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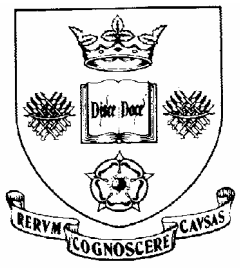

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Incorporating Ethics into Economics:
Problems and Possibilities

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Abstract

In traditional economics the decision-making process for individuals has effectively no role for ethics as individuals are self-interested. The key concepts in economics which determine the role of ethics in the decision-making process are utility, rationality and methodological individualism and hence how these can be and are formulated and combined determines different roles for ethics in economics. Amitai Etzioni, Amartya Sen and John Broome use different definitions of these concepts and hence find different problems and possibilities for a greater role for ethics in economics. This paper integrates the different approaches of these authors and suggests a general mono-utility framework for incorporating ethics into economics whereby the concept of utility requires adaptation.

Keywords: ethics, utility, methodological individualism

JEL Numbers: D11, D64

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I INTRODUCTION

In traditional economics individuals are assumed to be self-interested, and hence the decision-making process for individuals currently has effectively no role for ethics. Hausman and McPherson (1993), in their renowned survey of the literature regarding economics and ethics, ask the prominent question "To be a good person, one must take ethics seriously. But can the same be said about being a good economist? Does morality matter to economic analysis?" (1993: 671). Casual empiricism suggests that ethical considerations impact on decision making, hence arguably morality does matter to economic analysis. By adapting the self-interested *homo economicus* to be other-regarding as well as self-interested, this will enable a greater role for ethics within economics.

Standard economic theory models behaviour using constrained maximisation, where individuals are rational and have well defined utility functions that represent their preferences, and choose their action by maximising their utility subject to appropriately defined constraints. Behavioural relationships are obtained by observing how choices change when the conditions the individual faces are altered. This approach to decision-making ignores ethical considerations, as when the individual assesses the consequences of choosing each bundle in order to decide which to consume, only the consequences that the individual faces are considered, and hence the consequences faced by others are not considered. Therefore, the individual is motivated only by self-interest and is not motivated by ethical considerations, such as altruism, sympathy or fairness. Although this individual may be classed as being selfishly self-interested, they are only so because the analysis does not allow them to be otherwise. The individual is therefore self-interested rather than selfish, as they would only be selfish if they considered the consequences faced by others and subsequently decided to ignore them. Furthermore, although the choice the individual makes may be the choice that is the most ethical, this occurs by chance not through intent. Therefore, although the choice may be ethical, the individual is not ethical as they act only in their self-interest and are unaware of how their decisions impact upon others.

A self-interested individual can be ethical, yet is not ethical in the standard framework. To clarify, in this paper ethical behaviour is separated into two types; first-order and second-order.[1] First-order ethical behaviour may be described as doing the right course of action simply because it is right, and no benefit needs to be, or indeed is, derived by the individual as a result of performing the action. Second-order ethical behaviour may be described as doing the right course of action, but that action will in some way benefit the individual, and hence the individual performs the right course of action *in part* because they derive utility from it.[2] The behaviour in each case will reach the same ethical outcome and both can involve ethical considerations, as the difference lies in the *principle of action* that causes this behaviour, not the final outcome. The principle of action that causes the ethical behaviour may be thought of as involving two factors; the first factor involves the undertaking of a commitment to ethical considerations, and the second factor entails that a utility gain is derived from ethical actions. First-order ethical behaviour occurs when the principle of action involves the first factor alone, and second-order ethical behaviour involves both factors.

The separation of two types of ethical behaviour, although not the terms used, is in accordance with the discussion of Sen (1977), who argues that ethical behaviour can either demonstrate sympathy or commitment, where the notions of commitment and sympathy accord with first-order and second-order ethical behaviour respectively. Sympathy reflects the notion that your welfare is directly affected by a concern for other individuals, whereas commitment reflects the notion that although your welfare is not affected by a given situation, you are prepared to take action about the situation as you do not believe that the situation is ethically acceptable. Sympathy can therefore be classed as an extension of a self-interested preference and is a form of an externality, whereas commitment cannot be classed as a self-interested preference. Therefore, second-order ethical behaviour is an extension of the self-interested framework where the individual can derive utility from acting ethically, whereas a first-order ethical act is undertaken simply because it is right, not because the individual derives utility from it, and hence it is inappropriate to think of the individual deriving utility from first-order ethical behaviour.

For example, the behaviour of an adult jumping in a river to save an unknown drowning child although they themselves face the risk of drowning is first-order ethical, because the principle of action requires only that the act is right, not that the individual also derives positive utility from doing the act. However, if the drowning child was not unknown but was instead their daughter, the principle of action is in part self-interested as they will derive utility from the survival of the child, if only from the continued survival of their genes, and hence the behaviour is second-order ethical. In standard economic theory *homo economicus* is neither first-order nor second-order ethical, they are self-interested, as any ethical outcome does not occur through intent, as the individual is unaware of how their decisions impact upon others. We argue in section VI that the mono-utility framework cannot facilitate first-order ethical behaviour, but that it can facilitate second-order ethical behaviour, and hence this is the approach taken in section VII.

In order to incorporate ethics into economics, the assumption of self-interested individuals must be adapted in order to enable individuals to have ethical considerations and social awareness. Therefore, in order to incorporate ethics into economics, the concepts which require and reinforce the assumption of the self-interested individual must be examined in order to determine whether it is indeed possible to adapt these concepts in order to enable an ethically and socially aware individual who has other-regarding preferences. Arguably, the key concepts in economics which determine the role of ethics in the decision-making process through their current requirements and reinforcements of the self-interested individual are utility, rationality and methodological individualism. Therefore, the ways in which utility, rationality and methodological individualism can be and are formulated and combined determine different roles for ethics in economics. Amitai Etzioni, Amartya Sen and John Broome use different definitions of these concepts and hence find different problems and possibilities for a greater role for ethics in economics.

