ENVIRONMENTAL VALUATION: AN APPLICATION OF THE CONTINGENT VALUATION METHOD

by

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ABSTRACT

The term welfare clearly reaches beyond the biological, physiological and economic necessities that directly sustain an individual's life. Welfare includes inherent values for the existence of family bonds, aesthetically pleasing settings and numerous other qualities and quantities that elicit pleasure in individuals simply through existing and remaining available for future generations to benefit from. Market failures occur wherein these inherent values are ignored within decisions that are based upon cost-efficiency alone.

This thesis investigates the applicability of environmental valuation techniques as a method of correcting for market failures in the environmental realm. The theoretical basis for the increased popularization of environmental valuation techniques within public policy as welfare enhancing measures is also identified.

The focus is on estimating pecuniary values for environmental goods and services that do not exhibit market prices. More specifically, this study estimated monetary values for the unpriced environmental goods and services that are negatively impacted by paper use at Acadia University. The estimated environmental values ranged from a total of $64 621.50 to $71 373, or $16.75 to $18.50 per student. These values could now be compared with objective values in Acadia University's paper purchasing decisions of the future.

CHAPTER 1

Introduction

1.1 Project Rationale

According to Joan Masterson, Manager of Financial Services at Acadia University (personal communication, February 4, 2003), "Acadia makes purchasing decisions based on value to the University which does not always mean the cheapest price". King and Mazzotta (2002) note that purchasing decisions are the result of three influences. Figure 1.1 illustrates these influences in the context of Acadia University. They are as follows:

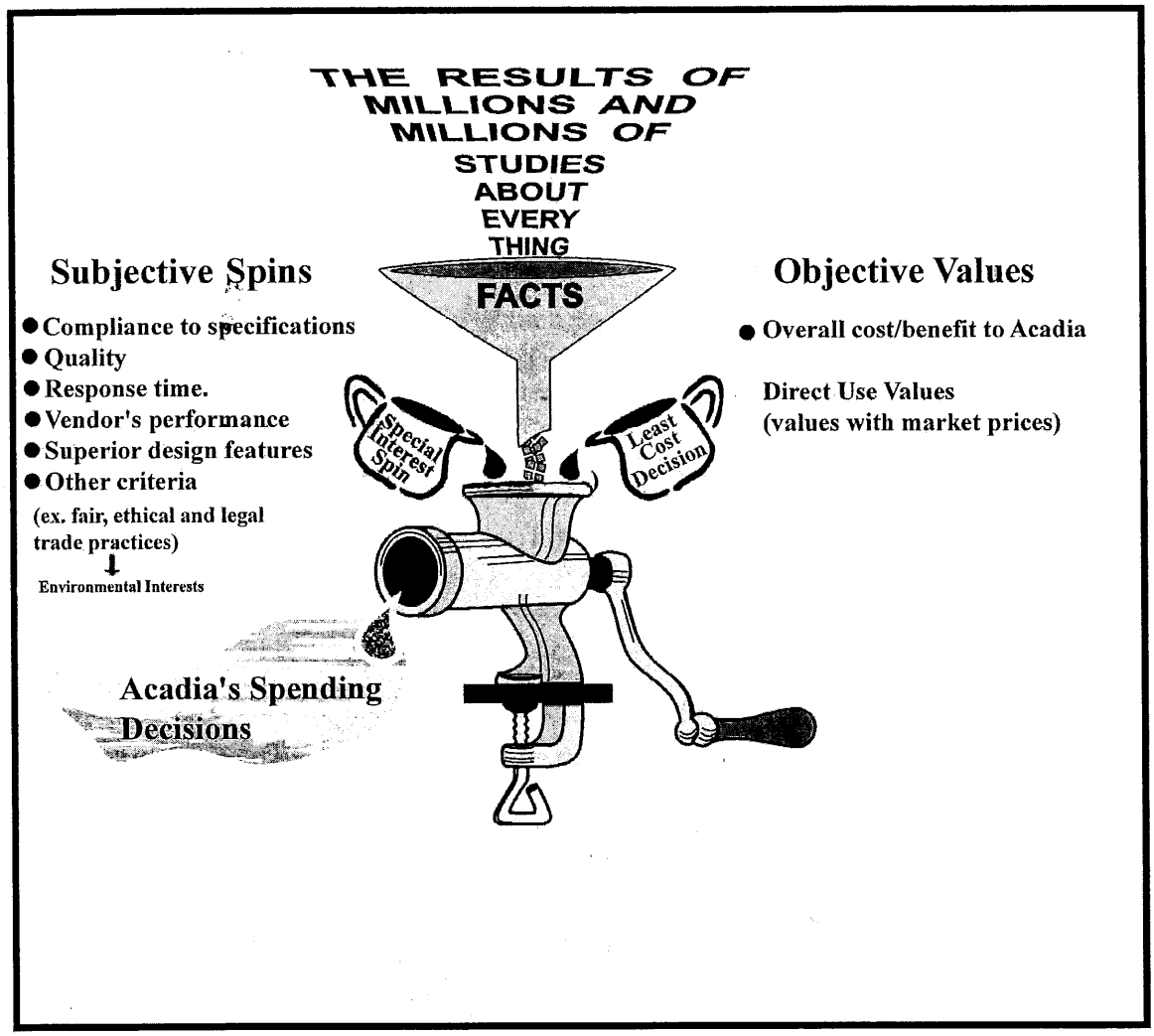
- Value free facts encompass virtually everything that is known to be true. Facts generally instigate the decision making process and offer solutions (King & Mazzotto, 2002).
- Subjective values, or values of special interest, include the inherent values held for goods and services that do not exhibit market prices. The subjective values listed in Figure 1.1 were noted specifically by Joan Masterson (personal communication, February 4, 2003). However, there are undoubtedly many more.
- Objective values encompass the assessment of the costs and benefits of each purchase. These values exhibit market prices (King & Mazzotto, 2002).

The three components are then merged to form the purchasing decision.

It is unlikely that the chosen outcome will maximize the welfare of Acadia University's stakeholders. This is because individual values for goods and services that do not display market prices (subjective values), will be implicitly treated as yielding zero value or will be randomly assigned weight within decisions. Therefore, the university

Figure 1.1

Acadia's Current Purchasing Pattern



cannot guarantee that its decisions will reflect the true values of its stakeholders as long as inherent subjective values remain incomparable with objective values. Exclusion of non-market values can lead to inefficiencies and suboptimal decisions. (Perman, Ma, McGilvray & Common, 1999). It would thus be in the university's best interest to implement techniques that would allow for priced and unpriced individual values to be compared on a common scale. Potential welfare increasing changes in the university's allocations of resources could then be identified and implemented.

In the past thirty years several economic environmental valuation techniques have been introduced in order to bring forth such welfare inducing changes (Hanley & Spash, 1993). These techniques are capable of generating monetary values for individual subjective values held for environmental goods that do not exhibit market prices (Tietenberg, 2000). Resulting outcomes, however, are often controversial (Perman et al., 1999). This is because many individuals consider environmental goods and services to be priceless. They realize that the existence of the human race and thus all economic activity is entirely reliant on the functioning of the natural environment. Thus they believe it to be absurd and/or unethical for monetary prices to be placed on components of the natural environment.

It must be recognized that spending decisions involve tradeoffs in the allocation of resources. The natural environment simply cannot be left untouched within all decisions. Difficult choices must be made according to which outcome will maximize benefits for society as a whole. Environmental valuations can be useful in providing justification for programs, policies, or actions that protect or restore the environment and also in

measuring the extent to which environmental improvements are economically feasible compared to other welfare eliciting initiatives (King & Mazzotto, 2002).

The primary focus of this thesis is on the application of an environmental valuation technique namely a contingent valuation (CV). The chosen topic for the CV study was specified after questioning numerous Acadia University students about their subjective environmental concerns. Wasteful paper consumption was continually noted as a source of contention due to its resulting destruction of life sustaining biological processes. Specific concerns were for losses in carbon sinks, losses in biodiversity, worsened air quality, and water and soil degradation. Additionally, students remarked that the innate spiritual values that they derive from natural landscapes are diminished as a result of the deforestation accompanying paper production.

The contingent valuation survey attempts to quantify (in monetary terms) the welfare losses that are being incurred by the students of Acadia as a result of paper use at the university. It is hoped this thesis will form a basis for future valuation surveys that are aimed at addressing environmental issues. Future initiatives are encouraged in order to enable subjective and fiscal values to be compared on a common scale so as to prioritize the university's purchasing decisions according to which outcome would maximize the welfare of its stakeholders.

CHAPTER 2

Environmental Valuation

2.1 Introduction

The environmental goods and services provided by the earth, a closed system, are available in limited quantities. They are therefore, scarce. This is apparent for non-renewable resources such as fossil fuels. Yet, even renewable resources such as forests have critical limits after which the stock will collapse. Faced with scarcity, resources must be allocated amongst competing users in an effort to yield an economically efficient outcome (Perman et al., 1999). As Chapman (2000) points out, "Increasingly, we need to think of 'environmental resources' as exhibiting two economic characteristics: they are closely linked to natural resources, and they have significant external value related to environmental protection" (p. 3). Currently, suboptimal outcomes are commonplace wherein unpriced external values relating to environmental protection are not accounted for in decisions and actions that are based upon the maximization of monetary profits. Thus individual welfare losses caused by the resulting environmental damages will be excluded from the costs within decision options. Clearly, this will lead to inefficient results.

This chapter explores the nature of the dilemma facing policy makers in trying to implement decisions that maximize benefits among stakeholders whilst simultaneously preserving the natural environment. The first section outlines the global state of growing environmental concern and its effects on policy decisions. It becomes clear that predicted future trends for the stability of the biosphere are uncertain in that they range from inevitable disaster to boundless improvement. Thus, policy makers must consider

employing a variety of different initiatives in order to ensure that social welfare maximization occurs. Such a situation is deemed Pareto optimum and will be described in the second section. Section three considers some of the market failures that prevent Pareto optimal situations from occurring. Sections four to eight follow with an explication of how the process of estimating pecuniary values for intangible environmental goods and services can provide a means of correcting for these market failures.

2.2 Theorized Trends for the Future State of the Environment

Since the 1972 publication of "The Limits to Growth", a world wide environmental movement has been gaining momentum. Throughout this period, industries, governments and other sectors of society have been lobbied to undergo major changes in preparation for a "sustainable" future. That is, a future that "focuses on long-term human health, wellbeing and environmental integrity" (Beck-Oliver, 2002. p. 1).

Several economists have attempted to identify the causes and effects of this increased concern for the environment (Martinez-Atlier, 1995). The increased concern has often been attributed to increases in income per capita over the past three decades. It is clear that as individual standards of living have improved, the opportunity cost of diverting expenditures and time toward bringing about environmental improvements has become lessened. That is, the expenditures and quantities of time that are sacrificed for environmental improvements are no longer required to secure the individual's survival and can thus be allocated elsewhere (Martinez-Atlier, 1995). Some economists believe that the demand to protect environmental goods and services at any given price rises more

than in proportion to rises in income. That is, they consider environmental stewardship to be a luxury good (Martinez-Atlier, 1995).

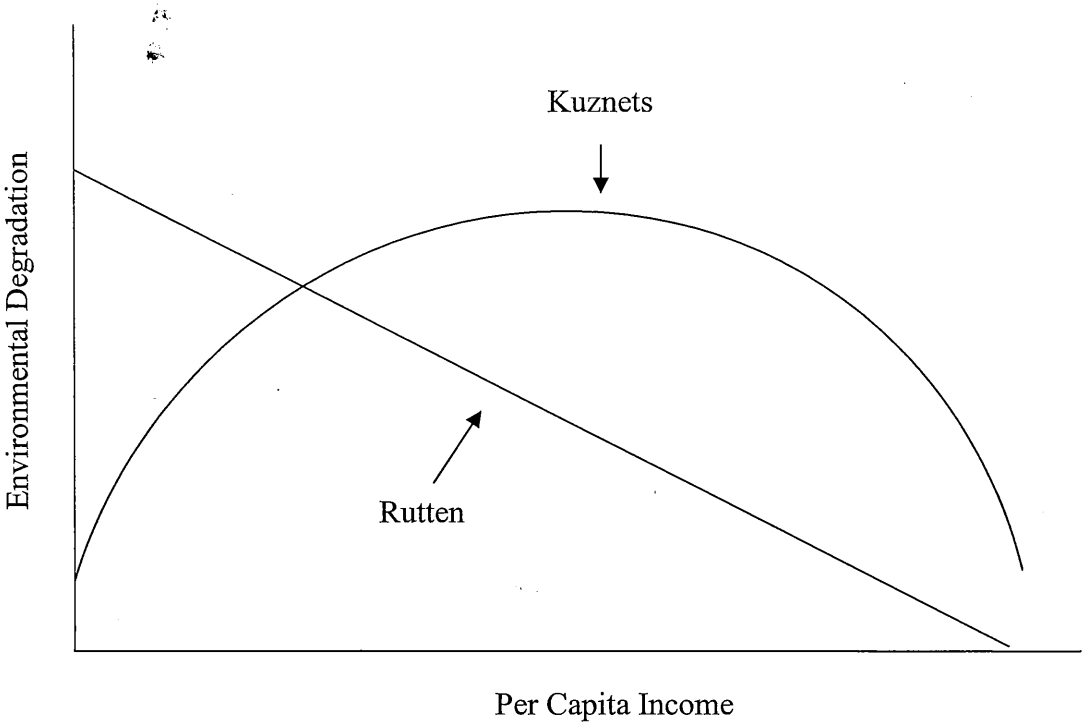
Ruttan (2002) similarly denoted that increases in income will spur increases in concern for the environment. Thus environmental concerns are at least normal goods if not luxury goods. Consequently, policy makers should be aware that actions must be taken in order to ensure that environmental quality will improve indefinitely into the future as income per capita rises. Ruttan's theory is depicted in Figure 2.1 wherein increases in income per capita have lead to continuous decreases in environmental degradation.

Kuznets (1955) argued that beyond a certain income per capita, suggested to be in the $4000 to $5000 range, environmental concerns will display characteristics of a normal or luxury good. However, in contrast to Ruttan's argument, Kuznets indicates that prior to earning this set amount of income, environmental degradation will rise at a decreasing rate as economic development occurs (Chapman, 2000). When faced with such a scenario, policy makers must carefully monitor the preferences and the incomes per capita of their stakeholders in deciding when to commence the allocation of resources toward environmental protection. A graphical representation of Kuznet's theory is provided in Figure 2.1 wherein increases in income per capita will initially cause environmental degradations to increase, however these environmental degradations will recede as income continues to increase.

Other economists disagree with the ideas of Kuznets and Ruttan. They believe that the opening of trade combined with increases in income will contribute to rising global environmental degradations (Chapman, 2000). That is, actions resulting in environmental

Figure 2.1

The Environmental Kuznets Curve and Ruttan's Theory



damage will not be voluntarily prevented unless the effects will negatively impact the individual that is the source of harm. Economists generally assume that individuals rather than policy makers are the most capable of judging what is best for society (King & Mazzotta, 2002). Global environmental degradations would then remain and increase if policy makers were to represent individual preferences under such a scenario. This would lead to an inequitable welfare distribution among geographic regions and generations. Such situations promote a need for international cooperation to form treaties such as the Kyoto Protocol. Representation of the interests of future generations is also vital.

