain criteria accepted to be important to both afforestation generated carbon offset projects in particular and the New Institutional Economics in general are found to be unimportant in explaining overall project attractiveness, specifically, planning requirements, market facilitation and transaction costs. Finally, the ideological basis of these distinctions is clear from both the very fact that groups with distinct values which form the basis of their level of attraction for a given project can be identified by discriminant analysis, and the important role played by permanence, profit and regional considerations in determining project attractiveness. Given these results, the overall explanatory power of the New Institutional Economics must be examined and questioned, a task to which I now turn in Chapter 6.0.
Because familiarity is such an important test of acceptability, the acceptable ideas have great stability. They are highly predictable. It will be convenient to have a name for the ideas which are esteemed at any time for their acceptability, and it should be a term that emphasizes this predictability. I shall refer to these ideas henceforth as the conventional wisdom.

- J. K. Galbraith (1958)

6.0 Implications for afforestation generated carbon offset projects and the NIE

6.1 A brief review

This dissertation has focused on answering two questions, “What are the economic implications of afforestation generated carbon offset institutions in Canada – and how appropriate are the tools of the New Institutional Economics to respond to this question?” Through the application of a variety of techniques and tools, these questions have been answered: the implications for the distribution of costs and benefits under new exercises in collective action have been examined, and the relationship between this distribution and the ideology and power of policy makers has been demonstrated. Specifically, I have shown that:

a) a variety of marketing institutions are reasonable depending on the goals of policy makers (Chapter 3.0), which can only be discerned by both sectoral (Chapter 3.0) and spatial (Chapter 4.0) analysis of the distribution of benefits,

b) transaction costs play a key role in these distributional effects (Chapters 2.0 and 3.0),

c) the political sustainability of climate change policy is at stake in this distributional analysis (Chapters 4.0 and 5.0),
d) that there are no apolitical means of responding to these issues, since they are located in questions both of power and ideology (Chapters 4.0 and 5.0), and
e) that even NIE analysis reformed in practice to incorporate these foci does not provide the type of results which inform the decisions of policy-makers (Chapter 5.0).

Hoping for a moment that the medium, is not, indeed, the message, these questions have been revealed to not have solely academic relevance, but to have important implications for the lives of Canadian producers and consumers, as well as for the function of government. These implications will now be discussed in more detail.

6.2 Implications for methodology

Two methodological issues of importance have been addressed here, relating to multi-criteria methods specifically and the New Institutional Economics in general. With respect to the former, multi-criteria methods have proven effective at identifying ideologies within the policy making community. That the shape of the ideologies of two distinct groups within provincial policy makers has been demonstrated, as well as their regional distinctiveness, is a result worth noting. This success suggests a fruitful future for this technique in identifying areas of potential conflict in other policy development contexts, but also recommends itself to a broader application in the context of afforestation generated carbon offset policy.
With respect to the New Institutional Economics, in particular its transaction costs stream, a focus on the distributional implications of institutional design has been shown to provide valuable insight into the ability of aggregating marketing institutions to fulfill policy goals. That this effort has been undertaken in concert with an emphasis on the role of ideology and power shows that the New Institutional Economics is flexible enough to show Ronald Coase (1998) wrong: economics can concern itself with the world as it really is. However, in spite these seemingly valuable results and great potential, these results challenge the ultimate usefulness of reformed-or-otherwise NIE insofar as policy-maker preferences for climate change mitigation are not informed by the outputs that the NIE provides (namely, information on alternative institutional arrangements and transaction costs). While this is not a substantive critique of NIE in theory, it is certainly a strong mark against it in practice, unless a revolution occurs in policy maker decision-making processes.

6.3 Implications for federal and provincial climate change mitigation policy

A focus on the redistributive effects of seemingly objective modelling parameters (such as discount rate, rotation age and growth and yield curve shape) reveals not even these innocuous efforts can be said to be apolitical: reality is shaped by them, opportunities are created and limited. However innocent their intent, they are exercises of power. This cannot help but exacerbate already existing tensions and difficulties in the crafting of federal climate change mitigation policy. There is no hope found here for the idea that effective action on climate change will be taken at a federal level in the near future.
Given the rise of the Western Climate Initiative, and the partner status of three of the four largest Canadian provinces (in terms of population, GDP and area) this result implies a continued emphasis on the provinces as the locus of policy action, but the role of ideology at the provincial level clouds the prospects of this effort as well. While regionally focused distinctions in ideology within provincial environmentally focused ministries exist (between the Prairies and Ontario), non-regional divisions are demonstrable as well. Two camps exist, one which favours business opportunity oriented projects, and another favouring projects emphasizing environmental benefits. These two camps are divided based on their perceived importance of, and relative preference between, permanent vs impermanent plantations, profit oriented vs non-profit oriented management, the market clarity of the demand for carbon offsets and the legacy of the Kyoto Protocol. It is not as simple as saying that Ontario policy makers favour environmental projects and Prairie policy makers favour projects as business opportunities (though this division exists), rather two competing ideologies exist within provincial ministries on these matters – a conflict which will further mitigate against effective and timely policy establishment.