Sections II, III and IV outline the arguments of respectively Amitai Etzioni, Amartya Sen, and John Broome, focussing upon the key concepts of utility and rationality. The discussion focuses upon their perceptions of the current concepts of utility and rationality

used in economics, not on what they believe is most productive or desirable. In section V methodological individualism will be discussed, and in section VI the views of Etzioni, Sen and Broome will be contrasted and considered alongside methodological individualism, and mono-utility and multiple utility frameworks will be discussed. In section VII a general framework will be discussed drawing on the insights from Etzioni, Sen and Broome. This approach is chosen because the conceptions of utility and rationality when combined with methodological individualism form a foundation for the final framework of choice. Therefore, when the conceptions of utility, rationality and methodological individualism are combined they determine behaviour and the role of ethics in the final choice framework, and hence they determine the role for ethics in the decision-making process. This framework is not explicitly used in the literature, yet the focus and reasoning behind the choice of framework is consistent with the existing literature. This paper is not a survey of the literature, it is a survey focussing on three important differing approaches in order to integrate the different approaches of these authors and to suggest a general framework for incorporating ethics into economics.

II ETZIONI

Etzioni (1988) states that the neoclassical concept of rational utility maximisation has two factors, where firstly the most efficient means are chosen to achieve the individual's goal, and secondly the goal of an individual's action is to maximise their utility, where utility is only concerned with self-interest. Etzioni finds this definition unsuitable, as the second factor requires that individuals who are other-regarding will be deemed irrational. Therefore, Etzioni believes that rationality should focus upon the means of reaching a decision, rather than the value judgement of the goal that should be achieved. Etzioni argues that the neoclassical definition of rationality requires self-interest due to its focus upon utility, where utility is only concerned with self-interest, yet this is undesirable. The neoclassical concept of rationality suffers from the problem that either all individual behaviour is assumed to be rational, or rationality is defined such that practically all behaviour must be rational, and hence the concept may be regarded as a tautology. Etzioni suggests that the most productive definition of rationality is instrumental

rationality, where decision-making is based on deliberation, where the individual collects and uses information to reach a decision using sound reasoning. Therefore it is the process of making the decision, not the consequences of the decision, that are important.

Etzioni (1986, 1988) outlines three different types of utility that are currently used in economics: pleasure-utility, interdependent-utility and X-utility. Pleasure-utility is where utility represents happiness, satisfaction and pleasure, as developed from Jeremy Bentham. Interdependent-utility is where utility is interdependent in the sense that an individual can gain satisfaction from another individual's pleasure. This type of utility therefore assumes that utility represents happiness, satisfaction and pleasure, but furthermore the individual's happiness, satisfaction and pleasure can also be affected by the happiness, satisfaction and pleasure of another individual. Etzioni is concerned that this may lead to a tautology where the individual can gain happiness, satisfaction and pleasure from anything and everything, namely all observed actions can be explained by some motivation and hence all actions are a result of maximising satisfaction. X-utility is the formal measure of utility where utility is a measure which is used to represent other values, such as in formal economic models where utility represents the ordinal values of the satisfaction of preferences. This definition of utility is reliant upon preference rankings, and the preferences themselves are not clearly defined, as different rankings may be given depending upon whether the preferences are regarding, for example, consumption or ethical value.

Therefore, pleasure-utility requires self-interest and does not enable other-regarding motivation. Interdependent-utility does allow self-interested and other-regarding motivation, yet suffers from the problem that it may encompass everything as all actions are a result of maximising satisfaction. X-utility is dependent upon preferences, and hence will require self-interest only if the preferences require self-interest. Etzioni argues that none of the three types of utility can adequately represent satisfaction and affirmation. *Satisfaction* is obtained by satisfying self-interested preferences and hence is obtained by doing actions that the individual likes, enjoys and finds pleasurable, whereas *affirmation* is obtained by satisfying ethical or other-regarding preferences and hence

need not be likable, enjoyable or pleasurable, for example, refraining from premarital sex or religious fasting involves a sense of satisfaction that may not be best described as being enjoyable or pleasurable. An ethical act, which achieves affirmation, may not necessarily be the act which gives the individual the most satisfaction. The three types of utility as described above adequately represent satisfaction, but fail to adequately represent affirmation, and hence are suitable for representing self-interested preferences but not for representing other-regarding preferences.

The above discussion of rationality and utility suggests that Etzioni views rationality as not necessarily requiring the maximisation of self-interest, yet believes that the current conception of mono-utility is unable to adequately represent other-regarding preferences, and hence requires self-interested preferences. Therefore, the current concepts of rationality and utility combined together form a model of behaviour based upon the maximisation of self-interest, yet in order to move toward a model enabling non-self-interested preferences only the concept of utility requires adaptation.

III SEN

Sen (1987) suggests that two different definitions of rationality are used in economics, which are internal consistency of choice, and maximisation of self-interest. Internal consistency of choice may be necessary for rationality, yet internal consistency of choice alone does not seem sufficient for rationality, as we could consistently always act to achieve exactly the opposite of what we want to achieve. Sen (1987) therefore suggests that rationality should require that you act so as to ensure that you achieve what you want to achieve. Rationality as the maximisation of self-interest requires that the choices of the individual are concerned solely with the maximisation of their own self-regarding preferences. Sen questions whether it is correct to classify self-interest as the *only* motivation, rather than one of many motivations. Sen suggests that neither the definition of rationality as internal consistency of choice nor as the maximisation of self-interest are ideal, yet Sen uses the definition of rationality as the maximisation of self-interest.

Sen states that " utility is, at best, a reflection of a person's well-being" (1987: 40). The definition of well-being that Sen uses is crucial, yet he never appears to explicitly define well-being. Sen seems to use well-being as representing whether an individual feels good, well and happy in their mental state and body, yet his arguments also seem to suggest that well-being is affected only by self-interest, as he does not seem to believe that well-being is dependent upon or even affected by the well-being of others. Therefore, well-being is a reflection of rationality as the maximisation of self-interest, as well-being is determined by the maximisation of self-interest, and hence represents personal advantage alone. Sen argues that the concept of utility as a measurement of well-being is too narrow, and the argument can be divided into three main points. These points argue, using interrelated reasons, that the concept of utility as a measure of well-being causes utility to have a limited scope as the concept is restrictive and somewhat unrealistic. The argument is not that the current concept of utility should be rejected, but that economics would benefit if the concept of utility was widened to incorporate additional factors, such that these additional factors and well-being can determine and affect utility, rather than utility being determined by well-being alone. Confusion may arise in the discussion of this issue, as the current conceptions of both utility and well-being are problematic, as each represents the other. Therefore, to clarify, under our interpretation either utility needs to be altered in order to include aspects other than well-being where well-being is identified by personal advantage alone, or utility can remain unaltered but then well-being needs to be altered in order to include aspects other than personal advantage.