Overall, it is apparent that predictions of how income per capita will affect environmental quality and quantity remain controversial. Predictions of the future range from inevitable environmental improvement to impending doom (Tietenberg, 2000). Thus, the invisible hand cannot be relied upon to bring forth a sustainable future. It is the responsibility of policy makers to continually monitor individual preferences in order to bring about situations that maximize welfare gains. Such a situation is termed Pareto Optimum. However, achieving the conditions necessary for a Pareto Optimal situation in the context of environmental quality can be an illusive task.

2.3 Pareto Optimum

A Pareto Optimal situation exists wherein "no other feasible allocation could benefit some people without any deleterious effects on at least one other person" (Tietenberg, 2000. p. 28). This requires efficient allocations in consumption and production decisions. These conditions must then correspond with welfare maximization. A simple model based on the work of Perman et al. (1999) demonstrates such a situation.

Assume that there are only two individuals (A and B) and that there are only two goods produced (X and Y). Individual A's total utility (U^A) is a function of the quantities they consume of goods X and Y. The same is true for individual B.

$$U^A = U^A (X^A, Y^A) \qquad U^B = U^B (X^B, Y^B) \tag{2.1}$$

The marginal utilities of individuals A and B derived by consuming an extra unit of X and Y are as follows:

$$MU^A_X = \partial U^A / \partial X^A \qquad MU^B_X = \partial U^B / \partial X^B \tag{2.2}$$

$$MU^A_Y = \partial U^A / \partial Y^A \qquad MU^B_Y = \partial U^B / \partial Y^B$$

Efficiency in consumption (shown in equation 2.3) requires that the ratios of marginal utilities derived from goods X and Y are equal between consumers A and B. Were this not to be the case, consumers could exchange goods amongst themselves in order to obtain extra utility.

$$MU^A_X / MU^A_Y = MU^B_X / MU^B_Y \tag{2.3}$$

In order to bring about productive efficiency in this model we must assume that both X and Y are private goods. That is, "any good or service which if used by one individual or firm is not available to others" (Black, 1997. p. 368).

Goods Y and X use two inputs: capital (K) and labour (L). Thus X and Y are both functions of their inputs:

$$X = X(K^X, L^X) \tag{2.4}$$

$$Y = Y(K^Y, L^Y)$$

The marginal products of adding one more unit of input to produce goods X and Y are as follows:

$$MP^{X}_{L} = \partial X/\partial L \qquad MP^{Y}_{L} = \partial Y/\partial L \tag{2.5}$$

$$MP^{X}_{K} = \partial X/\partial K \qquad MP^{Y}_{K} = \partial Y/\partial K$$

Efficiency in production requires that the ratios of marginal products of the inputs to be equal for X and Y. If this were not the case, producers could exchange inputs amongst themselves in order to increase the total quantity produced.

$$MP^{X}_{L}/\ MP^{X}_{K} = MP^{Y}_{L}/\ MP^{Y}_{K} \tag{2.6}$$

In order to obtain an economically efficient outcome, the ratio of marginal utilities for goods X and Y (which is the same between individuals A and B) must then be equal to the marginal product of using an extra unit of labour or capital to produce goods X and Y. Thus, an economically efficient situation requires that:

$$MUx/MUy = MP^{Y}_{L}/\ MP^{X}_{L} = MP^{Y}_{K}/\ MP^{X}_{K} \tag{2.7}$$

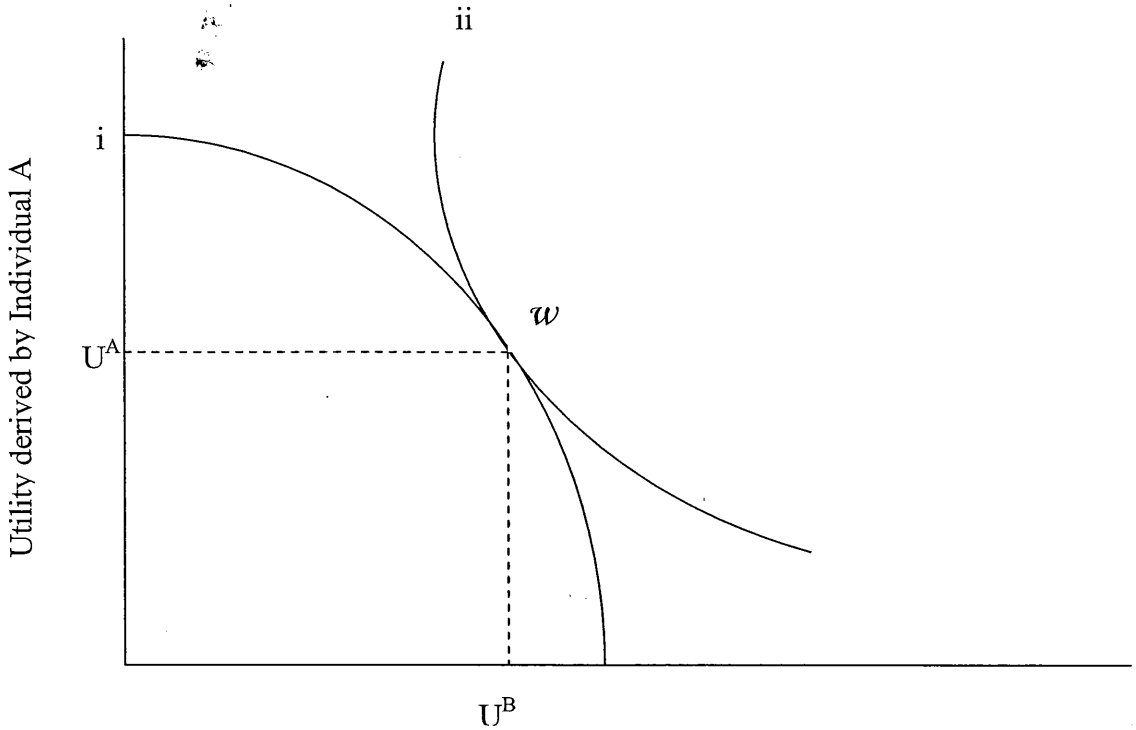
There are many possible efficient allocations. This is because outcomes will depend on the initial quantities and distribution of the inputs. Each point on the utility possibility frontier (depicted in Figure 2.2 as curve i) represents a possible efficient allocation of resources depending on the initial distribution of inputs. The slope of this curve is:

$$MU^{B}_{X}/\ MU^{A}_{X} \quad \text{for extra units of X} \tag{2.8}$$

In order to bring about a Pareto Optimal situation, this allocation must then correspond with the social welfare maximizing situation. Social welfare (W) is a function

Figure 2.2

Pareto Optimum



of the total utility of individual A and individual B:

$$W = W(U^A, U^B) \tag{2.9}$$

The marginal welfare of individuals A and B gaining an extra unit of utility is:

$$MW_U{}^A = \partial W/\partial U^A \qquad MW_U{}^B = \partial W/\partial U^B \tag{2.10}$$

The slope of the welfare indifference curve is then:

$$MW_U{}^A / MW_U{}^B \tag{2.11}$$

This curve is depicted as curve ii in Figure 2.2. The utility levels enjoyed by individuals A and B are given on the axes. At any point on the welfare indifference curve, any combination of individual A and B's utility will yield an equal total utility outcome. Social welfare maximization (Pareto Optimum) occurs at the point where the slope of the welfare indifference curve is equal to the utility possibilities frontier.

$$MW_U{}^A / MW_U{}^B = MU^B{}_X / MU^A{}_X \tag{2.12}$$

This situation is depicted graphically in Figure 2.2 at W. At this point, individuals A and B derive equal amounts of welfare, U^A and U^B respectively.

2.4 Externalities as Market Failures

It is uncommon for markets to operate under Pareto Optimal conditions. This cannot be attributed to poor management, incompetence or immoral objectives (Baumol, 1979). Rather, market failures are embedded within the existing economic structure. Thus, the full social costs and benefits of an action are often not reflected in decisions that are based upon individual profit maximization.

Environmental amenities and natural resources bring forth market failures when they exhibit properties of public goods or services, lack property rights and are vulnerable to externalities. Under such circumstances, the environmental amenities will be transacted in incomplete markets or will not be transacted at all (Perman, et al., 1999). Examples include:

- Deforestation and its resulting reduction in carbon sinks is an example of an incomplete market. The loss in social benefits previously derived from carbon sinks will be excluded from the cost of timber.
- The air we breathe is an example of an environmental service that is not transacted within markets. Yet it is apparent that clean air is a crucial asset to human welfare. This was verified in the summer of 2002 when large quantities of smog migrated from the eastern United States and Ontario into the Annapolis Valley. The smog negatively affected the health and livelihoods of individuals residing in the Annapolis Valley region.

Each example illustrates a negative externality. As Baumol and Oates (1979) explain, "an externality is present whenever some individual's (say A) utility or production relationships include real (that is, non-monetary) variables, whose real values are chosen by others (persons, corporations, governments) without particular attention to the effects on A's welfare" (p. 17). According to Perman et al. (1999), there are four types of externalities. They are as follows:

- A beneficial production externality accompanies environmental education. If a student shares his or her acquired information with other individuals that have not participated in the course, the social benefits will multiply from there on in.

- An adverse production externality occurs when a factory dumps its wastes into an adjacent river. This would have detrimental effects on individuals residing downstream.
- A beneficial consumption externality occurs when an individual purchases a property that is overrun with solid waste that can be seen from miles around. If the individual cleans the property so that it regains its natural state as an aesthetic vista, s/he will induce welfare increases in nearby inhabitants.
- An adverse consumption externality occurs when the use of motor vehicles contributes to fossil fuel emissions and thus also to global warming.

The presence of such externalities makes it unlikely that the market will be operating in a welfare maximizing situation if individuals are acting purely out of self interest.

The following model illustrates how consumption externalities can lead to suboptimal allocations of resources. Recall that efficiency in consumption requires that the ratios of marginal utilities derived from goods X and Y are equal between the two consumers (A and B) is shown below. Note that that this relationship is now depicted in terms of private marginal utility (PMU).

$$PMU^{A}_{X} / PMU^{A}_{Y} = PMU^{B}_{X} / PMU^{B}_{Y} \qquad (2.13)$$

Simply ensuring that the above condition is satisfied does not ensure that utility has been maximized for all of society if externalities are present. In such a case, consumer A's consumption of goods X and Y would impact consumer B in an unintended way and vice versa. In the presence of externalities, Pareto Optimum occurs where social

marginal utility is equal among individuals. Social marginal utility is the sum of private marginal utility and external marginal utility (EMU).

$$(PMU^{A}_{X} + EMU^{B}_{X}) / (PMU^{A}_{Y} + EMU^{B}_{Y}) = (PMU^{B}_{X} + EMU^{A}x) / (PMU^{B}_{Y} + EMU^{A}_{Y})$$

$$= SMU^{A}_{X} / SMU^{A}_{Y} = SMU^{B}_{X} / SMU^{B}_{Y} \quad (2.14)$$

Pareto Optimum is then:

$$MW_{U}{}^{A} / MW_{U}{}^{B} = SMU^{B}_{X} / SMU^{A}_{X} \quad (2.15)$$

Clearly, if individuals act purely out of self interest, the resulting outcome will differ from the social welfare maximizing outcome that would have been obtained had the external effects of individual's actions been considered.

$$MW_{U}{}^{A} / MW_{U}{}^{B} \neq PMU^{B}_{X} / PMU^{B}_{X} \quad (2.16)$$

However, it should be noted that if by some chance the externalities on each side of the equation 2.14 were to be perfectly offsetting, the resulting outcome caused by individuals acting purely out of self interest would be the same as the social welfare maximizing situation.

Suboptimal outcomes are a common occurrence in markets wherein values for environmental amenities that have not been assigned monetary prices (called intangible goods and services) are excluded or subjectively given weight in measuring the costs and benefits of an action. Ignoring intangible benefits or costs will bias results in favour of goods and services that have been assigned monetary prices (tangible goods) (Tietenberg, 2000). After all, it is known that concerns for the environment reflect negative externalities that will accompany decisions and actions that cause damage to the environment. These actions will bring about decreases in individual utility derived from

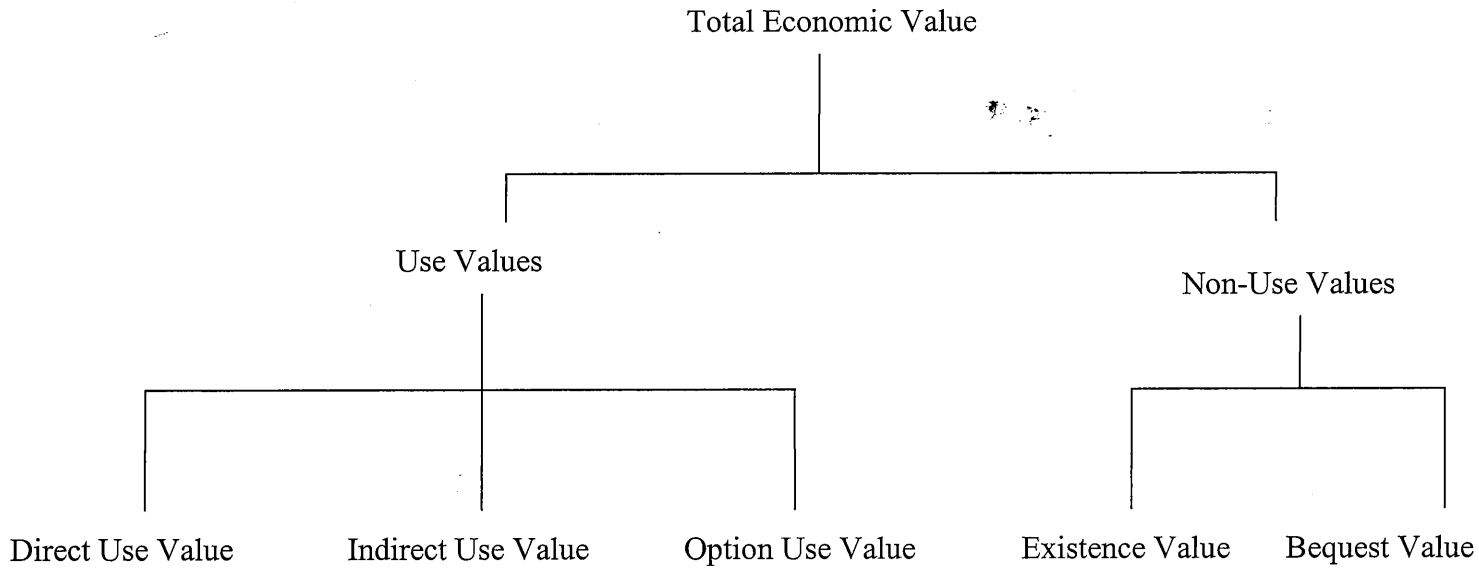
environmental goods and services regardless of whether the individual will personally experience the damage or not. If these intangible values are then to be excluded from economic analyses, expanding an industry (which derives direct monetary returns) would continually be triumphant over the option of preserving a pristine natural area (which does not yield any market returns). This certainly should not always be portrayed as the optimal situation (Baumol & Oates, 1979). Thus policy makers have a responsibility to ensure that intangible values are included where they exist into decision processes. In order to do so, however, it is necessary for these values to be quantified so that they can be compared on a common scale with given monetary values. The welfare maximizing decision could then be decided upon within a cost-benefit framework.

2.5 Environmental Values Categorized

Policy makers must first identify values for intangible environmental amenities before they attempt to quantify these values. Economists generally categorize values into use values and non-use values (Perman et al., 1999). These categories and sub-categories are depicted in Figure 2.3.