In the Prairies, the dominant ideology strongly favours business oriented projects (see Table 5.6), so one can reasonably expect the evolution of policies which promote afforestation generated carbon offset projects conforming to the values of this group: low permanence, explicit inclusion of carbon offsets as fungible with emissions reductions, standards not compliant with those relevant to the Kyoto Protocol, and operated as profit generating businesses. My commentary here is not pejorative: this relative unity of
ideology will lead to earlier action and immediate environmental benefits – even if they may not be as high as they could be were projects focused in another direction. It should not be surprising that Alberta has the most developed set of offset protocols in Canada (see http://www.carbonoffsetsolutions.ca).

In Ontario, by contrast, though a preference for environmentally focused projects exists, its preference over business oriented projects is only significant at the 84% confidence level. One would expect greater conflict in the elaboration of the characteristics of afforestation generated carbon offset projects here, particularly relating to questions of permanence, Kyoto Protocol compliance, profit orientation and market clarity. This division cannot help but to slow the development of climate change mitigation policy, and risks considerably watering it down. The situation is reminiscent of that at the federal level in the 1990s, where conflict between and within the Ministries of Finance and Environment on the question of climate change resulted in untimely, ineffective policies, in addition to leading directly to the downfall of at least one prominent elected official (see Simpson et al. 2007). It is possible, however, that Ontario’s status as a partner in the Western Climate Initiative will mitigate this conflict – with policy makers more-or-less accepting the afforestation standards elaborated within that body. On the other hand, it could simply pass this conflict up to a higher level of negotiation, delaying action within that body as well. On this question, only time will tell. Certainly, the important role of sub-national political processes in establishing climate change mitigation policy and activity, should receive a new emphasis in future research.
6.4 Implications for marketing institutions

The preceding research has demonstrated that several aggregating, market facilitating institutions would perform reasonably in fulfilling a variety of foreseeable climate change mitigation policy goals, including maximizing the production of afforestation generated carbon offsets, minimizing price, maximizing welfare or maximizing producer surplus. That is, banking performs best at minimizing unit price, cooperatives for maximizing welfare and single-desk sellers in maximizing producer welfare, while banks and cooperatives are equal in terms of maximizing total offset production. However, if a precautionary decision-rule is used (in order to reflect policy uncertainty in Canada) these results favour the cooperative approach. This derives from the ability of cooperatives to reduce transaction costs (specifically monitoring and approval costs) through aggregation to a greater degree than banks, while also exercising market power in limiting production so as to increase producer surplus. If the gap between the transaction costs facing cooperative members relative to banks decreases, precautionary decision-rules cannot consistently distinguish between the cooperative and banking scenarios. However, this difficulty only exists if banks act as non-profit agents – even low levels of profit extraction by the banks result in significant out performance by cooperatives across all policies considered here unless large unknown inefficiencies within cooperatives exist. However, it must be stressed that there is no necessity placed upon policy makers to adopt a precautionary decision rule in policy design or recommendation, neither is there a requirement to consider the transaction cost effects of marketing institutions under consideration in policy design. Rather the opposite is true: policy makers do not believe
that market facilitation is particularly important, and have a slight preference for handling market facilitation themselves through providing advice and extension services rather than through co-operatives, and it certainly does not affect their decision as to whether a project is attractive or not. It can safely be concluded, therefore, that if co-operatives are to be promoted as a component of climate change mitigation policy, this will have to be done by some other group in civil society. That this is in the perceived best interests of farmers is supported by van Kooten et al.’s (2002) finding that 82% of Prairie farmers expressed a willingness to join a co-operative for the purposes of marketing carbon offsets. It seems appropriate, therefore, that farmers take the lead in climate change mitigation discussions to promote outcomes which distribute a greater share of benefits to producers in a co-operative based framework. Future research projects in the vein of those of Chapter 5, but identifying the driving ideologies of farmers rather than policy makers, may help identify why farmers (and farmers’ organizations) have as yet been reluctant so to do.

6.5 Implications for future research

This research lays the groundwork for four additional lines of inquiry that should prove profitable for understanding the link between distributional concerns, ideology and climate change mitigation policy. First, future research should focus on expanding the ideological analysis to include a more diverse set of policy stakeholders. That is, the driving ideologies of federal policy makers, small-scale farmers, large emitters and ENGO members and directors, and in particular those points which they have in common
and upon which they diverge should be identified. Scaling these analyses up to the international level should also prove fruitful. Employing these tools to compare ideological divergence or convergence in Sub-Saharan Africa, China and within important international agencies such as the UNDP, UNFCCC, CCX, NSW GGAS, etc would provide useful results. Multi-criteria analysis has proved a helpful tool in this regards, and should be employed. The quantification of these ideologies could be particularly useful in reducing the negotiation costs (and thereby increasing the political sustainability) of establishing national level climate change mitigation policy, by identifying points of contact and points of division in advance.