Firstly, although utility can reflect well-being, this may be insufficient, and furthermore well-being may be better described as something other than utility. Secondly, Sen (1985, 1987) argues that an individual has both an 'agency aspect' and a 'well-being aspect', and each is relevant and important for the assessment of outcomes and actions in the decision-making process. The well-being aspect examines achievements in the context of their personal advantage alone, whereas the agency aspect examines achievements in terms of objectives and values other than personal advantage, such as autonomy and personal liberty. Failing to recognise the agency aspect of individuals means that ethical actions arise as a response to circumstances or because the ethical outcome coincides

with the maximisation of self-interest, rather than through ethical motivations which are recognised by the agency aspect. Therefore, Sen (1985) argues that although well-being is of intrinsic value and is fundamentally important, this does not lead to the conclusion that it is the only source that has intrinsic value and importance.

Thirdly, Sen (1985, 1987) argues that an individuals' freedom may be seen as being valuable in addition to their achievements, as the freedom that an individual has may be seen as being valuable regardless of what the individual achieves as a result of the freedom. For example, choosing *x* when *y* is available may be seen as being different to choosing *x* when *y* is not available. Therefore, in addition to individual utilities, rights and liberties are also seen as having intrinsic value for an ethical evaluation of outcomes.

The above discussion of rationality and utility suggests that Sen views rationality as requiring the maximisation of self-interest and believes that the current conception of utility is inadequate as it measures only well-being, and well-being values achievements in terms of personal advantage alone. Therefore, the concept of rationality and utility combined together form a model of behaviour based upon the maximisation of self-interest. The separation of the agency and well-being aspects of an individual do not and will not occur in a framework of self-interested behaviour, and vice versa, as in a framework focusing upon utility as well-being a separation of behaviour from the maximisation of self-interest does not and will not occur. Therefore, in order to expand rational behaviour beyond the maximisation of self-interest and to expand the definition of utility beyond well-being so as to enable a role for ethics in the decision-making process, the concepts of rationality and utility need to be simultaneously widened.

IV BROOME

Broome's view regarding rationality is not explicit, as although he assumes that rationality holds he never clearly explains what he believes rationality is. However, it is clear from Broome's discussion that he believes that a rational individual optimises, but he does not believe that rationality requires that the individual is self-interested, which is

consistent with the definition used by Harsanyi (1982). Broome seems to believe that any assumption that an individual is self-interested is derived from the definition of what the individual is maximising, and consequently whatever the individual is maximising does not have to be based solely upon self-interest.

Broome (1991(a)) suggests that there is great confusion over the term utility, where although utility is given many different meanings, the two main definitions of 'good' and 'that which represents an individuals preferences' are confusing and misleading if used interchangeably, and hence the definition which should be and is mainly adopted is utility as that which represents an individual's preferences. Modern axiomatic utility theory assumes that provided an individual's preferences conform to some axioms they can be represented using a utility function, where greater utility is given to the preferred option, and hence utility is the value of a function that represents an individual's preferences, and hence is defined as "that which represents a person's preferences" (1991(a): 3).

Broome outlines a problem caused by having two separate and frequently used definitions of utility, because the option which an individual prefers may not necessarily be the option which is best for them, and hence which gives them the most 'good'. If utility represents preferences, and utility also represents good, there may be a contradiction, as it seems feasible to suggest that an individual may not always prefer the option which is best for them. For example, we may prefer chocolate to apples, yet apples may be better for us as they will do us the most 'good'.

Broome concludes that the meaning of utility in economics is that which represents preferences, and utility should not be used to mean 'good' as this leads to confusion, and hence the term 'good' should be used to mean good. If utility is that which represents preferences, and rationality requires that preferences satisfy the axioms of expected utility theory, this suggests that provided our preferences satisfy certain axioms, our preferences do not have to be self-interested, and hence there is a role for ethics in the decision-making process. Therefore, Broome suggests that it may be the case that modern axiomatic utility theory is consistent with ethical considerations. The conventional view

states that instrumental rationality takes the objectives as given, and then involves calculating how to best meet those objectives, which is usually the objective of maximising utility (Hargreaves-Heap, 1994). This suggests that the objectives are not specified by instrumental rationality but are taken as being exogenous, and hence it may be possible that the objective does not require that individuals are self-interested. However, some objectives will not satisfy the axioms, and it may be the case that only objectives requiring the maximisation of self-interest can satisfy the axioms. Furthermore, although the maximisation of self-interest is not explicitly assumed it may be an implicit assumption in modern axiomatic theory, indeed it may be an implicit assumption that the objective must involve the maximisation of self-interest. However, if the maximisation of self-interest is an implicit rather than an explicit assumption this suggests that it may be possible to have an objective other than the maximisation of self-interest that is able to be used in modern axiomatic utility theory provided that the axioms are satisfied. That is, it may not be inconsistent to pursue an objective that involves ethical considerations rather than the maximisation of self-interest alone.

V METHODOLOGICAL INDIVIDUALISM

Economics, and more specifically welfare economics, focuses upon individuals through its commitment to methodological individualism, and hence this appears to remain as one barrier to increasing the association of economics with ethics. Hodgson (1994) states that methodological individualism can be defined as a doctrine where all social phenomena are explained only in terms of individuals, such as in terms of their properties, goals and beliefs. Methodological individualism emphasises the primary importance of the individual, and the virtues of self-reliance and personal independence. Therefore, the individual is focussed upon, and this individual is independent and self-interested and does not consider other individuals. To illustrate, welfare economics states that the well-being of individuals is determined by their consumption bundles alone, yet this neglects the issue of relationships with others and social interaction, and hence ethical considerations cannot enter the decision-making process. This raises the issue that Hodgson's definition may actually be referring to two separable parts of methodological

individualism, which are methodological individualism as an analytical method or as a principle of action.

Arguably methodological individualism may be consistent with ethical considerations, if methodological individualism can have two definitions; minimal and maximal. Minimal methodological individualism refers to an analytical method where individuals are focussed upon and used to explain social phenomena. Maximal methodological individualism refers not only to a method where individuals are focussed upon, but also to a principle of action, where the well-being of an individual is unaffected by the actions of others. This assumes that the principle of action of the individual is not a necessary part of methodological individualism, and hence no specific principle of action for the individual is necessarily required for all social phenomena to be able to be explained only in terms of individuals. For example, some aspects of game theory use minimal methodological individualism as individuals are focussed upon, but the well-being of an individual is affected by the actions of others (for example Young, 1998).