Use values are obtained through "the actual or planned use of a good or service by an individual" (Perman et al., 1999. p. 378). Use values can be subdivided into:

- Direct use values yield market prices or shadow prices. A shadow price is the cost of a good or service that indirectly replaces an environmental asset. For example, the utility gained by an individual from fishing (a direct use) can be reflected in the price of fishing licenses (Perman et al., 1999).


Total Economic Value
Use Values
Non-Use Values
Direct Use Value
Indirect Use Value
Option Use Value
Existence Value
Bequest Value

- Indirect use values typically do not exhibit market prices. An example would be the utility an individual accrues from watching a television program about fishing (Bateman & Langford, 1997).
- Option use values do not hold market values. These values arise whereby the availability of the good or service for future direct use or indirect use elicits utility for an individual (Tietenberg, 2000). An example would be the utility an individual derives knowing that a particular lake will be protected in order to ensure that they will someday have the option to fish in that lake.

Non-use values are accrued by the knowledge that the environmental amenity will remain available for present and future generations without the intention of ever visiting the site (Perman et al., 1999). They do not yield market prices. Non-use values can be classified as bequest values or existence values.

- A bequest value elicits utility for an individual in knowing that an environmental amenity will be available for future generations to enjoy. An example would be the utility an individual gains in knowing that a housing development on a particular lake has been cancelled in order to preserve wilderness fishing in the area for future generations (Chapman, 2000).
- Existence values are the utility gains accrued by individuals in knowing that an environmental good or service will continue to endure. An example would be the value a man residing in China places on conserving fish stocks in Atlantic Canada, even though he has no intention of ever traveling to the area (Chapman, 2000).

Total value for an environmental good or service is therefore the sum of all use values and non-use values for that good or service. That is:

Total Value = Direct Use Values + Indirect Use Values + Option Use Values + Bequest Values + Existence Values

2.6 Assigning Monetary Values to Unpriced Environmental Goods and Services

A cardinal estimate of environmental values would make it possible to compare environmental and economic values on a common scale. Value is defined by King and Mazzotta (2002) as "the maximum amount of one thing a person is willing to give up to get more of something else" (p. 3). Dollar values are widely accepted as a representation of value. By spending more on one good or service, the individual will have less to spend on other goods and services.

This thesis will focus on assigning dollar values to environmental concerns. In doing so, the net social gains and/or losses to society can be estimated and employed in a cost-benefit analysis. Within such an analysis, different alternatives can be scrutinized and optimal solutions based on economic efficiency identified. It is noted by King and Mazzotta (2002) that this "may or may not be the same as the most socially acceptable option, or the most environmentally beneficial option. Remember, economic values are based on peoples' preferences, which may not coincide with what is best, ecologically, for a particular ecosystem" (p. 3). Yet, because policy makers are making public decisions, it is expected that they should choose solutions that reflect the preferences of its stakeholders. The economically efficient outcome could then be used in conjunction with other related information or any overriding concerns. Environmental valuation thus does not ensure a Pareto Optimal outcome. It is expected, however, to provide information that could bring a society closer to such a situation.

2.7 Willingness to Pay and Willingness to Accept Compensation

Hicks (1941) ascertained four measures of money values for changes in utility resulting from a decision or action that has externalities relating to the environment. The following model is based on the work of Hanley and Spash (1993) and contains these four measures, namely; compensating variation, equivalent variation, compensating surplus and equivalent surplus.

It is assumed that there are only two goods or services, A and B. The price of A is held fixed while the price of B varies. The individual's income is also held fixed at Y so that their budget constraint always consists of a combination of A and B. Thus:

$$A + PB = Y, \tag{2.17}$$

where P is the price of B at the given time.

The individual's indifference curve would then be a function of the two goods or services, A and B.

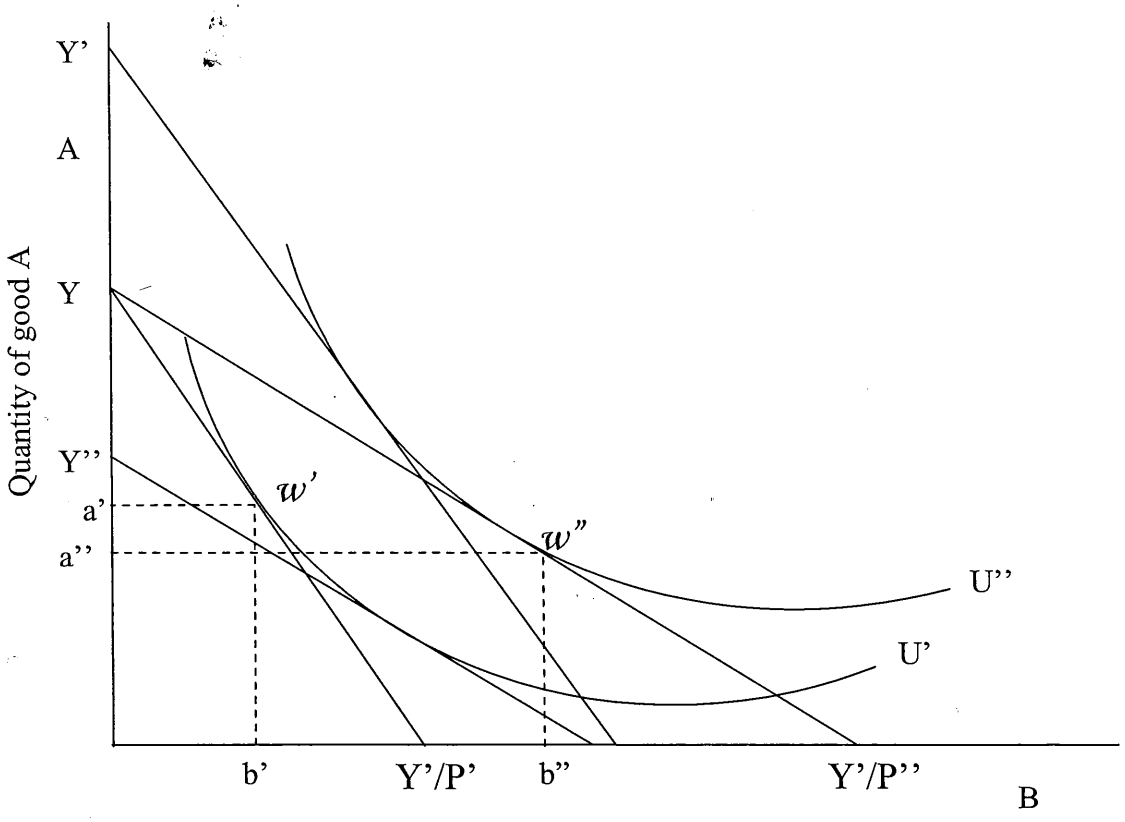
$$U = U(A,B) \tag{2.18}$$

The utility maximizing position is depicted at point W in Figure 2.4. If price were to decrease from P' to P'', the new utility maximizing level would change from W'- W''. If income were then to be held constant at Y, the quantity of A consumed would decrease from a'-a'' and the quantity of B consumed would increase from b'-b''.

The utility gains by this individual can be shown by the variation of income. The equivalent variation (EV) is the amount of money that if given to the individual, would put them back at their initial utility level, as though the change had never occurred. This is given on the graph as Y'-Y. The compensating variation (CV) is the amount of money

Figure 2.4

Equivalent and Compensating Variation



that if forgone by the individual, would also put the individual back at their pre-change utility level. This is shown as Y-Y''.

It is now possible to define these EV and CV values in terms of individual willingness to pay (WTP) and willingness to accept (WTA) compensation (Perman et al., 1999). With a price fall, the CV is a measure of the individual's WTP for the change to occur while EV is a measure of the individual's WTA compensation for the change not to occur. For a price rise, the CV is a measure of the individual's WTA compensation in order to allow the change to occur. The EV is then a measure of the individual's WTP for the change not to occur.

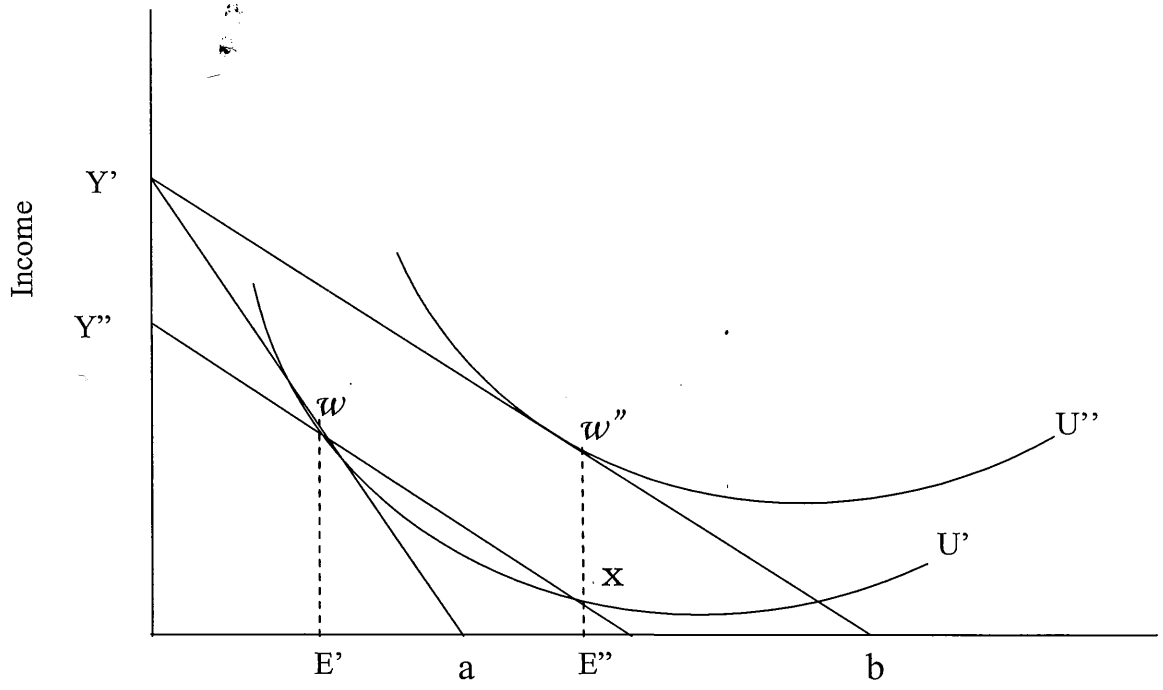
This model changes slightly wherein it is changes in environmental quality and quantity that is being measured rather than price (as depicted in Figue 2.5). It must first be assumed that the individual's utility is a function of a particular environmental good or service (E) and also of his or her income (Y).

$$U = U(E, Y) \tag{2.19}$$

Next, it is assumed that E is a good or service that is transacted in an incomplete market or is not transacted at all. Therefore, the individual has no control over how much E they consume. The individual's initial indifference curve is labeled U' in Figure 2.5. They begin with an initial income of Y' and a quantity or quality of the environmental good or service at E'. The individual's welfare maximizing situation is at W'. Now, if the quality or quantity of the environmental good or service were to increase (assume that this is a positive change), it would shift the budget line from Y'a to Y'b. The individual would now have a higher utility at U''. The new welfare maximizing point would be at W''. By

Figure 2.5

Compensating Surplus



drawing a parallel line to Y'b that intersects point W, we derive point X. At point X, the individual is not at a welfare maximizing tangency. However, if the individual were to pay an amount of W''-X, they would be brought back to their original level of utility and experience E at E''. This is called their compensating surplus (CS). Hence, W''-X represents the maximum amount that the individual would be willing to pay for the environmental improvement.

Referring to Figure 2.6, suppose the quality or quantity of the environmental good or service has increased, causing the budget line to move outward from Y'a to Y'b. By drawing a parallel line to the original budget constraint Y'a, that passes through w'', we derive point x. If the individual were compensated by the amount of X-W, they would remain at the same level of utility as in the initial situation. This is known as the individual's equivalent surplus (ES). Thus, X-W is the minimum amount the individual would be willing to accept as compensation to allow the environmental improvement not to occur.

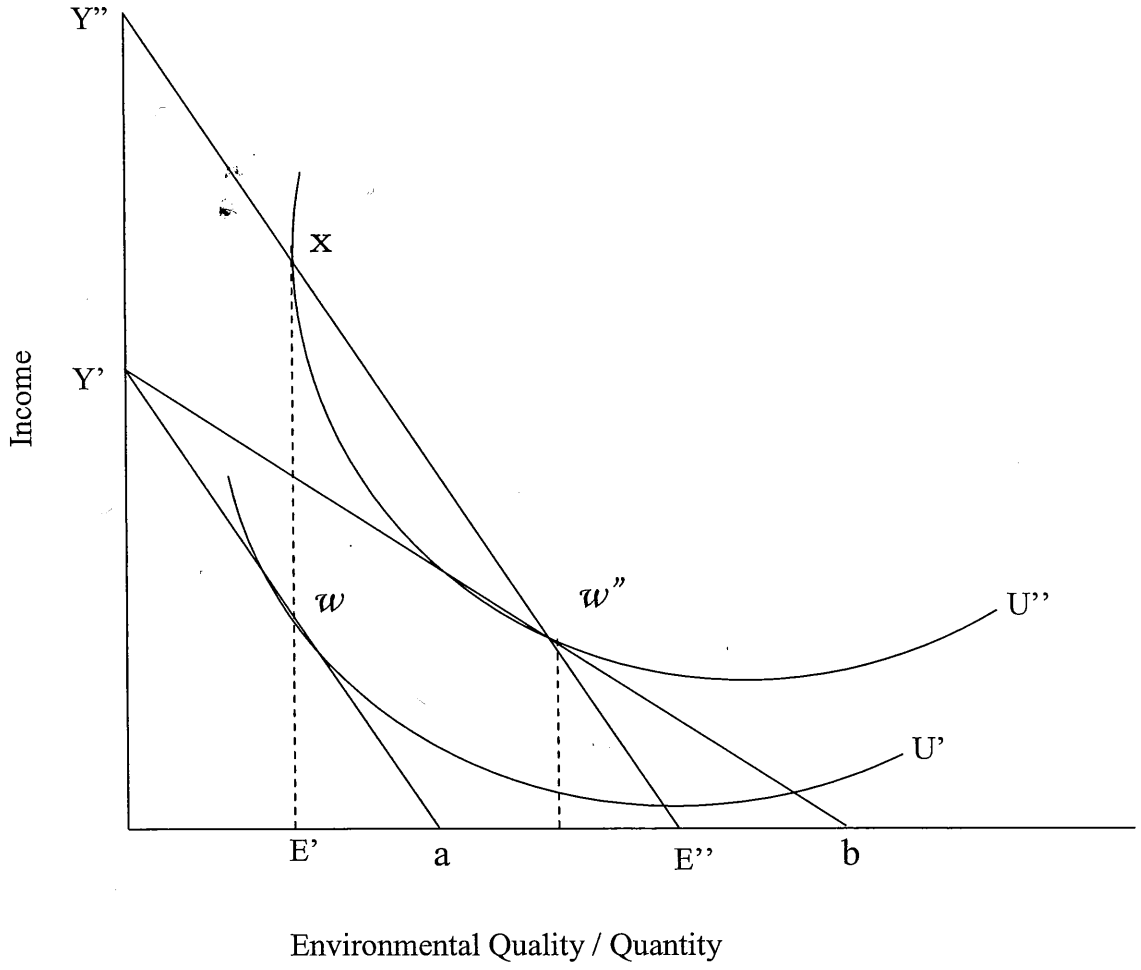
Conversely if there had been deterioration in environmental quality or quantity rather than an improvement, CS would have been a measure of WTA compensation for the change to occur and ES would have been a measure of WTP for the change not to occur.