Second, the distributional analysis of Chapter 3 could be replicated using alternative measures of distribution. In particular, less intuitive, but more theoretically robust measures (such as Equivalent and Compensating Surplus) could be pursued. While such research may be theoretically pleasing, perhaps more interesting (and ultimately fruitful) would be examining the distribution of costs and benefits over other divisions within society, such as income quintiles, age groups, language groups and all provinces over a broader range of climate change mitigation policies than just afforestation.

Third, the focus of this research has been on the federal climate change policy context, while its results have emphasized the importance of provincial dynamics. An analysis of the climate change mitigation policy development contexts at a provincial level, in particular in the more influential provinces on national policy formation (such as British
Columbia, Alberta, Ontario, Quebec, and, lately, Saskatchewan) could therefore provide important insights.

Finally, this dissertation has demonstrated the superior performance of cooperatives relative to other aggregating institutions in achieving a variety of outcomes in a precautionary policy context. Further examination of the transaction cost minimizing effects of co-operatives, and both the theory and practice of their marketing functions and, in particular, their distributive processes should therefore be pursued. While a small literature on this topic already exists, it is dominated by the U.S. experience. Grounding this research in Canadian contexts (potentially in partnership with the Centre for the Study of Cooperatives at the University of Saskatchewan, or the British Columbia Institute for Cooperative Studies at the University of Victoria) should therefore take a high priority, given Canada’s distinct and diverse institutional history.

6.6 Climate change mitigation policy and the conventional wisdom

In spite of these seemingly valuable results and great potential, this dissertation ultimately challenges the usefulness of analyses focusing on distribution, ideology and power in informing public policy processes, since policy-maker preferences for climate change mitigation are not informed by such outputs. This has not changed, and shows no serious signs of changing that I can see, since the NIE has been incorporated into mainstream, neoclassical economics. Schluter (2007) seems optimistic that this change is inevitable, though I am less sanguine, as in and of itself this resistance to change is evidence in
favour of Veblen’s (1898b) original understanding of human behaviour as primarily emulative: in spite of repeated calls for a more explicit inclusion of questions of distribution and ideology, the discipline has continued in its existing pattern largely unchanged. Ultimately, economics as a discipline in public service is currently in the throes of what the late (lamented) John Kenneth Galbraith called the conventional wisdom. The conventional wisdom is popular because of its acceptability, and it is acceptable because it is familiar. Fortunately, the correlation between what is familiar and what is true has yet to be demonstrated to be particularly strong. Comfortingly, if the arguments in this dissertation are correct in that economic behaviour has an institutional core, then there is no ultimate reality which requires either the New Institutional Economics to continue to be practiced in the way in which it has been, or the resistance to its results that exists in the policy community. What is lacking is the will required to establish a new standard for economic research, and the opportunity to hold it up for emulation.
References


publication by International Emissions Trading Association and Carbon Finance
Unit of the World Bank, Washington DC: 57 p. Available from

Unit of the World Bank.

publication by International Emissions Trading Association and Carbon Finance

development,” Published by the Carbon Finance Unit at the World Bank,

to pay differ in choice experiments?” Journal of Environmental Economics and
Management 41: 179-192.


Featherstone, A., Roessler, L. and Barry, P. (2006). “Determining the probability of
default and risk-rating class for loans in the Seventh Farm Credit District portfolio,”


productivity in Chinese agriculture: A microeconomic model of disequilibrium,”


transaction costs on the cost effectiveness of project-based Kyoto mechanisms,”

*Climate Policy* 3: 249-259.

Forest Sector Table (1999). “Options report: Options for the forest sector to contribute to
Canada’s national implementation strategy for the Kyoto Protocol.” Forest Sector
Table, Canadian Forest Service of Natural Resources Canada and Environment
Canada, National Climate Change Process.

Foss, N. (1994). *The Austrian school and modern economics*. Handelshojskolen Forlag,

Copenhagen: 229 p.


Laghi (2007).

[www.theglobeandmail.com/servlet/story/RTGAM.20070605.wg8main05/PPVStory](http://www.theglobeandmail.com/servlet/story/RTGAM.20070605.wg8main05/PPVStory)


“A Bioeconomic assessment of Sirex Noctilio Fabricius spread and potential
impacts on pine wood supply and harvests in eastern Canada,” Canadian Journal


Economics 36: 197-204.