Minimal methodological individualism refers to an individualistic analytical method but allows a holistic principle of action, whereas maximal methodological individualism refers to an individualistic analytical method and individualism as a principle of action. Methodological holism can also be separated into a minimal and maximal form, where minimal methodological holism refers to a holistic analytical method but allows an individualistic principle of action, whereas maximal methodological holism refers to a holistic analytical method and holism as a principle of action. Figure 1 illustrates the difference between minimal and maximal methodological individualism and minimal and maximal methodological holism.

	Principle of action		
Method		Individualistic	Holistic
	Individualistic	Maximal methodological individualism e.g. standard utility maximising individual	Minimal methodological individualism e.g. some aspects of game theory
	Holistic	Minimal methodological holism e.g. some (particularly functional) sociology	Maximal methodological holism e.g. Veblen

Figure 1 Minimal and maximal methodologies

Therefore, although maximal methodological individualism is currently used in economics, which is the definition from Hodgson (1994) as outlined above, minimal methodological individualism may be sufficient, and hence it may be possible to incorporate ethics into this framework by assuming minimal methodological individualism, where individuals are focussed upon but there are no requirements regarding the principle of action of the individual, and hence in welfare economics well-being and utility may be determined by factors other than the individual's consumption, and relationships between individuals may be considered important. Therefore if methodological individualism can be separated into minimal and maximal methodological individualism, the increased association of economics with ethical considerations is easier and achievable using minimal methodological individualism, and an approach using methodological holism is not required and hence individuals may remain the focus of the analysis.

VI ETHICS IN ECONOMICS

In this section, initially some linkages between the views of Etzioni, Sen and Broome are discussed, and following this possible problems and possibilities for incorporating ethics

and morality into economics are considered with reference to the relationship between utility, rationality and methodological individualism.[3] The initial discussion is structured around three key components, based on earlier discussion, which are the conception of rationality, the conception of utility and consequently the decision-making framework. The assertions of these key components collectively define the linkages between the three writers considered above.[4]

1. Conception of rationality:

Sen uses a definition of rationality such that rationality requires the maximisation of self-interest and hence individuals must be self-interested. Etzioni believes that rationality focuses more upon the process of making the decision, not the consequences of the decision. Broome believes that rationality only requires that individuals optimise and have preferences that satisfy the axioms of utility theory. Hence according to Etzioni and Broome, rationality as it is currently used does not necessarily require that individuals are self-interested.

2. Conception of utility:

Sen believes that the definition of utility as well-being, where well-being is measured in terms of personal advantage alone, means that individuals must be self-interested. Etzioni recognises that the interdependent-utility definition of utility allows for non-self-interested preferences, yet is concerned that this may lead to a tautology where all observed actions can be explained by some motivation and hence all actions are a result of maximising satisfaction. Therefore, Etzioni believes that the current conception of utility requires self-interested preferences. Broome does not use a definition of utility that requires that individuals are self-interested, as Broome defines utility as that which represents preferences, and hence if the preferences do not have to be self-interested, utility will not be either.

3. Decision making framework:

Combining the conceptions of rationality and utility to determine the decision-making framework, Broome believes that the dominant decision-making methodology does

not necessarily require self-interested motivation, whereas Etzioni and Sen believe that it does.

Therefore, in summary, Sen argues that both utility and rationality as they are currently conceived require that individuals are self-interested, and hence both must be adapted in order to increase the role of ethics in the decision-making process. Etzioni believes that rationality as it is currently conceived can enable non-self-interested motivation but utility as it is currently used requires the assumption that individuals are self-interested, and hence utility must be adapted in order to increase the role of ethics in the decision-making process. Broome believes that utility and rationality as they are currently conceived can enable non-self-interested motivation, but both rely on the assumption that the individual optimises according to their preferences, and hence it is the preferences which currently assure that the individual is self-interested, not the conceptions of utility and rationality. Therefore the current uses of utility and rationality together combine to form a model of self-interested behaviour with no role for ethical considerations under the conceptions of Etzioni and Sen, and furthermore under the conceptions of Broome *if* we assume that preferences as they are currently used require self-interest. Figure two demonstrates whether Etzioni, Sen and Broome believe that the current conceptions of utility and rationality necessarily require that individuals are self-interested.

		Rationality	
		Requires self-interest	Does not require self-interest
Utility	Requires self-interest	Sen	Etzioni
	Does not require self-interest		Broome

Figure 2 Viewpoints regarding the necessity of the assumption of self-interest for utility and rationality as they are currently used and conceived

Figure 2 illustrates two separate linkages. Firstly, the rows of figure 2 illustrate that Etzioni and Sen have common ground, as utility and rationality as they are currently conceived will together form a model which requires self-interest. Broome, however, is somewhat different. Utility and rationality are dependent upon the individual's preferences, and hence *only if* preferences are assumed to require self-interest will utility and rationality require self-interest, the assumption of self-interest relies upon preferences, not upon the concepts of utility and rationality. Secondly, the columns of figure 2 illustrate that Etzioni and Broome have common ground whereas Sen is somewhat different. Etzioni and Broome adopt the common position that rationality does not necessarily imply self-interested behaviour, whereas Sen maintains that it does. With regard to figure 2, it is interesting to recognise the empty cell in which rationality requires self-interest but utility does not. This cell can be interpreted as a plea for the recognition of non-self interested behaviour, but the underlying analytical method does not allow this, and hence without any reconstruction of the basic principles of economics this is an empty rhetoric.

Figure 2 illustrates that Broome and Sen take views in opposing corners, as Sen believes that the current conceptions of utility and rationality necessarily require self-interest, and Broome believes that they do not. If utility and rationality when combined require self-interested behaviour maximal methodological individualism is appropriate, as maximal methodological individualism requires not only that individuals are focussed upon and used to explain social phenomena, but also that the well-being of an individual is unaffected by the actions of others and hence the individual is self-interested, whereas minimal methodological individualism only requires that individuals are focussed upon and used to explain social phenomena. The use of maximal methodological individualism leads to the assumption of self-interest where the individual is not ethical, as they act only in their self-interest and are unaware of how their decisions impact upon others. Once an individual recognises ethical considerations and has a social awareness they are aware of how their decisions impact upon others, and hence their principle of action is no longer

individualistic but is holistic, and hence maximal methodological individualism cannot be used as it requires an individualistic principle of action.