2.8 Techniques for valuing the Environment

There are several methods that can be used to elicit values for willingness to pay and willingness to accept compensation for changes in environmental goods and services.

Figure 2.6

Equivalent Surplus



The noted methods can be categorized into two types; direct and indirect methods. Direct methods can be further subdivided into direct observable behaviour and direct hypothetical behaviour (Tietenberg, 2000).

- Direct observable behaviour involves collecting tangible values from a direct source. For example, you could directly observe how water pollution has affected the sales of vendors on a public beach by looking at changes in their total revenues.
- Direct hypothetical behaviour involves the utilization of a Contingent Valuation survey. A CV survey directly asks respondents what they would be willing to pay for the good or service in question. This concept will be explored extensively in the subsequent chapter.

Indirect methods can also be subdivided into types. They are, indirect observable behaviour and indirect hypothetical behaviour (Tietenberg, 2000).

- Indirect observable behaviour involves inferring a value from an observed behaviour. The three most popular methods of inferring indirect observable behaviour are the travel cost method, hedonic property value and averting expenditures.
    - The travel cost method is carried out by inferring the cost incurred by an individual to visit an environmental good or service. The cost then mirrors the minimum monetary worth of the environmental amenity. This method could be implemented by monitoring the price of gas, the number of times the site has been visited or any other number of travel related variants.

- The hedonic property approach involves inferring how the value of a property is affected by the surrounding quality of environmental goods and services. It does so by isolating the various components that together comprise a property value. It then monitors the affects of environmental changes, ceribus paribus, within a multiple regression analysis.
- Finally, an averted expenditure is used to prevent environmental degradations. Therefore, the price of a retaining wall used to prevent erosion can be interpreted as a measure of the pecuniary value of an un-eroded landscape.

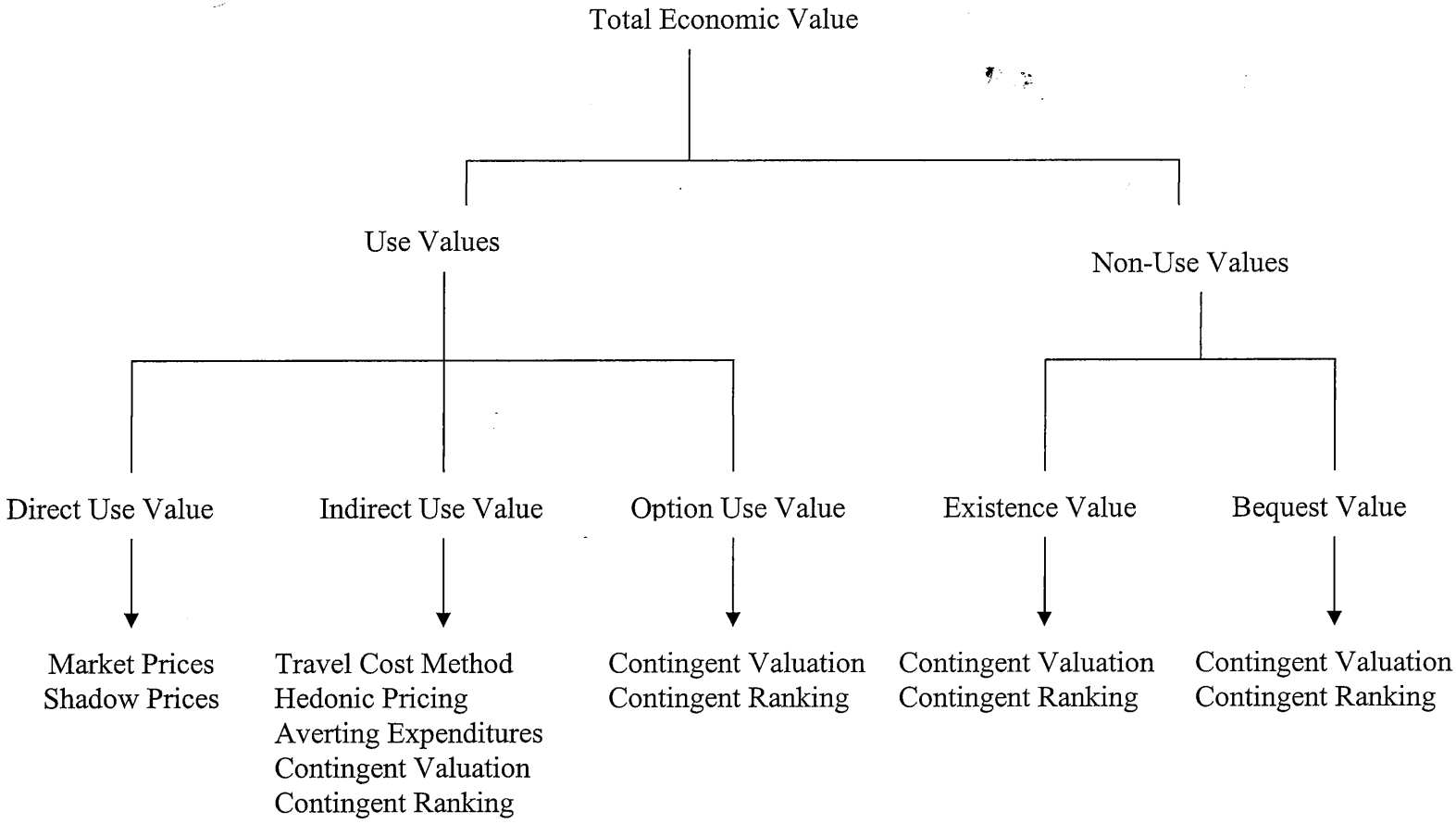
- The indirect hypothetical method involves a procedure called contingent ranking wherein individuals are asked to rank a list of hypothetical situations ranging in environmental quality and attributes. Surveyors can then infer the ranking of environmental amenities in policy decisions (Tietenberg, 2000).

These techniques can be applied to the different types of values as shown at the bottom of Figure 2.7.

It is recognized that these techniques are not flawless. For instance, unless the environmental amenity in question enters the utility function of at least one individual, somewhere in the world, it will have little opportunity to be factored into any economic cost-benefit analyses.

The fact that only anthropocentric or human based concerns are included within economic cost benefit analyses is a source of apprehension for those individuals believing that the intrinsic value of animals and plants should also be given weight within policy (Hanley & Spash, 1993). Moreover, as noted in section 1.1, these values are subject to

Figure 2.7
Environmental Valuation Techniques



rejection by individuals believing that it is immoral to assign dollar values to "priceless" goods and services.

Other shortcomings include obtaining unrealistic values because of the heavy reliance on estimation required by these techniques. Obtaining these values could also be extremely expensive in itself, thereby reducing the economic efficiency of any actions in the short term. Also, once these values are obtained, one must be mindful that the results are not misused or skewed for altruistic motives (Perman et al., 1999).

Despite these deficiencies, environmental valuation has been deemed an essential component of economic analysis in correcting for market failures. Thus, the current techniques should not be abandoned altogether. Efforts should be made to refine these techniques over time.

2.9 Summary

The predicted effects of increased wealth on the future of the environment are arguable as can be seen by the theories of Ruttan, Kuznets and others. Policy makers must monitor the interests of stakeholders in order to prioritize their actions according to an outcome that will maximize social benefits. This is called Pareto optimality.

Pareto optimality occurs when "no feasible change can raise anybody's welfare without lowering that of somebody else" (Black, 1997. p. 342). This occurs at the point where the slope of the welfare indifference curve is equal to the utility possibilities frontier and shown in equation 2.12. Pareto Optimality, however, is difficult to achieve. This is a result of market failures. Environmental amenities are particularly susceptible to bringing about market failures when they exhibit properties of public goods or services

wherein they are open to use by all members of society, or if they lack property rights or both (Black, 1997). Such characteristics bring forth externalities. Externalities are "a cost or benefit arising from an activity which does not accrue to the person or organization carrying on the activity" (Black, 1997. p. 168) In the presence of externalities, Pareto Optimum occurs where social marginal utility is equal among individuals. Social marginal utility is the sum of private marginal utility and external marginal utility as shown in equation 2.14. Pareto optimum thus occurs at the point where the slope of the welfare indifference curve is equal to the utility possibilities frontier as shown in equation 2.15.

As Perman et al. (1999) point out, "market failures should be corrected for – all of the impacts arising from going ahead with the project should be taken into account of, irrespective of whether they have market prices attached to them" (p. 377).

Economists need the means of quantifying unpriced environmental goods and services to be compared on a common scale with priced goods and services within an economic cost benefit analysis. In doing so, environmental values must first be identified and categorized. There are a variety of strategies that can be employed in order to elicit pecuniary values for an individual's willingness to pay and willingness to accept compensation for either an environmental change to occur or not to occur. These include the travel cost method, hedonic pricing, investigations of averted expenditures, contingent valuation studies and contingent rankings.

Chapter 3 elaborates on the contingent valuation method as an example of an environmental valuation technique that is capable of eliciting values for WTP and WTA. Its focus is an application of a CV survey on the Acadia University campus.

CHAPTER 3

Application of a Contingent Valuation Survey at Acadia University

3.1 Background

Value free facts provide grounds for the university's decision to purchase paper. For instance, it is known that Acadia's stakeholders will require a means of keeping record of their information during the academic year. The options available to meet this requirement are paper (many different types, some with recycled content) and technological storage. There are a myriad of other general facts that may influence the decision.

The subjective values of focus in this thesis are the individual concerns held for the environmental goods and services that are negatively impacted by Acadia University's use of paper. It seems clear that the utility levels of many individual stakeholders at Acadia University are diminished by degradations relating to Acadia'a paper use policy. This is a negative externality. For instance, student interest groups such as the Student Taskforce for Environmental Policy (STEP) and the Acadia Environmental Society (AES) have committed themselves to reducing the university's ecological footprint by suggesting alternatives to current practices. According to Beck-Oliver (2002), author of the AES and STEP's *The Acadia University Project*, "Paper comes from trees, and trees are being harvested faster than they can replenish themselves with ecological integrity, which is not sustainable...there is no reason for Acadia to go through as much paper as it does. All memos and letters can be sent through email easily, and do not need to be printed out" (p.14). It is quite obvious, however, that these subjective values or the utility reductions caused to these individuals by environmental degradations

have not influenced paper purchases. This conclusion is based on the fact that Acadia will have purchased approximately 5.5 million sheets of 8.5' × 11' paper with 100% virgin fiber content by the end of this academic year, 2002-2003 (Dan Sweeny, personal communication, January 17, 2003). Virgin fiber content paper is substantially cheaper for the university at $6.52 per 1000 sheets, compared to the $9.71 it would pay for paper with 30% post consumer recycled content or the $25.53 it would pay for paper with 100% post-consumer recycled content (Unisource Canada Inc. Customer Service Representative, personal communication, December 10, 2002). Although the latter two are more costly in terms of explicit prices, both would help to reduce the environmental damage incurred by Acadia's paper usage and increase the welfare of individuals with environmental concerns.

A further departure from environmentally considerate decisions is Acadia's agreement with Inter-University Services Inc. (ISI). ISI has negotiated Acadia's contract for paper with Unisource Canada Inc (Joan Masterson, personal communication, February 4, 2003). When asked if ISI ever considered a company's environmental record or policy before choosing to purchase its product, ISI's response was "No, this has never been included in our tenders" (Inter-University Services Inc. Customer Service Representative, personal communication, February 4, 2003). Unisource Canada Inc. also lacks an environmental policy, nor does it require the various pulp and paper mills from which it purchases its paper products to abide by set environmental standards (Unisource Canada Inc. Customer Service Representative, personal communication, December 10, 2002).

It seems that cost-effectiveness and objective values have been the primary influence in the university's paper purchasing decisions. It was noted in an official

Acadia documentation that "As a member of Inter-University Services Inc. several agreements are in place with selected suppliers making it possible to receive reduced pricing" ("Guide to Administration," 2001. p. 7). For ISI, "The primary decision criteria is price. The second is product quality" (Inter-University Services Inc. Customer Service Representative, personal communication, February 4, 2003). Based on this purchasing criteria, the price received by ISI would presumably be the cheapest available rate for the university. Unisource Canada Inc. also purchases its paper according to which mills provide the most economical prices at the time (Unisource Canada Inc. Customer Service Representative, personal communication, December 10, 2002).

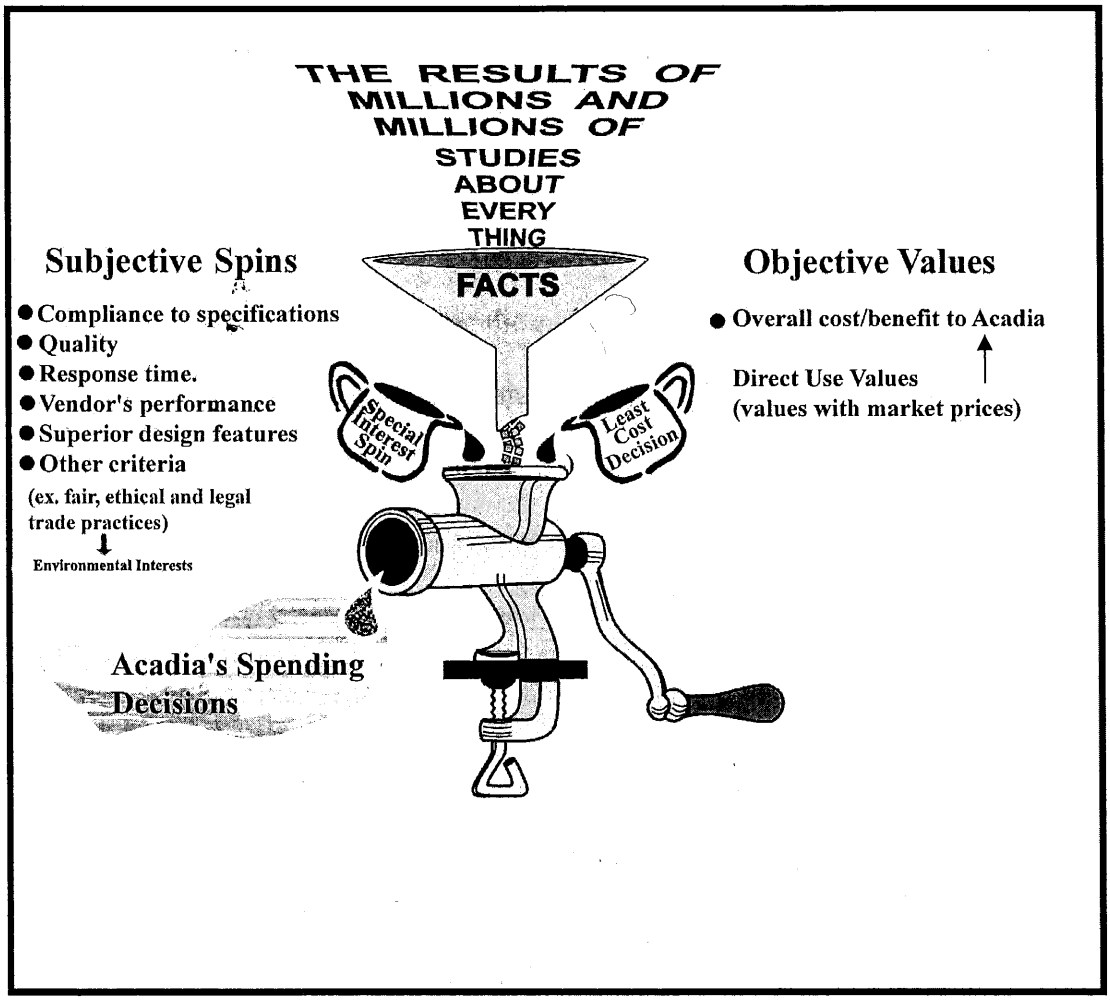
It is questionable whether current practices, albeit displaying properties of financially optimality (according to objective values), are truly socially optimal, given that subjective values for environmental goods and services have been excluded from the decision making process. Thus the welfare derived by individuals as a result of financial savings may not outweigh the welfare reductions incurred by individuals as a result environmental damage. Figure 3.1 (a replication of Figure 1.1) serves as a reminder of this issue.