Therefore, maximal methodological individualism is inconsistent with uses and definitions of utility and rationality which enable other-regarding behaviour because maximal methodological individualism cannot allow the well-being of an individual to be affected by the actions of others as this means that the principle of action is holistic rather than individualistic, and hence a framework which enables self-interested and other-regarding behaviour must use minimal methodological individualism. Methodological individualism in its maximal form provides a barrier for the incorporation of ethical considerations in the decision-making process, yet this barrier can be removed by adopting minimal methodological individualism, which facilitates non-self-interested behaviour yet does not require a holistic methodological approach. These differing conceptions of individualism, with the implications that follow from them, are more than just a logical matter. If we are to develop a dialogue within economics on the importance of ethics, a minimal common ground is required. Without this common ground all that is feasibly possible is the development of isolated positions and hence the dominance of current thinking, that among other things marginalises ethics.

Although each of the outlined viewpoints regarding utility and rationality have their own internal merits, we believe that rationality does not necessarily require self-interest, and hence do not believe that the current concept of rationality provides a problem for the incorporation of ethical considerations in the decision-making process. In this aspect we distance ourselves from Sen. But the current usage of utility is problematic, as we believe that utility as it is currently used does require self-interest. Consequently we distance ourselves from Broome on this matter. Therefore, the problem lies only with the current conception of utility. We believe that utility is both a measure of well-being, as stated by Sen, and a representation of preferences, as stated by Broome, which are very similar to the pleasure-utility and formal-utility definitions outlined by Etzioni. Therefore, adaptation is required both for the conception of well-being and preferences, yet as they are interrelated the adaptation should be interrelated.

The question remains how utility can be adapted in order to facilitate non-self-interested or other-regarding motivation. Using figure two, two possibilities emerge where an adaptation of the viewpoints of Etzioni and Sen from the first row potentially suggest a multiple utility approach, and an adaptation of the viewpoint from the bottom row of Broome potentially suggests a mono-utility approach. Etzioni believes that the mono-utility framework and the concept of a single utility cannot facilitate non-self-interested or other-regarding preferences, Sen (1977) suggests that the mono-utility framework may not be the most suitable framework for analysing self-interested and non-self-interested preferences, whereas Broome believes that the mono-utility framework can facilitate ethical considerations. Etzioni endorses a multiple utility framework where individuals are not solely concerned with single utility maximisation, but are also motivated by factors such as morality, altruism and so forth, as he argues that one single concept of utility, however defined, will be unable to adequately represent both self-interested and other-regarding preferences, as it cannot account for both satisfaction and affirmation as there are qualitative differences between self-interested and other-regarding preferences.

The multiple utility framework does not have a single grand maximand, which is where there is a single object to be maximised, and hence there is not a single utility function including, for example, self-interested and other-regarding preferences, and hence self-interested and other-regarding expenditure cannot be traded off against each other. There are at least two maximands for each individual, and hence this is not in accordance with the standard rational choice framework. The motivation for two maximands (e.g. private and social) is that the different types of preferences are qualitatively different and hence cannot be traded-off against each other. Therefore there is not one single concept of utility, but two or more utilities which represent the satisfaction of different types of preferences. These utilities are not reducible to a single value due to their qualitative differences, and if they were this would be a mono-utility rather than a multiple utility framework. The motivation behind the multiple utility framework is extremely persuasive, as two different types of utility can be used to represent the satisfaction of self-interested and ethical preferences, hence meaning that an individual can perform an

ethical act simply because it is right, not because it increases their utility in the usual sense, as some value which is derived from performing an ethical act may be nothing more than a ‘warm sensation’ from knowing that they did the right action at great detriment to themselves, such as risking their life to save a drowning child. Therefore, in this framework an individual can be first-order ethical rather than simply second-order ethical as earlier defined in section I, as an action may be performed due to commitment rather than sympathy, and the sensation derived from satisfying ethical and self-interested preferences can be separated into affirmation and satisfaction.

The multiple utility framework has the advantage over a mono-utility framework that an individual can be first-order ethical rather than second-order ethical, as earlier defined. In the mono-utility framework if other-regarding and ethical considerations enter the individual’s utility function the individual makes the ethical choice not only because it is the ethical choice, but in part because they derive utility from it. Therefore, in the mono-utility framework the individual can be second-order ethical but not first-order ethical. The mono-utility framework can therefore only be used as an extension of self-interest, and all non-self-interested preferences must be based upon a self-interested foundation, whereas the multiple utility framework can facilitate pure non-self-interested preferences. This means that the mono-utility framework can only accommodate psychological egoism, where all actions are ultimately motivated by self-interest, whereas the multiple utility framework can accommodate psychological altruism, where at least some actions are motivated by factors other than self-interest.

However, the multiple utility framework suffers from the problem that a formal specification is difficult due to the requirement of multiple maximands. It is not the intention to provide a full critique of the multiple utility framework here, this is done elsewhere (for example see Brennan (1989, 1993)), yet it is our belief that the mono-utility framework is more suitable for the incorporation of ethical preferences, and furthermore this approach is used by other authors (for example see Arrow (1972), Becker (1981, 1991), Boulding (1973) and Collard (1978)). The mono-utility framework is more appropriate for the incorporation of ethical preferences because it can overcome

three major problems faced by the multiple utility framework. Firstly, the multiple utility framework fails to recognise opportunity cost or trade-offs between conflicting preferences due its strong separability requirement of self-interested and non-self-interested preferences such that the different preferences must be placed in different separable spheres. Arguably individuals choose whether to follow self-interested preferences or other-regarding preferences using trade-offs and opportunity cost, as they will use all information and preferences to make decisions, and the individual may, for example, decide to act more ethically in some circumstances than if they were solely motivated by self-interest, as although they would yield utility from acting less ethically from a self-interested viewpoint they would yield a counteracting disutility from acting immorally, and this is facilitated in the mono-utility framework, as discussed by Brennan (1989).

Secondly the multiple utility framework fails to unambiguously and unanimously specify how conflicting preferences are resolved in order to make a decision, and this is further aggravated by the problem that there is no trade-off between these conflicting preferences.[5] The determination of criteria for which preferences should take priority is problematic, as discussed by Brennan (1989), as ethical or higher order preferences may actually not be ethical, especially if the preferences thought to be ethical are so purely due to greater reflection, as you can have premeditated murder for example, and racist or sexist preferences may reflect the will of society yet they should not necessarily be given priority over a self-interested preference of equality. Furthermore, choices may not be consistent with higher order or non-self-interested preferences, and hence may not actually be the choice the individual actually wants. The problem of how to resolve conflicting preferences does not arise in the mono-utility framework as there is only one set of preferences and one type of utility.