3.2 The Application of a Contingent Valuation Survey

A contingent valuation survey was chosen as the method for placing pecuniary values on the unpriced environmental goods and services that are being negatively impacted by paper use at Acadia University. The dollar values given by the CV survey's results are meant to be representative of the individual utility gains that would be derived by noted environmental improvements (Chapman, 2000). These individual willingness to pay values were then aggregated to measure the student population's compensating

Figure 3.1

Acadia's Current Purchasing Pattern



surplus (CS) derived from bringing about the environmental improvements that were specified within the survey (Perman et al., 1999). Figure 3.2 (a replication of Figure 2.4) illustrates the concept of compensating surplus. As explained in section 2.7, CS is the amount of money that if foregone by the individual, or student population in this case, in order to bring about an environmental improvement, would result in the individual or group of individuals returning to their pre-change utility level. The CS value equals W''-X in Figure 3.2.

A key assumption underlying the application of the CV method is that the survey respondents know their own "true" values for the environmental goods and services that are in question (Mitchell & Carson, 1989). A unique estimate of each individual value for the different components of an ecosystem was not attempted within this study. It was recognised that respondents are not likely to be precisely aware of these values within a complex and multifaceted world. Rather, it was assumed that respondents are capable of identifying the true value of the combined environmental goods and services that are currently being impacted by the paper industry (Mitchell and Carson, 1989). Individual inherent values for particular environmental goods and services were thus identified and later combined to form two descriptive scenarios that were provided as background information within the survey. The identified values are categorised in Figure 3.3.

3.3 Identified Values for Environmental Goods and Services

The paper purchased by Acadia University yields a market price. Therefore, the resources used to produce paper also have direct use values. In addition, it is assumed

Figure 3.2

Compensating Surplus

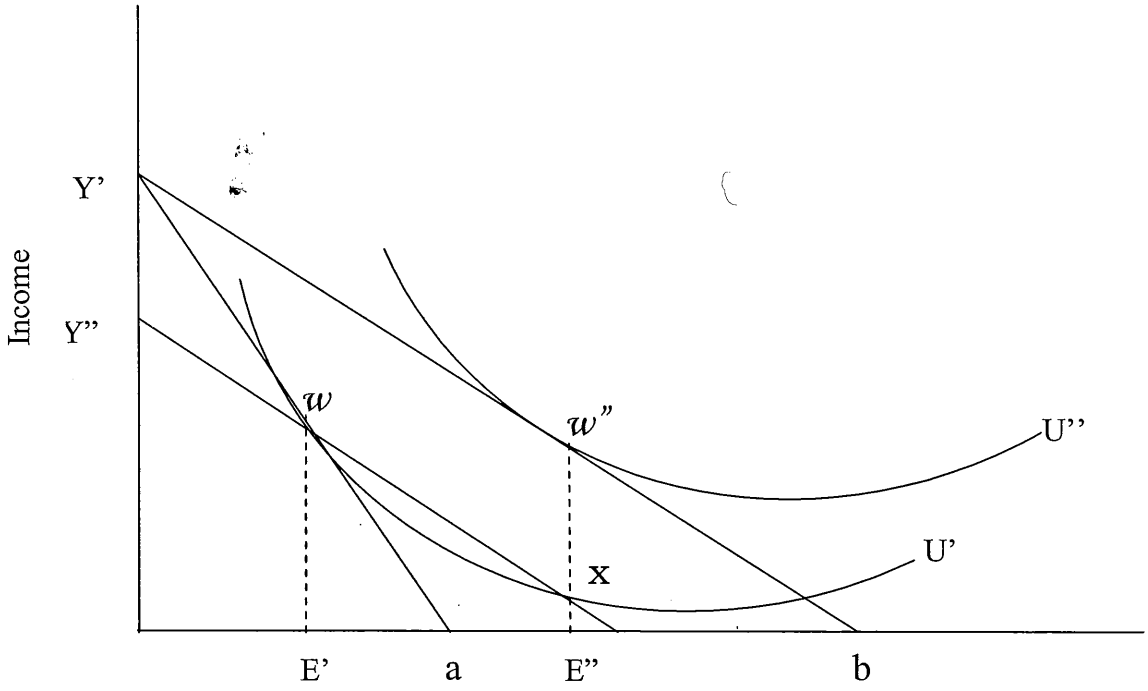
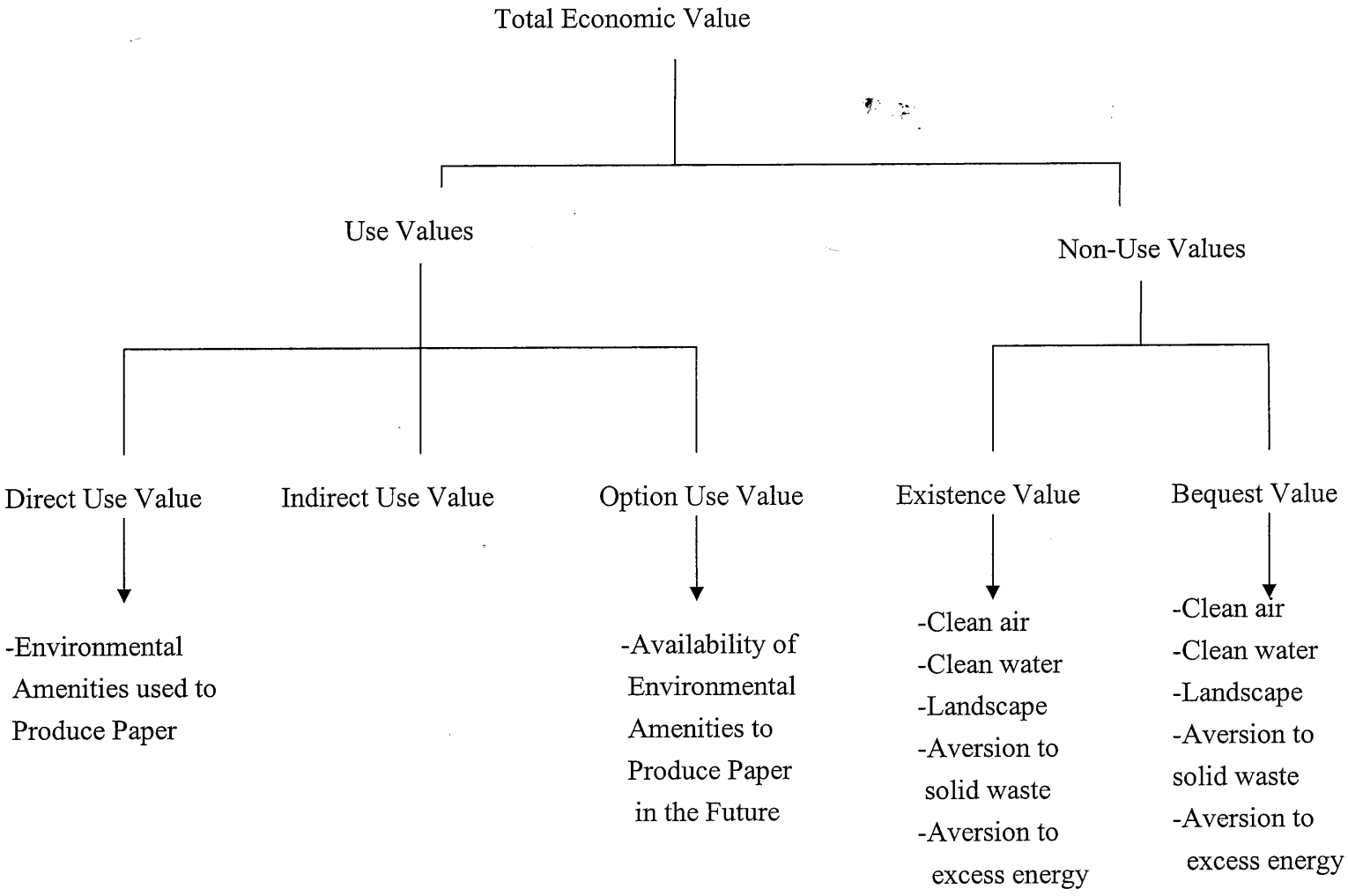


Figure 3.3
Environmental Values Identified



that there is value in maintaining the availability of these resources for the future purpose of producing paper. These values, however, were not included within the CV study because they were assumed to have already been factored into the prices paid by Acadia and its students as consumers.

Indirect values for environmental goods and services and the option to use these environmental goods and services for indirect uses in the future were also excluded from the study. This was for the reason that Unisource Canada Inc. purchases its' paper from varying pulp and paper mills in the eastern United States and Ontario (Unisource Canada Inc. Customer Service Representative, personal communication, December 10, 2002). It is very difficult then to isolate which persons at the university will experience or have the opportunity to experience the use values provided by these forests when the exact locations are unknown. However, it is recognised that the assumption that students will not personally experience the degradation of these resources may prove to be incorrect in the case of migratory pollutants.

Non-use values affected by the paper industry were included within the study. They include the utility derived from conserving energy, by not contributing to damaging atmospheric emissions, in preventing the formation of solid wastes, in preventing waterborne wastes and in conserving standing forests. Bequest values occur whereby individuals lose utility in knowing that the above resources will be altered so as to negatively impact future generations. Existence values occur whereby an individual gains utility in knowing that these natural assets will not be damaged even without the intention of ever visiting the forest sites and having the knowledge that the external affects will never reach them.

3.4 Survey Implementation

According to Boardman, Greenberg, Vining and Weimer (2001), CV studies should be applied to the relevant population. That population being "all individuals withstanding who are affected by the policy." (Boardman, Greenberg, Vining & Weimer, 2001. p. 366) The CV study was confined to measure the values held by students at Acadia University for the stated environmental amenities that are negatively impacted by the university's use of paper. It is recognised that faculty and staff are also directly affected by any changes in the university's paper use. Therefore, it would be reasonable for the values of these individuals to be included were the survey to be implemented for a second time. However, at the time of its first implementation, it was thought that accounting for the budgetary differences between these parties would be beyond the scale of the primary research. It is also recognised that other individuals residing away from the university such as alumni, or the residents of Wolfville or even a stranger to the area might also value these environmental goods and services. However, the inclusion of an overly large population within a CV study risks obtaining unrealistically large values (Tietenberg, 2000).

The study commenced in December of 2002 with a series of pre-tests involving differing scenario explanations and payment quantities. These pre-tests were performed on five small focus groups. The purpose of these pre-tests was to ensure content validity, question comprehension and to alter any questions subject to biases that would decrease the effectiveness of the survey (Perman et al., 1999). The most effective design was later sent to Acadia's student population in February of 2003. This design was based upon the format of Bennet and Blaney's (2002) study.

The internet was used as the medium for distributing and collecting data for the

survey. It was chosen because of its low distribution and collection costs (Boardman, Greenberg, Vining & Weimer, 2001). An online survey was also considered to be the optimal means of reaching the desired respondents due to the availability of an Acadia University student population email list. Other positive aspects of using an online survey included a low risk of interviewer biases because the researcher was able to remain anonymous to the respondents. Interviewer biases were of particular concern within the small academic setting wherein the survey took place because the survey respondents would not necessarily have been strangers to the researcher. This would have become problematic if, for instance, the survey respondent was aware that the researcher is affiliated with student environmental interest groups and thus felt obliged to answer survey questions in a different way than they would have had the researcher not been present.

There are shortcomings in using online surveys. This method is known to be less effective in conveying information clearly relative to personal interviews. The pre-tests however, were meant to identify 'amenity mis-specification' biases whereby respondents do not grasp the image intended and are therefore unable to make accurate value judgements (Perman et al., 1999). It is also thought that respondents are more apt to strategically vote in order to sway the results toward their own personal beliefs under anonymous circumstances such as the one presented in this survey (Boardman et al., 2001).

Each member of the Acadia student population received a copy of one of the three versions of the survey via email. Ideally the socio-economic and attitudinal characteristics of the students choosing to the respond to the survey would be equivalent to the characteristics of the total population (Perman et al., 1999). Non-response bias occurs

when the survey attracts the responses of individuals with common characteristics leaving the individual characteristics of non-responders underrepresented (Boardman et al., 2001). In order to minimize this potential bias, a title for the survey was not specified in the email so as not to deter individuals from focusing on either the environmental or economic content of the survey at the expense of the other. Furthermore, an incentive of the chance to win $10 was offered to those having completed the survey. It was thought that this incentive would attract a wider range of individuals. Whether these initiatives to avoid a non-response bias at the university were successful is unknown because statistics about the socio-economic and attitudinal characteristics of the student population at Acadia University were unavailable to the researcher.

3.5 Survey Content

Respondents initially disclosed personal information such as their weekly budgets and environmental attitudes. This information was later used in identifying correlations in the data collected. Responses to these questions were also helpful in identifying outlaying and protest responses (Perman et al., 1999). Figure 3.4 displays the list of attitudinal and personal information questions as they were stated in the survey.

Based upon "The Resource Assessment Commission South-East Forest CV Study" (Perman et al., 1999), respondents were presented with two hypothetical scenarios. The objective was to incorporate scenarios that were comprehensible, accurate and non-biased. The purpose of these scenarios was to prevent information biases whereby respondents are required to place pecuniary values upon a good or service in they know little about (Tietenberg, 2000). Figure 3.5 gives the two scenarios as they were stated in the survey.

Figure 3.4

Attitudinal Variables/ Personal Information

1. What is your sex?
2. What is your age? .....years
3. Are you either a Canadian or an American citizen?
4. Which of the following best describes your weekly budget? (excluding rent and tuition)
Less than $20 between $20 and $40 between $40 and $60 over $60
5. Do you have a student loan?
6. Approximately how much do you spend weekly on printing and photocopying from Acadia owned machines? (Remember printing and photocopying costs 10 cents per page).....
7. Do you avoid using excess paper when possible?
8. Do you purchase your paper according to its recycled content?
9. To what extent are you concerned about environmental degradations causing air pollution, contributing to global warming, contributing to solid waste and energy use?

(1)Very concerned (2) Somewhat concerned (3) Neither concerned nor unconcerned
(4) Not really concerned (5) Not at all concerned

10. Do you avoid purchasing or using any particular product because of environmental concerns?
If Yes, which products.....

Section 2:
11. Please score on a scale of 1-4 the extent to which you think the following statements reflect your opinions.

1=Very much my way of thinking **2**= Somewhat my way of thinking
3= Not really my way of thinking **4**= Not at all my way of thinking

a. It is morally wrong for my actions to inflict damage upon other individuals either in the present or in the future.
b. It is okay for some environmental damage to be incurred in order to provide materials for present citizens.

12. Please score on a scale of 1-4 the importance, in your view, of each of the following issues for University to address.

1= Very Important **2**=Somewhat Important **3**=Not very important **4**= Very Unimportant

a. Recycling programs on campus
b. Reducing in food waste in meal hall
c. Energy Conservation on campus
d. Water Conservation on campus
e. Preserving green spaces (lawns, trees) on campus

Figure 3.5

Hypothetical Scenarios

Scenario 1

Acadia University's current paper consumption:

- Acadia University consumes approximately 52 tons of paper annually. This is equivalent to the weight of 65 average sized cars.
- There is no recycled content within the 8.5 × 11 paper purchased by Acadia University for printing and photocopying.
- Widely used photocopiers and printers in the Vaughan Library and the User Support Centre operate only on single side print settings.
- Through the Acadia Advantage, all papers, assignments and memos could be distributed and submitted online. Yet, it is apparent that this is not yet the case.

Annual resulting environmental damages from this scenario include:

- Approximately 300 thousand lbs of wood to be extracted from forests.
- Approximately 100 thousand lbs of solid waste.
- The emission of approximately 300 thousand lbs of greenhouse gases. Greenhouse gases have been proven to contribute to global warming.
- Approximately 2 billion BTU's of energy to be utilized
- Approximately 6000 lbs of waterborne wastes will be released.

Scenario 2

Acadia University's potential paper consumption:

- Acadia University will reduce its paper consumption by 30%. By requiring that most-all essays, assignments and memos be distributed and submitted online will aid in this goal.
- Acadia will purchase paper that is made up of 30% post-consumer recycled content.
- Students and faculty will have the option to print and photocopy on double sided pages.

Annual resulting environmental damages would now be:

- Scenario 2 would 180 thousand lbs to be extracted from forests. (A reduction of 120 thousand lbs from scenario 1)
- Approximately 70 thousand lbs of solid waste would be created. (A reduction of 30 thousand lbs from scenario 1)
- Approximately 180 thousand lbs of greenhouse gases would be emitted. (A reduction of approximately 120 thousand lbs. from scenario 1)
- Approximately 1.2 billion BTU's of energy would be used. (A reduction of 80 million BTU's from scenario 1)
- Approximately 3000 lbs of waterborne wastes would be released. (A reduction of 3000 lbs from scenario 1)

The information contained within these scenarios concerning the quantity of paper entering the university annually was provided by the Acadia Print Shop. Currently, the Acadia Print Shop is the primary distributor of paper at the university. It provides paper to each faculty, administration, the Campus Store, the Vaughan Memorial Library and to the User Support Centre (Dan Sweeny, personal communication, January 17, 2003). It should be noted then that these estimates exclude paper purchases from the Copy Shop or from external sources.

The environmental damages resulting from the quantities of paper consumed were calculated by "The Web-based Paper Calculator". This instrument was developed by the White House Task Force on Greening the Government through Waste Prevention and Recycling in conjunction with the United States Postal Service, Environmental Defence and the United States Environmental Protection Agency. It allowed for estimations of the average amount of pollutants released, the energy used and wood extracted as a result of Acadia's annual purchases and consumption of paper products.

3.6 The Willingness to Pay Question

Monetary values for individual utility losses as a result of Acadia University operating under the conditions outlined in Scenario 1 were obtained by asking the Acadia student population to state their willingness to pay (WTP) to bring about the environmental improvements noted in Scenario 2. The willingness to pay (WTP) for environmental improvements format was chosen over willingness to accept (WTA) compensation for deteriorations in environmental goods and services format due to the latter's tendency to bring forth unrealistically large values (Perman et al., 1999).

The key assumption underlying the willingness to pay question is that survey

respondents would react in the same way toward the hypothetical scenario presented by the survey as they would were this to be a real world situation (Chapman, 2000). Thus in order to obtain realistic results, it was critical that the payment vehicle portrayed a plausible happening. A one-time increase in administrative fees was decided upon as the suitable explanation for how the incurred costs would be spent in order to bring about Scenario 2.

3.7 Monetary Values Chosen

Three surveys with three differing starting prices were each distributed to a third of Acadia's student population as suggested by Tietenberg (2000). Each WTP question was posed in the manner stated in Figure 3.6. The chosen starting bids were the most commonly stated values by the pre-test focus groups when asked what they would be willing to pay to bring about the environmental improvements in Scenario 2 in an open ended question.

Survey 1 began with a starting bid of $10. Respondents were asked whether they would be willing to pay this amount in order to bring about Scenario 2. Respondents answering "yes" were then asked if they would be willing to pay $20 while respondents answering "no" were asked if they would be willing to pay $5. Surveys 2 and 3 had starting bids of $5 and $20 respectively. The later two amounts were then doubled and halved in the same manner as survey 1 within the follow up questions. Figure 3.7 depicts this question format. This type of questioning is known as the double dichotomous choice model using the referendum (yes or no answer) format (Perman et al., 1999). Mitchell and Carson (1989) introduced this questioning method in order to provide a wider range of responses (yes-yes, yes-no, no-yes, no-no) than would be possible under the single

Figure 3.6

Willingness to Pay Question

While considering the following question, please remember that your budget is limited. There may be many issues that you would be willing to put money towards, however, by contributing to one project, you will have less to give to another.

Suppose Acadia University's administration announced that a one time charge of ... would bring about scenario 2 for the next year. This charge would go directly towards Acadia's initiatives to reduce paper consumption. Would you vote yes to implement this initiative? Yes No

If you answered yes:

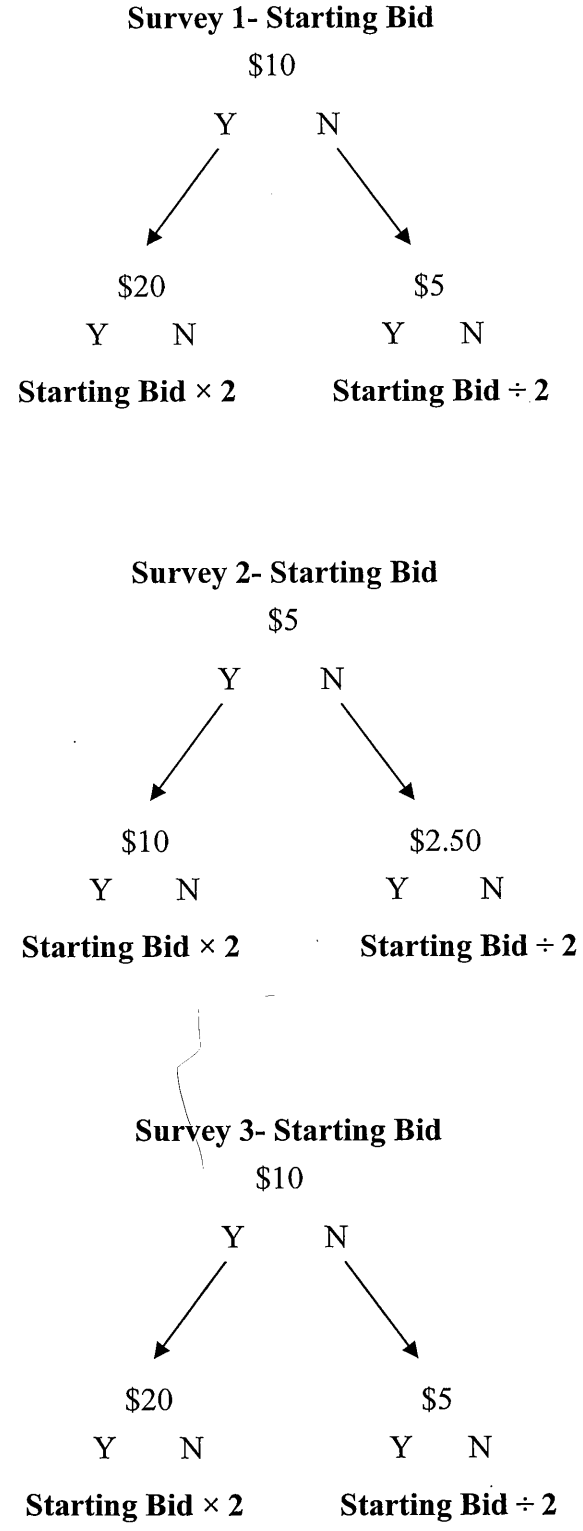
Would you vote yes for a charge of ... to implement this initiative? Yes No

If you answered no:

Would you vote yes for a charge of ... to implement this initiative? Yes No

Figure 3.7

Double Dichotomous Choice Model



dichotomous choice model wherein respondents stop after responding to the first question (yes or no).

The double dichotomous choice model is useful in reducing risks that are most often present in non-referendum format questions. For instance, when respondents are faced with open ended WTP questions rather than ones that simply require yes or no answers, they may face cognitive limitations. This results from the respondent having had no experience in placing monetary values on these unpriced amenities in the past (Perman et al., 1999).

By reminding survey respondents of budget constraints and ensuring that it was understood that increased fees would result in less purchasing power for other goods and services, the researcher attempted to prevent cognitive limitations and the warm glow effect. The warm glow effect occurs wherein the respondent agrees with the general idea of bringing about positive change and will over-state the value in which they are willing to pay so that they feel that they have made the correct decision (Boardman et al., 2001). Stating values was meant to prevent unrealistic responses such as these. At the same time, it is recognised that stating values may have limited the accuracy of some responses. For this reason, a much larger sample size is required under the double dichotomous choice model than would be under other the open ended question format in order for responses to be statistically significant (Boardman et al., 2001).

The use of the referendum format also opens the survey up to starting point biases. These occur whereby respondents assume that the first bid is an appropriate payment to bring about the environmental improvement. This would immediately limit the respondent's ability to think about and choose independently the amount of money that they would truly be willing to give up in order to bring about the noted change. Within

the double dichotomous choice model, there is danger in that the respondent's exposure to the first question might affect the answer given to the follow-up bid because the price will appear to be negotiable (Boardman et al., 2001).

Overall, whether the pros of using the double dichotomous choice model outweigh its cons remains a question within environmental economics (Boardman et al., 2001).

3.8 Survey Results/ Relationships between Variables

In all, 144 students completed Survey 1. This represents a 13% response rate. Survey 2 represented an 18% response rate with 202 votes. Survey 3 received only 75 responses, representing a mere 7% response rate.

A summary of the percentages of the respondents voting "yes" and "no" for the three starting bid amounts and their ensuing follow up questions is given in Figure 3.8. The data in this Figure provides evidence that starting point biases were present. If the assumption that the respondents were aware of their own true valuation of the environmental goods and services had held true, one would have seen the responses between surveys cluster toward a mean or median payment (Perman et al., 1999). However, the percentages of respondents voting yes to the first question were 88% for a $2.50 starting bid, 86.14% for a $5 starting bid and 84.72% for the $10 starting bid. The fact that these percentages are close in value suggests that respondents assumed that the first bid was an appropriate payment to bring about the environmental improvement.

The percentages of "yes" responses do, display a downward trend as the starting bid increases in price. This is consistent with the law of demand. However, the use of a logit regression (which will be explained extensively in section 3.9) proved that this

Figure 3.8

Percentages of Respondents Voting "Yes" and "No" for the Three Starting Bid Amounts

	"yes, yes" responses to the referendum questions	"yes, no" responses to the referendum questions	"no, yes" responses to the referendum questions	"no, no" responses to the referendum questions
$2.50 starting bid	66.67%	21.33%	1.33%	10.67%
$5 starting bid	58.91%	27.23%	1.49%	12.38%
$10 starting bid	47.22%	37.50%	4.17%	11.11%

relationship is statistically insignificant based on the t-statistic being found to be smaller than the critical value at the 10% confidence interval (0.799 < 1.645). In forming the regression equation, the percentage of respondents answering "yes' to the starting bid was the dependant variable and starting bid was the independent variable. The regression statistics are depicted in Figure 3.9.

The three different surveys did display interesting characteristics independently of one another. For instance, economically intuitive relationships existed between attitudinal and socioeconomic information and the probability of respondents voting "yes" for any given fee increase within each survey. This was particularly evident with weekly budget and environmental concerns. Figure 3.10 depicts one such relationship as found in Survey 1. It shows that as the a respondent's weekly budget increases, so does the probability of him or her voting "yes" to a $5 increase in fees. This relationship was true of each stated fee increase within the three surveys ($1.25, $2.50, $5, $10, $20). Thus it would be reasonable to conclude that the environmental goods and services that are impacted by the paper industry are normal goods.

Environmental concerns were also found to be correlated with the probabilities of "yes" responses to the willingness to pay questions. Note that environmental concerns were calculated as the mean of stated values in question 12 of the survey (refer to Figure 3.4). In Survey 1, respondents answering "yes" to the initial bid had an average environmental concern of 1.44 (1= Very Important 2=Somewhat Important 3=Not very important 4= Very Unimportant) while respondents answering "no" had an average value for environmental concern of 1.79. Similarly in Survey 2, the average was 1.42 for "yes" responses and 1.75 for "no" responses. Within Survey 3, "yes" responses had an average of 1.41 for environmental concerns and "no" responses had environmental

Figure 3.9

Logit Regression Analysis

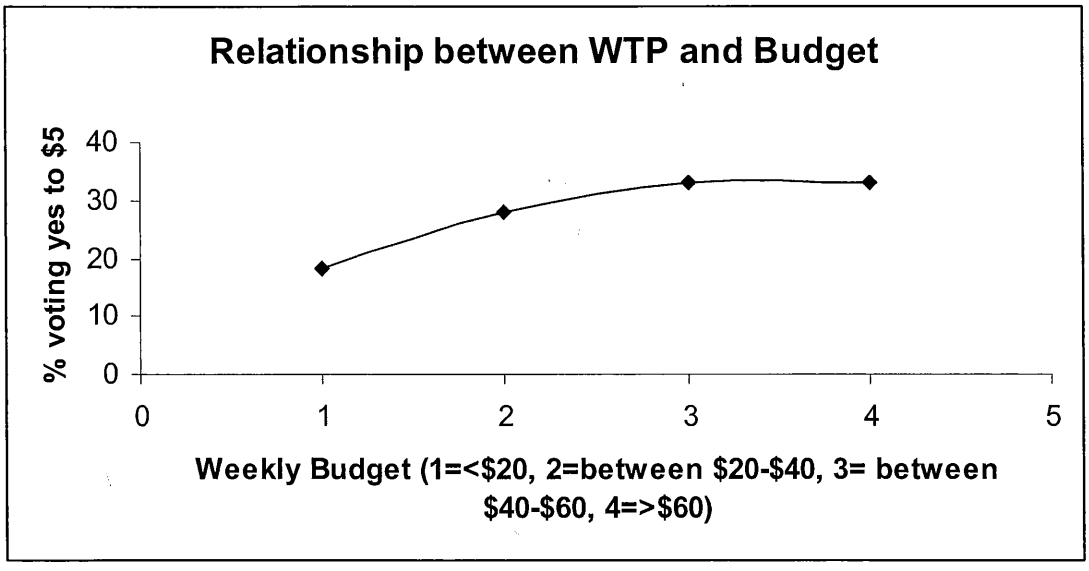
Initial Bid of $10

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	2.06700	0.363383	5.688	
Starting Bid	0.0420879	0.0526839	0.799	0.00504481

Logit estimates using the 300 observations 1-300
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp= 0.140
Number of cases 'correctly predicted' = 258 (86.0%)

Figure 3.10

Weekly Budget and Willingness to Pay



concerns of 1.67.