Thirdly, the multiple utility framework fails to account for the strategic, or socio-political, interaction of individuals, as each individual is considered in isolation without considering the effects that an individuals' decisions, and even their preferences, have on other individuals, and vice versa. The interdependency and interaction of individuals is an

important aspect of ethical and social behaviour and decision-making, and this can be incorporated into the mono-utility framework using one set of preferences and one type of utility that may be affected by non-self-interested factors.

The mono-utility framework can facilitate ethical considerations, where the individual has a holistic principle of action as they consider how their decisions impact upon others, yet the individual is second-order ethical rather than first-order ethical, as they still undertake the ethical action in part because they gain utility from doing so. The mono-utility framework may be unable to accommodate for the qualitatively different sensations of affirmation and satisfaction as outlined by Etzioni which are obtained from satisfying ethical or self-interested preferences, as doing so would require multiple utilities rather than a single utility. Instead, the mono-utility framework enables the satisfaction of both ethical and self-interested preferences to be measured using a single umbrella measurement of 'utility', which therefore enables the usage of a formal framework where decisions can be made using a consideration of all types of preferences. In this extension of the standard framework, utility as it is currently conceived requires a minor adaptation, as although utility still represents the satisfaction of preferences, these *preferences* are not concerned with self-interest alone, rather these preferences also involve and are concerned with ethical considerations and social awareness. Therefore, utility is not a representation of well-being where well-being reflects personal advantage alone, rather utility reflects well-being where well-being reflects personal advantage *and* objectives and values other than personal advantage, such as morality, altruism, autonomy and personal liberty, that in some way benefit the individual.[6]

It is not claimed that using one single measurement of the umbrella term of utility for the satisfaction of different preferences is unproblematic, yet when combined with the standard mono-utility framework it will enable morality to enter the decision-making framework, where an individual may be ethical, but in part will be ethical because it is in their self-interest to do so, and hence this is more in accordance with economic discourse than ethical discourse. Using a mono-utility framework means that an ethical principle of action is still built upon a self-interested foundation, and hence the sensation derived

from the satisfaction of all preferences has a common underlying property that it benefits the individual in some way. The sensation from satisfying these preferences will be qualitatively different, just as the sensation of eating a chilli is very different that that of eating ice cream, yet both have many similarities, and these similarities are arguably more important than the differences.

VII POSSIBILITIES

Therefore ethics may be incorporated into economics using a decision-making framework that uses minimal rather than maximal methodological individualism and although the current role of rationality may remain, the current conception of utility requires adaptation as discussed above, whilst maintaining a mono-utility approach. One possibility is to amend the single utility function such that non-self-interested factors can affect utility, and hence the individual has other-regarding preferences as well as self-regarding preferences. This approach is not unique (for example see Becker (1981, 1991), Boulding (1973) and Collard (1978)), and will overcome the first two problems faced by the multiple utility framework as outlined above, as firstly individuals may choose whether to follow self-interested preferences or other-regarding preferences using trade-offs and opportunity cost as they will use all information and preferences to make decisions, and secondly the problem of how to resolve conflicting preferences does not arise in the mono-utility framework as there is only one set of preferences and one type of utility. However, an extra step must be taken in order to combat the third problem faced by the multiple utility framework, where it fails to account for the strategic, or socio-political, interaction of individuals. This extra step must be consistent with the current conception of rationality and minimal methodological individualism, where individualism is used as the analytical method but not as the principle of action. Therefore we suggest that an amended mono-utility function may be used to calculate the payoffs for an ethical strategic game, in order to analyse the strategic ethical interaction between two individuals.

A simple utility function can be written $U = E^a$ where U is utility, E is expenditure on goods and services, and a is the common parameter, and this functional form may be used to develop a simple economic analysis of morality. Assuming a community with a population of *n* individuals, two players are chosen at random from the community. Assume a two player game, where each player can behave ethically or non-ethically. Income for each player is $Y_i(i = 1,2)$, and this income differs from expenditure, E_i, because each player may donate some income to the other player, D_i, and may receive a donation of income in return:

$$E_1 = Y_1 - D_1 + D_2 \tag{1}$$

$$E_2 = Y_2 - D_2 + D_1 \tag{2}$$

D_1 represents a donation from player 1 to player 2. Utility is derived from expenditure, and furthermore *if a player behaves ethically* they donate some income to the other player and there is a positive utility derived from making the donation. *If a player behaves non-ethically* no donation is made and no positive utility can be derived from donating resources to the other player:

$$U_1 = m_1(Y_1 - D_1 + D_2)^{\alpha_1} D_1^{\beta_1} + (1 - m_1)(Y_1 + D_2)^{\tau_1} \text{ where } \alpha_1, \beta_1, \tau_1 > 0 \tag{3}$$

$$U_2 = m_2(Y_2 - D_2 + D_1)^{\alpha_2} D_2^{\beta_2} + (1 - m_2)(Y_2 + D_1)^{\tau_2} \text{ where } \alpha_2, \beta_2, \tau_2 > 0 \tag{4}$$

m_i is an indicator function which reflects the *principle of action* of player *i*, where:

$$m_i = \begin{cases} 1, & \text{if player } i \text{ has an ethical principle of action, hence } D_i > 0, \\ 0, & \text{if player } i \text{ has a non-ethical principle of action, hence } D_i = 0. \end{cases} \tag{5}$$

Utility is derived from expenditure, where negative utility is derived from a loss of income and positive utility is derived from a gain in income, and furthermore utility is derived from donating income to the other player, where this donation will increase the

income and consumption opportunities and hence utility of the other player. Therefore, the donation has both a positive and a negative impact on utility, and hence for player 1 the size of the donation will be affected by the parameters α_i and β_i. Although the satisfaction or sensation derived either from expenditure or from a donation will be significantly different, they are still measured under the umbrella term of utility, where utility represents the satisfaction of extended self-interested preferences, where these preferences can encompass ethical and altruistic preferences.

Ethical behaviour involves undertaking some activity that involves a cost to the player undertaking the activity but involves a direct benefit to the other player in the game. In generic terms this activity is called here a donation that is costly to the donor but has direct income advantages to the recipient. Each donor has the ability to choose the amount of the donation but is unable to exert influence over the consumption choices undertaken by the other player with their donation. Furthermore, neither player can exert influence over whether the other individual makes a reciprocal donation. A donation is not undertaken for any instrumental individual advantage, and although this action will be second-order ethical, this action will not be first-order ethical as earlier described, because the individual makes the donation in part because they derive utility from it. Therefore, utility represents the satisfaction of extended self-interested preferences rather than non-self-interested preferences. The indicator function, m_i, is a step towards recognising the first factor of a principle of action as defined in section I, where a commitment to ethical considerations is undertaken through the existence of m_i.