Interestingly, a positive relationship between environmental concerns and weekly budget also existed. This is in tune with the theories of Kuznets (1955) and Ruttan (2002) as outlined in Chapter 2. Both economists noted that concern for the environment will increase as income per capita increases. Figure 3.11 depicts the relationship as found in Survey 3.

3.9 Derivation of Total Willingness to Pay

Another common relationship existing within the three surveys was that the percentages of "yes" responses to the starting bid offers decreased as the starting bid increased. For instance, in Survey 1 the offer payments to bring about the noted environmental improvements were $5, $10 and $20. The percentages of "yes" votes for these fee increases were 88.89%, 84.72% and 47.22% respectively. This is consistent with a downward sloping WTP distribution function which is depicted in Figure 3.12. This function shows the distribution of responses according to offer payments. The vertical axis depicts the percentage of respondents answering yes to the bid offered on the horizontal axis from the lowest starting bid of $0 to the highest bid of $20. It is assumed that the downward trend in the percent of the sample population answering "yes" to higher bid values would continue until zero percent of the population would answer "yes" to the specified payment value. This would occur wherein the welfare derived from environmental improvements would be less than the value of the fee increase for each individual within the sample. Thus an individual's wealth could be used elsewhere in order to bring about larger utility gains than would be brought about by the environmental improvements promised by scenario 2.

Figure 3.11

Relationship between Environmental Concerns and Weekly Budget

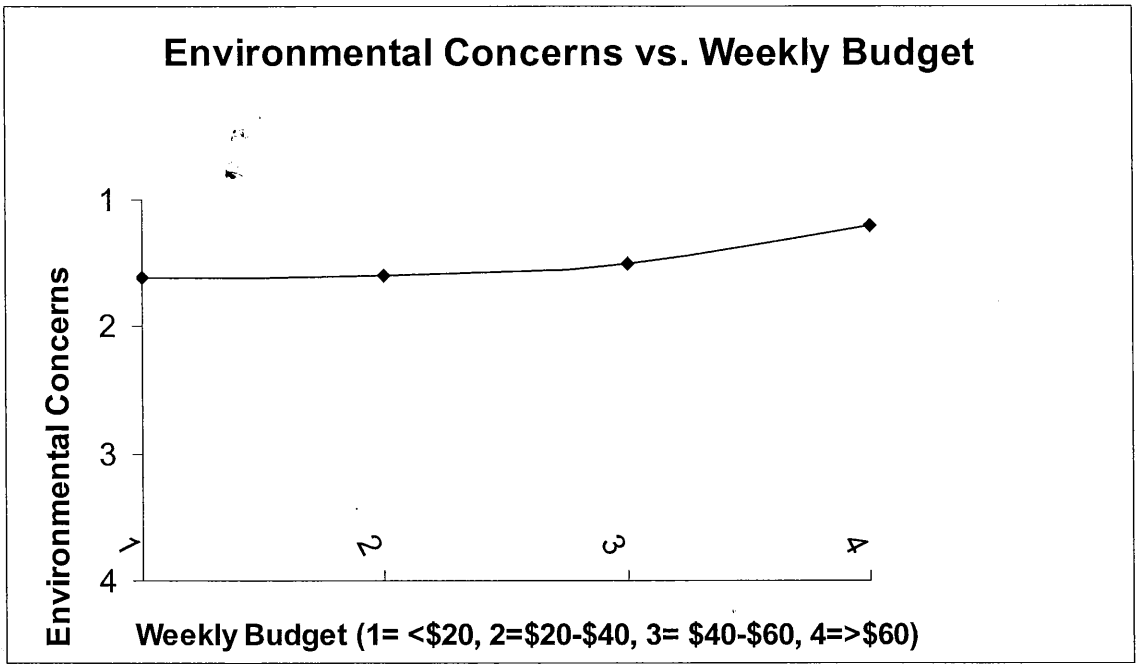


Figure 3.12

Relationship between Willingness to Pay and the Percentages of "Yes" Responses

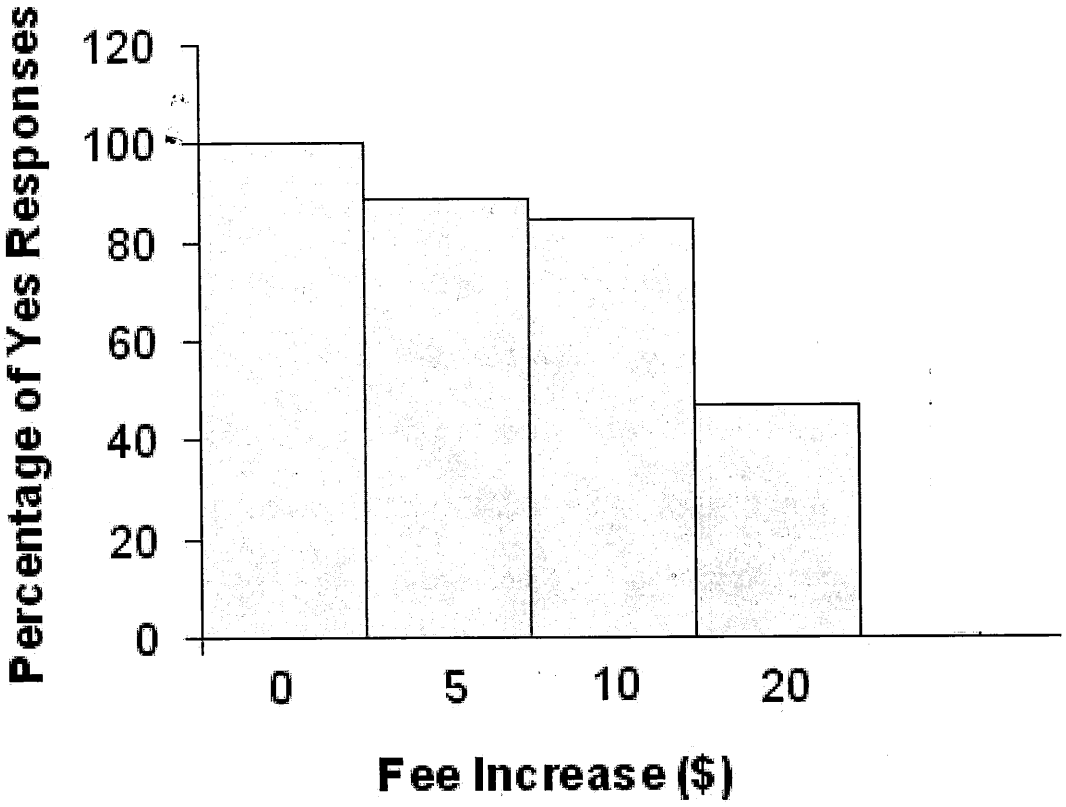
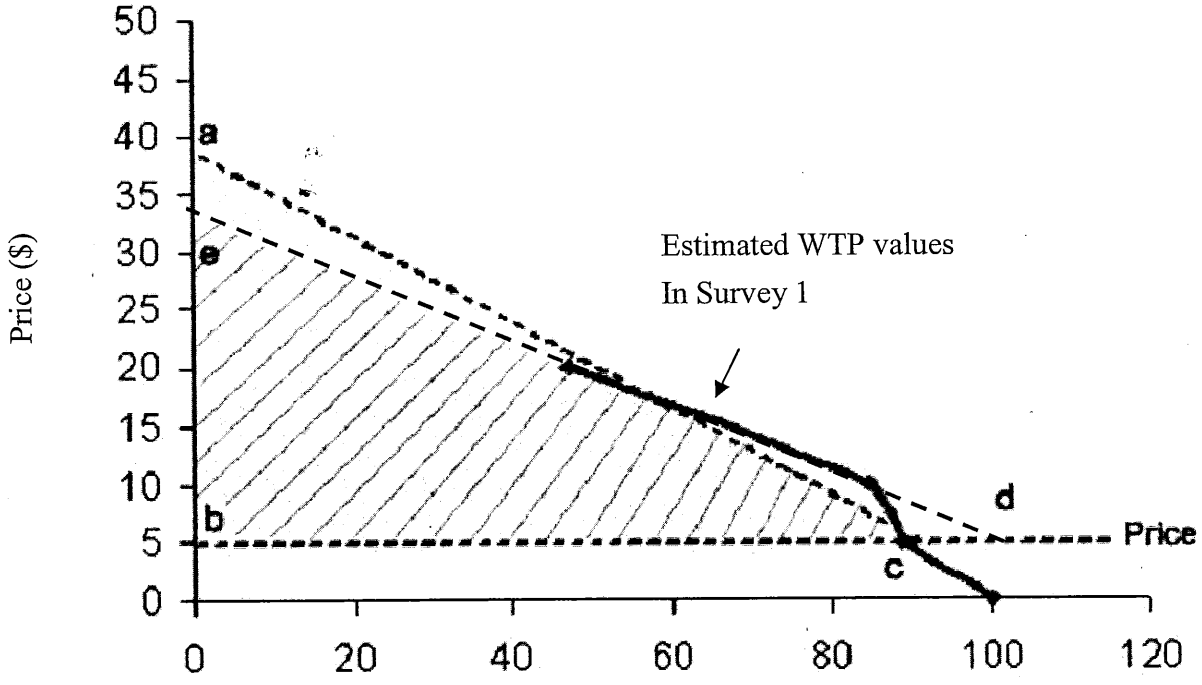


Figure 3.12 leads to the derivation of fitted demand functions as shown in Figure 3.13. Price is on the vertical axis and the percentage of respondents willing to pay for the environmental improvements is on the horizontal axis. Total WTP for Acadia University students could thus be found as the area under a linear demand curve that is fitted to the collected survey values. Total consumer surplus or "the excess utility a consumer gains from purchases of goods over the amount paid for them" (Black, 1997. p.83) would then be the area under the demand curve and above the bid price (given as $5 in this instance) (Boardman et al, 2001). Demand curve ac is fitted across the entire range of values found in Survey 1. This curve has been fitted on the assumption that consumers would react to price increases above $20 in the same way that they behaved "on average" across price increases from $5 to $20. Demand curve ac results in a larger consumer surplus (area abc) than does the demand curve ed which is fitted to the segment encompassing price values of $20 and $10 (area ebd). The later would be a more conservative estimate of total willingness to pay and consumer surplus. This curve is predicted on the idea that consumers would react to the price change about $20 in the same manner as they would to changes between $10 and $20 only. The dual approach taken is based on the different relationship between changes in price and changes in the percent of respondents willing to pay between $5 and $10 and between $10 and $20 which is reflected by the differing slopes of these segments.

According to Boardman et al. (2001), however, the more common and reliable method of deriving total willingness to pay is to use a logistic regression. Here, results are found by predicting the probability that individuals will vote "yes" to a particular bid price while taking into account his/her individual characteristics. The area under the logarithmic curve can then be estimated as the individual's mean willingness to pay.

Figure 3.13

Fitted Demand Curves



In setting up a logistic regression equation, the researcher would begin by using the method of Dupont (2000) in assuming that the logarithm of an individual's willingness to pay (log WTP_i) can be expressed as a linear function of his/her attitudinal and socio-economic characteristics so that:

$$\log WTP_i = x_i \beta + \varepsilon_i, \tag{3.1}$$

where x_i represents the coefficient of all relevant independent variables for the ith respondent and ε_i is the random error term (assumed to be normally distributed with a mean and standard deviation of 0). The error term accounts for any element of the dependent variable that cannot be explained by the independent variables.

The following equation represents the parameters of an individual's willingness to pay. That is, the logarithm of an individual's WTP (log WTP_i) must be greater or equal to the logarithm of the lowest fee increase offered (log f_i^L) and lesser or equal to the logarithm of the highest fee increase offered (log f_i^H). So that:

$$\log f_i^L \leq \log WTP_i \leq \log f_i^H \tag{3.2}$$

Now, the probability of a yes response (where yes = 1, and no = 0) to the lowest fee increase offered is:

$$\Pr (\log WTP_i \geq \log f_i^L)$$

Drawing from our linear function :

$$= \Pr (e_i \geq \log f_i^L - x_i \beta)$$

And assuming standard normal density :

$$= \Pr (e_i / \sigma \geq \log f_i^L - x_i \beta / \sigma)$$

$$= \Phi (\log f_i^L - x_i \beta / \sigma) \tag{3.3}$$

The probability of a yes response to the highest fee increase offered is derived in the same

manner. It is then:

$$= \Phi (\log f_i^H - x_i \beta / \sigma) \tag{3.4}$$

The contribution of the ith respondent to the log probability function is the probability that his or her WTP is found within the boundaries of the probabilities of the logarithms of the highest and lowest fee increase offerings. Thus:

$$\log P_i = \log [\Phi (\log f_i^H - x_i \beta / \sigma) - \Phi (\log f_i^L - x_i \beta / \sigma)] \tag{3.5}$$

Finally, the log-probability for a sample of N respondents is the sum of each individual's log P_i multiplied by the overall parameters. Thus:

$$\log P_N = \log_{i=1}^{N} \Sigma [\Phi (\log f_i^U - x_i \beta / \sigma) - \Phi (\log f_i^L - x_i / \sigma)] \tag{3.6}$$

The median willingness to pay could thus be found by summing the means of the statistically significant independent variables and multiplying by the overall estimated parameters. This will not be attempted within this particular study for the reason that obtaining results would be overly complex for the scope of this research.

The reason for this complexity is that the probability of voting "yes" to the follow up question cannot be deemed independent of the probability of voting "yes" to the initial bid. After all, the respondent will only have the opportunity to respond to a particular second bid pending upon his or her answer to the first. Thus, as the WTP questions branch out, equations become increasingly complex and controversial. This dilemma continues to plague the double dichotomous choice model. As of yet, there is no commonly agreed upon methodology for its resolution (Cameron & Quiggin, 1994).

Although the use of a logistical regression analysis was not used to explicitly elicit total willingness to pay, the use of logistical regressions within the statistical program "Gnu Regression, Econometrics and Time-series Library (gretl)" was a practical means of

identifying whether each survey's construct was capable of generating values that were statistically significant. It thus specified whether results generated by estimating the total willingness to pay value as the area under the fitted demand curve could be considered reliable.

A Logit regression was run on each of the nine "yes-no" referendum questions asked over the course of the three surveys. Willingness to pay was treated as the dependent variable while the regressors included a constant and various dummy variables representing attitudinal qualities and socioeconomic information. Other independent variables included rated information such as weekly budget and overall environmental concerns.

For each of the three initial bids, the statistically significant independent variables at the 10% confidence level were, not surprisingly, weekly budget and environmental concerns. Both were positively correlated with the probability that a respondent will say yes to any stated payment. This proved that the relationships that were found earlier between the percentage of respondents voting yes and their weekly budget and environmental concerns (discussed in section 3.8 and accompanied by graph 3.10) do have explanatory power and are statistically significant.

The remaining six logit regressions were run according to the follow up questions. Weekly budget and environmental concerns only proved to give the model explanatory power within Survey 1 at the 10% confidence level. Thus, it was concluded that Surveys 2 and 3 lacked content validity and the found results were excluded from there on. Perhaps the lack of content validity within these surveys can be attributed to the seemingly trivial amounts of money that were offered as starting bids ($5 and $2.50). Although these bids were commonly stated during pretests, respondents may have had

trouble differentiating between smaller amounts when stated in a choice format. Therefore, relationships among the independent variables may have been weaker than in the first survey wherein the starting bid was $10 and the intervals between the follow-up questions were of larger proportions. Figures 3.14-3.16 depict the statistical results of these regressions wherein * shows significance at the 5% confidence level and ** show significance at the 10% level.