Non-ethical behaviour involves gaining no utility from a donation, and thus implies that no donation will be made. If a player does not behave ethically it does not follow that they are behaving immorally. The specification of the utility function means that players do not consider the effects experienced by the other player and subsequently ignore those effects to the detriment of the other player, which would be the case if they were behaving immorally. Rather, the effects experienced by the other player are never considered and hence the player is self-interested and hence non-ethical rather than selfishly self-interested as discussed in section I.[7]

An example of this scenario is two people living in a large shared house together, where each individual donates some money to the other in part because they realise it will increase the utility of their housemate due to their increased income and hence consumption opportunities, but in part because they get utility from doing so. Another example is two people amongst many new acquaintances on an evening out, where they take it in turns to buy a round of drinks for both individuals, assuming autonomous independent individuals where neither individual exerts influence over what the other individual chooses to consume. These scenarios may be more persuasive and more interesting if we assume asymmetric income, and an analysis of the relationships between these individuals would enable a greater ethical discussion, yet the model we propose is a simple one. Although these scenarios would rarely warrant moral discourse, these are a simplified analysis of altruism occurring in standard economic discourse. A multi-player model would enable advantageous analysis, yet here it is decided to remove multiplayer complications and hence to focus upon a two player model, as done elsewhere (Minkler (2004)).

Assuming a one-shot game, finding the utility maximising level of donations for each individual is problematic. Neither individual has an intimate relationship with the other individual, and hence cannot accurately predict how the other individual will behave. Neither individual has complete information in order to know the principle of action of the other individual, as the principle of action is an internal motivation rather than an externally observable characteristic. For each individual their utility maximising level of donations could be found, yet this suffers from the problem that the utility maximising level of donations would be dependent upon whether the other individual also chose to donate, yet in a one-shot game of this nature each player does not have complete information and cannot know the action of the individual in advance.[8] It is therefore assumed that the individual will choose the size of their donation through consideration of their preferences and hence of the parameters α_i and β_i, furthermore as the individual is a member of a community it is also expected that their level of donations may be influenced by appealing to previously observed levels of donations made by individuals

within their community, as this indicates socially acceptable levels of donations. However, whilst observing average donation levels the individual will also observe the probability that community members act ethically and hence make donations. This does not pose a major problem for the model, it illustrates the role of acculturation and the reinforcement of community values, and these factors may indeed influence the principle of action of the individual which is reflected by m_i, and hence influence whether the individual decides to act ethically, as our ethical values are affected by our social surroundings. However, social and societal factors will not be the only factor affecting our principle of action, as this is an internal motivation which will be affected by many internalised values and objectives.

We can now define a game in which either player can behave ethically or non-ethically. For player 1, we can specify the utility payoffs as follows:

		Player 2	
		Ethical behaviour	Non-ethical behaviour
Player 1	Ethical behaviour	$(Y_1 - D_1 + D_2)^{\alpha_1} D_1^{\beta_1}$	$(Y_1 - D_1)^{\alpha_1} D_1^{\beta_1}$
	Non-ethical behaviour	$(Y_1 + D_2)^{\tau_1}$	$Y_1^{\tau_1}$

Figure 3 Ethical game showing the utility payoffs for player 1

Condition 1: If player 2 behaves ethically, player 1 behaves ethically if:[9]

$$(Y_1 - D_1 + D_2)^{\alpha_1} D_1^{\beta_1} > (Y_1 + D_2)^{\tau_1} \quad (6)$$

Condition 2: If player 2 behaves non-ethically player 1 behaves ethically if:

$$\left(Y_1 - D_1\right)^{\alpha_1} D_1^{\beta_1} > Y_1^{\tau_1} \tag{7}$$

Equivalent conditions can be derived for player 2. This demonstrates that the model demonstrates extended self-interest, as the individual decides whether to be ethical depending upon whether they will get a higher utility from being ethical, and hence whether it is in their self-interest to be ethical. If $\alpha_1 = \alpha_2$, $\beta_1 = \beta_2$, $\tau_1 = \tau_2$ and $Y_1 = Y_2$, three possible solutions exist, such that

1. If both conditions are satisfied there is a dominance of ethical behaviour and hence $m_i = 1, \quad i = 1,2$;

2. If neither condition is satisfied there is a dominance of non-ethical behaviour and hence $m_i = 0, \quad i = 1,2$; and

3. If condition 1 is satisfied but condition 2 is not satisfied we have a coordination game with two Nash equilibria involving ethical or non-ethical behaviour as there is no dominant strategy, and hence the value of m_i is affected by the action of the other player.

If both or neither conditions are satisfied, then:

$$\begin{aligned} m_1 = 1, &\quad \text{if } \left(Y_1 - D_1 + D_2\right)^{\alpha_1} D_1^{\beta_1} > \left(Y_1 + D_2\right)^{\tau_1} \quad \text{where } D_2 \geq 0 \\ 0, &\quad \text{if } \left(Y_1 - D_1 + D_2\right)^{\alpha_1} D_1^{\beta_1} < \left(Y_1 + D_2\right)^{\tau_1} \quad \text{where } D_2 \geq 0 \end{aligned} \tag{8}$$

The outcomes of the game are dependent upon the values of $\alpha_i, \beta_i, \tau_i$, where $i = 1,2$, and hence the model can be specified such that the player will always have preferences such that either ethical behaviour or non-ethical behaviour will always be dominant, and this is due to the fact that the preferences are defined by the parameters of the utility functions. The outcome will also be affected by the size of D_1 and D_2 when the individual chooses to act ethically. This therefore suggests that preferences and observed

previous behaviour within the community will affect the outcomes reached in this model, as they determine the size of donation and whether the individual chooses to act ethically.

The game where there is a coordination problem, where each player is better off choosing the same option as the other player, but the outcome where both players act ethically is the Pareto optimal outcome is of great interest. In this situation if both players can coordinate their actions they will achieve the Pareto optimal outcome, and this coordination of actions can be achieved using communication, bargaining or with the assistance of an external body. For example, religion may ensure that both players reach the Pareto optimal outcome, and hence the presence of societal values and institutions to promote these societal values may be of key importance in ensuring that the Pareto optimal outcome is achieved. More generally, the coordination game illustrates that simple observation of non-ethical behaviour does not imply the irrelevance, or non-viability, of ethical behaviour.

There is an implicit assumption in the above analysis that unqualified ethical behaviour by one player occurs if the other player is non-ethical. Arguably, more realistic behaviour may be represented as involving, in simple terms, a 'grievance cost', G_i, to a player that behaves ethically when the other player does not. For player 1:

		Player 2	
		Ethical behaviour	Non-ethical behaviour
Player 1	Ethical behaviour	$(Y_1 - D_1 + D_2)^{\alpha_1} D_1^{\beta_1}$	$(Y_1 - D_1)^{\alpha_1} (D_1 - G_1)^{\beta_1}$
	Non-ethical behaviour	$(Y_1 + D_2)^{\tau_1}$	$Y_1^{\tau_1}$

Figure 4 Ethical game showing the utility payoffs for player 1 when player 1 experiences a grievance cost when they behave ethically but player 2 behaves non-ethically[10]

Condition 2 may now be rewritten:

Condition 2': If player 2 now behaves non-ethically player 1 behaves ethically if:

$$(Y_1 - D_1)^{\alpha_1} (D_1 - G_1)^{\beta_1} > Y_1^{\tau_1} \tag{9}$$

Condition 2' is more restrictive than condition 2, and hence this grievance cost increases the importance of the coordination game solution.

The specification of the model suffers from the problem that each individual may have an ethical principle of action, yet their adherence to these ethical principles does not guarantee that the outcome of their behaviour will be ethical. To clarify, the model is in parts more deontological than consequentialist, as assuming that acting ethically is not the dominant strategy, the individual acting ethically whilst the other individual acts non-ethically will have a lower utility than if they too acted non-ethically, although combined utility will be greater. In this situation, it does not seem an ethical outcome, however if we return to the earlier examples, where one housemate donates income to the other housemate and receives none in return, or one drinker purchasing all drinks on an evening out together, despite equal income in both cases. These outcomes only seem ethical if other factors are taken into consideration, such as the recipient housemate may perform all household chores, or the recipient drinker may be struggling financially, and

hence the model could be made richer through adaptation to incorporate factors such as these.

VIII CONCLUSION

In conclusion, the decision-making process for individuals and society currently has a small role for ethics, as individuals are self-interested. The key concepts in economics which determine the role of ethics in the decision-making process are utility, rationality, and methodological individualism and hence how these are and may be used and defined will determine different roles for ethics in economics. The current conception of rationality may be consistent with non-self-interested behaviour, and methodological individualism may also be consistent with non-self-interested behaviour if it is used in the form of minimal methodological individualism, yet the current conception of utility requires some adaptation in order to enable ethical considerations to have a greater role in the decision-making process, and a mono-utility framework is able to accommodate this.

The advantages of using a mono-utility framework are that it can facilitate trade-offs between self-interested and non-self-interested preferences and allows for individuals to be more or less self-interested along a sliding scale, there is a single utility function which enables unambiguous criteria for a single optimal outcome to be reached, and furthermore it can enable strategic interaction between individuals where the actions of one individual will affect the actions of another individual. However, the multiple utility framework has the advantage over the mono-utility framework that in the multiple utility framework an individual can perform an act simply because it is right and not because it is in their self-interest to do so, whereas in the mono-utility framework if other-regarding and ethical considerations enter the individual's utility function, the individual makes the ethical choice not only because it is right, but in part because they derive utility from it. Therefore, in the mono-utility framework the individual can be second-order ethical but not first-order ethical, as the mono-utility framework can only be used as an extension of self-interest, as all non-self-interested preferences must be based upon a self-interested foundation.

An extension of the standard framework is suggested, where utility as it is currently conceived requires a minor adaptation, as although utility still represents the satisfaction of preferences, these *preferences* are not concerned with self-interest alone, rather these preferences also involve and are concerned with ethical considerations and social awareness. Rationality and methodological individualism do not have to be sacrificed in order to move toward this framework, and hence the current focus upon an individualistic methodological approach to decision-making does not need to be sacrificed. In the final section a simple framework was developed based on minimal methodological individualism in which the method is individualistic but behaviour need not be. This framework illustrates the potential importance of coordination issues to the development of ethical behaviour. The recognition of these issues demonstrates that institutional and socio-economic factors should be considered in an analysis of ethical behaviour.

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ENDNOTES

[1] These concepts are not to be confused with first-order and second-order preferences.

[2] Deriving and defining the right course of action is beyond the scope of this paper.

[3] The debate between Sen and Broome regarding the exact definition of the term utility is illustrative of their deep divide on this subject and the key importance of the term utility. Broome argues that Sen uses utility to mean "that which utilitarians believe to constitute good" (1991(a): 9), yet Sen (1991) denies this and criticises Broome's approach, and Broome (1991(b)) reinforces his original argument. This is not discussed further as it does not add anything to this analysis of ethics in economics.

[4] As earlier emphasised, the discussion focuses upon their perceptions of the current concepts of utility and rationality used in economics, not on what they believe is most productive or desirable.

[5] Although attempts have been made to unambiguously specify how conflicting preferences should be resolved, the application of this is not unanimous.

[6] Furthermore, utility is not used here as referring both to the satisfaction of preferences and 'good', as discussed by Broome, as no moral weight or significance is attached to the concept of utility.

[7] Please note that it does not follow that the selfishly self-interested individual is immoral.

[8] For person 1 the utility maximising level of D_1 can be found such that U_1 is differentiated with respect to D_1: $\frac{\partial U_1}{\partial D_1} = -\alpha_1 m\left(Y_1 - D_1 + D_2\right)^{\alpha_1 - 1} D_1^{\beta_1} + \beta_1 m\left(Y_1 - D_1 + D_2\right)^{\alpha_1} D_1^{\beta_1 - 1} = 0$.

Therefore $D_1 = m\frac{\beta_1}{\alpha_1 + \beta_1}\left(Y_1 + D_2\right)$, where $\frac{\partial D_1}{\partial Y_1} \geq 0$ and $\frac{\partial D_1}{\partial D_2} \geq 0$. This suffers from the problem that the level of D_1 depends on the value of D_2, yet this cannot be known in advance.

[9] Please note that D_2 may take different values on either side of the inequality.

[10] The formulations used in this, and earlier, games are examples of more general Stone-Geary functions as first developed by Geary (1950-1951) and Stone (1954).