In taking the fitted demand curves that were elicited over the entire range of results in Survey 1 (refer back to Figure 3.11), it can be estimated that the mean willingness to pay for the environmental improvements noted in Scenario 2 is $18.50 per student with total willingness to pay (the area under the demand curve) amounting to $71 373 wherein:

Acadia University's full time student population in 2002/ 2003 (100%) = 3858

While the fitted linear trend line intercepts the y axis at P= $37

Total WTP = (3858 × 37) / 2 = $ 71 373 (3.7)

Mean willingness to pay = 71 373 / 3858 = $18.50 (3.8)

Using the more conservative estimate that has been elicited by fitting a line to the range of values corresponding $10 and $20, gives that the mean willingness to pay for the environmental improvements to be $16.75 per student and total willingness to pay to be $64 621.50 wherein:

The fitted linear trend line intercepts y axis at P= $33.50

Total WTP = (3858 × 33.50) / 2 = $ 64 621.50 (3.9)

Mean willingness to pay = 64 621/3858 = $ 16.75 (3.10)

Both $18.50 and $16.75 are larger than the majority of the values that were stated during the pre-test stage of the study. Within the pre-tests, the most commonly stated willingness

Figure 3.14

Logit Regression Analyses for Survey 1

Initial Bid of $10

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-2.15739	0.795137	-2.713	
Budget	-0.697136	0.264185	2.639*	0.0743470
Environmental Concerns	1.22811	0.380596	3.227*	0.130974

Logit estimates using the 146 observations 1-146
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp = 0.158
Number of cases 'correctly predicted' = 127 (87.0%)

Follow up Bid of $20 (after yes response to initial bid)

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	0.209296	0.707040	0.296	
Budget	-0.811443	0.227208	3.571*	0.193993
Environmental Concerns	0.975208	0.403119	2.419 *	0.233144

Logit estimates using the 123 observations 1-123
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp= 0.410
Number of cases 'correctly predicted' = 78 (66.7%)

Follow up Bid of $5 (after no response to initial bid)

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-1.90714	2.92935	0.651	
Budget	-1.31295	0.678960	1.934**	0.113666
Environmental Concerns	3.58131	1.99434	1.796**	0.310045

Logit estimates using the 23 observations 1-23
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp= 0.739
Number of cases 'correctly predicted' = 22 (95.7%)

Figure 3.15

Logit Regression Analyses for Survey 2

Initial Bid of $5

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-2.31781	0.842116	2.752*	
Budget	-0.807937	0.229874	3.515*	0.0720682
Environmental Concerns	1.53242	0.430881	3.556*	0.136692

Logit estimates using the 204 observations 1-204
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp = 0.142
Number of cases 'correctly predicted' = 173 (84.8%)

Follow up Bid of $10 (after yes response to initial bid)

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-1.09490	0.684693	1.599	
Budget	-0.098792	0.163035	0.605	0.0214122
Environmental Concerns	0.427066	0.351403	.215	0.0926682

Logit estimates using the 175 observations 1-175
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp = 0.320
Number of cases 'correctly predicted' = 119 (68.0%)

Follow up Bid of $2.50 (after no response to initial bid)

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-6.17923	4.57810	-1.350	
Budget	-0.0972850	0.811201	-0.120	-0.00179820
Environmental Concerns	5.80372	3.30150	1.758**	0.107275

Logit estimates using the 29 observations 1-29
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp = 0.897
Number of cases 'correctly predicted' = 27 (93.1%)

Figure 3.16

Logit Regression Analyses for Survey 3

Initial Bid of $2.50

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-7.34098	2.22856	-3.294	
Budget	1.16847	0.461873	2.530**	0.0774722
Environmental Concerns	1.56870	0.746035	2.103**	0.104009

Logit estimates using the 75 observations 1-75
Dependent variable: Answer to Willingness to Pay Question
Mean of wtp = 0.120
Number of cases 'correctly predicted' = 66 (88.0%)

Follow up Bid of $5 (after yes response to initial bid)

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-2.13057	1.17711	-1.810	
Budget	-0.126437	0.336294	-0.376	-0.0226816
Environmental Concerns	0.851402	0.580241	1.467	0.152733

Logit estimates using the 66 observations 1-66
Dependent variable: Answer to Willingness to Pay Question
Mean of WTP2 = 0.242
Number of cases 'correctly predicted' = 50 (75.8%)

Follow up Bid of $1.25 (after no response to initial bid)

VARIABLE	COEFFICIENT	STDERROR (at mean)	T STAT	SLOPE
Constant	-2.13057	1.17711	1.810	
Budget	-0.126437	0.336294	0.376	0.0226816
Environmental Concerns	0.851402	0.580241	1.467	0.152733

Logit estimates using the 9 observations 1-9
Dependent variable: Answer Willingness to Pay Question
Mean of WTP3 = 0.889
Number of cases 'correctly predicted' = 8 (88.9%)

to pay value was $5. Perhaps the cause of this difference is that students did not truly consider the reminder of budget constraints. Perhaps hypothetical biases were present wherein the respondents were aware that they had merely been asked their willingness to pay rather than to actually pay (Perman et al., 1999). In fact, there seem to be a vast number of problems that could have potentially decreased the reliability of the data obtained within this CV survey. Thus, if the study were to be repeated, its design would attempt to minimize the biases that became apparent in order to further improve the accuracy of results.

These biases, however, do not mean the CV results are without meaning. There was considerable success in identifying statistically significant relationships between budget, environmental concerns and willingness to pay for environmental improvements. Policy makers could now utilise this information in deciding how to allocate spending decisions. For instance, it can be predicted that as the budgets of students increase, so will their environmental concerns. Thus their desire to pay for environmental improvements will also increase. Policy makers could use this general knowledge and gauge spending decisions toward environmentally friendly initiatives according to student wealth. They may also deduce that in times of increasing environmental activism on campus, willingness to pay for environmental improvement is also increasing. Spending should then be allocated toward greener initiatives so as to best represent the interests of Acadia's stakeholders.

Ideally, policy makers would go beyond the simple recognition that these subjective values should have weight in the decision making process. The derived willingness to pay amounts, which ranged from $64 621.50 to $71 373, should be factored into future decisions as measures of the present costs incurred to the university

by not operating under Scenario 2 conditions. These total WTP values could then be considered in terms of savings resulting from conservation practices that would bring the university closer toward a Scenario 2 situation. The dollar value estimates would also be a useful way for policy makers to verify the amount of influence that environmental concerns should be given within the decision.

3.10 Summary

It is thought that current paper purchasing practices at Acadia University are resulting in unequal welfare distributions among the university's stakeholders. This is because the welfare losses incurred by individuals as a result of negative environmental impacts caused by paper usage are excluded from paper purchasing decisions. These decisions are primarily based upon economic efficiency and getting the most paper for the least cost. It is unknown whether the welfare derived by individuals as a result of financial savings in purchasing paper, and in using the paper itself outweigh the welfare reductions incurred by individuals as a result of environmental damage.

A contingent valuation (CV) survey was applied at Acadia University in order to provide estimations of how much (in dollar values) the environmental amenities that are impacted by paper usage are worth to students. The survey results enable environmental and fiscal values to be compared on a common scale so as to prioritize the university's purchasing decisions according to which outcome would maximize the welfare of its stakeholders. The CV results were obtained by asking survey respondents what they would be willing to pay in order to bring about the environmental improvements that were specified within the survey.

The study was confined to measure the non-use values that the students of Acadia

University hold for paper. In taking the survey, respondents initially disclosed personal information such as weekly income and environmental attitudes. This information was then utilised in identifying positive relationships between weekly budget, environmental concerns and the probability of answering "yes" to willingness to pay questions.

The resulting willingness to pay values were estimated to be in the range of $16.75 to $18.50 per person with total willingness to pay values ranging from $64 621.50 to $71 373. These amounts were found by taking the area underneath a fitted demand curve.

Policy makers at Acadia University can now factor this monetary estimate into paper purchasing decisions as a present cost of operating under current conditions. They could also consider these values to be the savings resulting from conservation practices.

CHAPTER 4

Conclusion

4.1 The Implementation of the "Polluter Pays Principle" at Acadia University

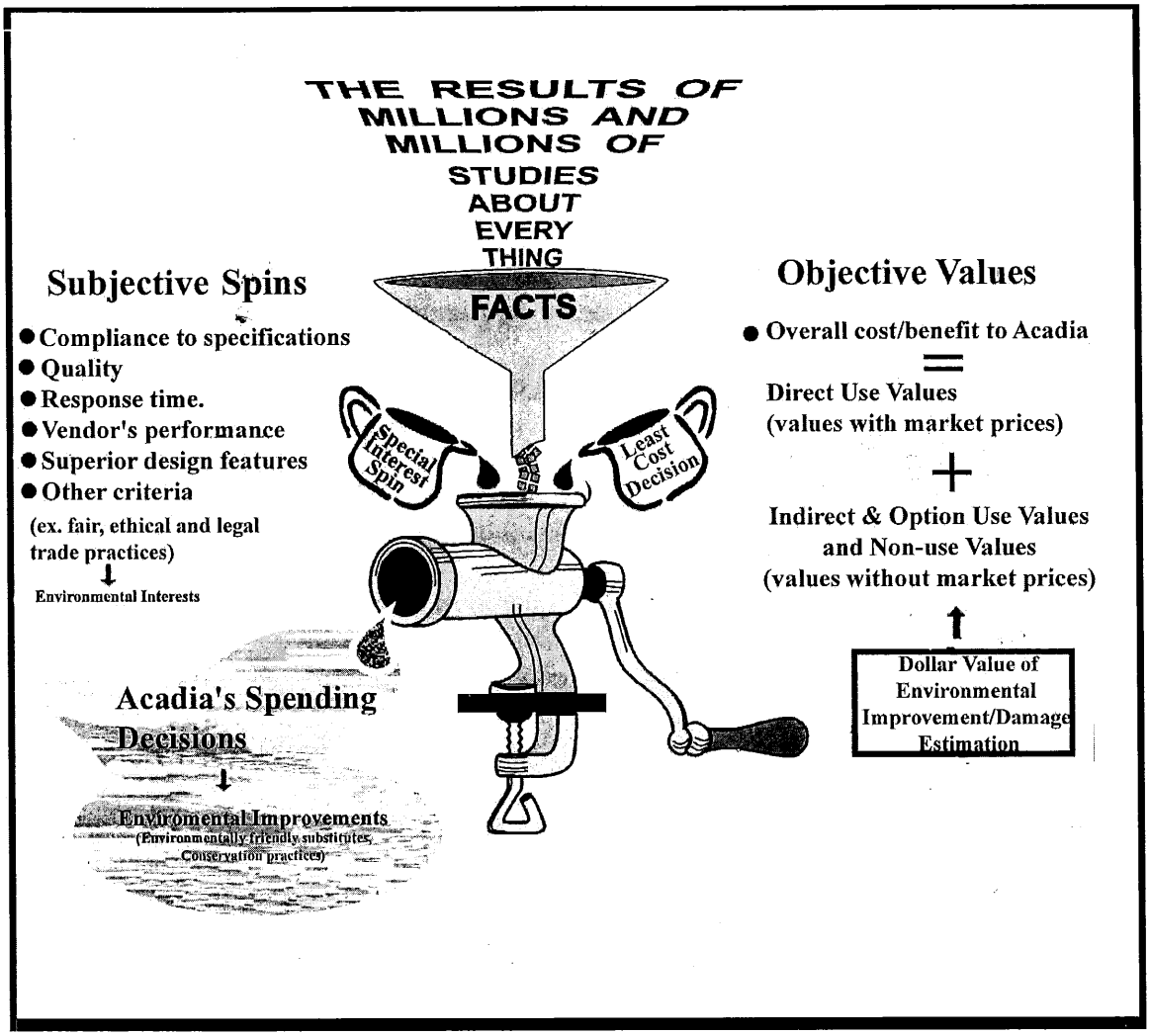
The incorporation of monetary figures as estimates of individual values for environmental amenities could be expected to alter purchasing and consumption decisions to ones that are more environmentally sustainable than those that would have resulted had these values been excluded from decisions. This is because the estimates would change the composition of objective influences entering the decision making process as illustrated in Figure 4.1.

Ideally, after the recognition and incorporation of these values into the decision making processes, the university would hold itself accountable for the damage resulting from its consumptive decisions. That is, Acadia would internalize the damage caused to these unpriced environmental goods or services. This concept is known as "The Polluter Pays Principle" (Pearce & Turner, 1998). Such payments could be born by the university as avoidance costs to prevent the environmental harm associated with its decisions. For example, Acadia University could opt to purchase 8.5 × 11 paper with a more expensive percentage of post-consumer recycled content rather than its current 8.5 × 11 paper with 100% virgin fibre.

The polluter pays principle could also be implemented as restoration costs. These are defined as the costs of improving the damaged environmental goods or services (Pearse & Turner, 1998). For example, Acadia could donate funds to the World Wide Fund for Nature (WWF) for the reason that this organization is known to support initiatives that urge paper producers to use sustainable practices (www.panda.org).

Figure 4.1

Acadia's Ideal Purchasing Pattern



Changing spending patterns, however, would not be the only responses that Acadia University could make in order to reduce their impact on the environment. Tradeoffs requiring the reduced consumption of environmentally unfriendly goods and services could also prove to be effective.

Often, these types of initiatives will result in monetary savings on top of the individual utility gains that they elicit. Examples of savings gained by other universities through the reduction of environmental impacts include the $65 000 saved at Brown University simply by replacing 'exit' sign light bulbs with LED or fluorescent bulbs, the $76 000 saved by the University of Vermont by eliminating styrofoam cups and the $8000 saved by Connecticut College by reducing room temperatures by 1 degree Fahrenheit ("Sustainable Campuses," 1999). Figure 4.2 provides more examples.

In the case of paper, Acadia could easily require that all essays, assignments and notes be taken and submitted electronically. This would not incur any additional costs. Also, where possible, printing and photocopy machines could be programmed to print double sided pages (Replacing machines that are not equipped with this function would be a good example of an avoidance cost). It is clear from the findings of the CV surveys that these initiatives would indeed be favourable for students unless they exceeded a cost of approximately $60 000-$70 000 or $16-19 per person (approximations of the final willingness to pay results).

The implementation of these initiatives could be the direct results of a successful environmental valuation. They would act as corrections for the market failures accompanying the unpriced environmental goods and services that are impacted by the paper industry. Thus the university would be brought closer toward the ideal target, Pareto optimality, with resulting welfare gains.

Figure 4.2

Examples of Cost Reducing Measures

Institution	Project Description	Annual revenues or savings ($US)
State U. of New York at Buffalo	-comprehensive energy-efficiency program	$3 000 000
Columbia Univ.	-new toilets and water fixtures	$235 000
Yale University	-converted incandescent bulbs to fluorescents	$200 000
Harvard University	-Use of washable cups in the Freshman Union	$186 500
U. of Vermont	-eliminated polystyrene foam	$76 000
Dartmouth Coll.	-use of efficient lights in dorms -used food waste as fertilizer	$75 000 $10 000
Brown University	-installed water-saving showerheads -replaced all incandescent fixtures in new dorms with compact fluorescent -replaced 2,200 'exit' sign light bulbs with LED or fluorescent bulbs	$45 800 $6000 $65 000
U. of Wisconsin	-replaced hazardous solvents with biodegradable fluids	$45 000
U. of Arizona	-converted single intro chemistry course to microscale	$12 000
Connecticut Coll.	-reduced room temperature by 1 degree F	$8000

("Sustainable Campuses," 1999)

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