

A reason to worry about environmental non-market valuation: WB-incommensurability

Can you compare your relief from less global warming with more anxiety at work? The loss of a friendship? Or even the pleasure of chocolate cake?

Edward Morey, University of Colorado, Boulder CO. U.S. Edward.Morey@colorado.edu. www.EdwardMorey.org, March 23,2020.

Abridged version:

Abstract: The choice theory that supports the valuation of environmental resources assumes you have a complete ordering of paths in terms of well-being, *WB*. But there are different flavors/kinds of *WB*: pleasurable and dis-pleasurable sensations, positive and negative thoughts, and positive and negative emotions. So, to have a complete ordering based on *WB* requires that all types of *WB* are *commensurable*, and all *bearers* are comparable. You must be able to compare those kinds of *WB* you would experience from a romance with Alex, with those if gorillas were saved from extinction, with those because you are now free to practice your religion, with those from eating cake. Philosophers, and regular people, mostly reject complete *WB* commensurability. I summarize the arguments and findings in the environmental context. If complete commensurability is rejected, *WTP* and *WTA* largely lack meaning.

Keywords: well-being and bearers-of-well-beings, value, incomparable and *WB*-incommensurable, an ordering based on well-being, well-being/bearer separability, neuroeconomics, and the ventromedial prefrontal cortex

The objective is to question two pillars that support the valuation of environmental and ecological resources: (1) all commodities and activities are *comparable* in terms of well-being (hereafter WB),¹ and (2) all kinds of WB are *commensurable*.

As explained below, if complete comparability and commensurability don't hold, the individual doesn't have a complete ordering of paths² and *WTP* for an environmental improvement and *WTA* an environmental deterioration are meaningless constructs as they are typically defined.

Unlike neoclassical economists, most people and philosophers don't believe in complete comparability nor complete commensurability. While most believe some bearers-of-WB are comparable (e.g., Coke and Pepsi), few believe every commodity and activity is comparable with every other. While the sensations, thoughts, and emotions produced by drinking a Coke might be commensurable with those produced by eating cake, are they commensurable with those that result when one finds out rhinos have gone extinct, or The Donald was elected, or there's a pandemic?

I present arguments for, and against, comparability and WB commensurability. Why is this important? If you are doing environmental non-market valuation to inform policy, you must defend complete comparability and complete WB commensurability. If they don't hold (the position of many/most non-economists), then non-market values are mostly meaningless constructs: "meaningless" in the sense that *WTP* and *WTA* for path changes don't exist (logically there is no number (not a finite positive nor negative number, not plus nor minus infinity, not zero)).

First, I produce a broad definition of WB. Then, I lay out a non-determinist neoclassical choice-model that includes, in addition to market goods, all commodities and activities that affect our WB, including environmental resources—what I teach in intermediate microeconomics but with risks, uncertainties, and time.

Next, I cover the distinction between WB and *bearers-of-WB*: consuming an ice-cream cone is, for example, a bearer of multiple kinds of WB, including pleasurable taste, gustatory,

¹ Commodities and activities can be compared on many criteria, e.g., *desirability*. Here, "comparable" means in terms of WB.

² Said the other way, if you have a complete ordering of path, you can compare all commodities and activities, and all kinds of WB are commensurable.

and visual sensations; positive thoughts; and positive emotions (*I'm happy*). But, at the same time, its consumption can decrease some kinds of WB: my later thought: *My diet is ruined*.

Then *incomparable* and *WB-incommensurable* are defined and discussed, including their relationship to *WTP* and *WTA*.

Only then do I add to the literature and arguments on whether different kinds of WB, including environmental kinds, are WB-incommensurable and on whether environmental bearers-of-WB (abbrev., *bearers*) are incomparable.

Before beginning, everyone seems to define *comparable* the same: paths/bundles are comparable if they can be ordered (here in terms of overall WB)—the [Chang \(1997\)](#) definition. Not so for *incommensurable*, it has various meanings, and often qualifying adjectives are omitted.

Commensurable is sometimes used as a property of paths; call this *path-commensurable*: two paths are path-commensurable if the compensating variation (*CV*) for a switch from one to the other is a finite amount of money. This paper is **not** about path commensurability, but I will need to make it an aside because some in non-market valuation discuss path-commensurability but omit the adjective *path*.³

This paper is, instead, on *WB-commensurability (value-commensurability)*. Two kinds of WB are *WB-commensurable* if they can be compared in terms of their contribution to overall WB ([Wiggins 1997](#) and [Hsieh 2016](#))

A critical word distinguishing *path* from *WB* commensurable is “lexicographic”. If commodity *g* is lexicographically preferred to commodity *h*, paths with more *g* are ranked higher than paths with less *g*, independent of the amount of *h* in each path. “Path-incommensurable” and “lexicographically preferred” are synonyms. To avoid confusion, I will add either the adjective “WB” or “path” to “commensurable”.

Well-being (WB)

An individual’s WB is generated by the sensations, perceptions, thoughts, and emotions they experience. Most people, including most economists and philosophers, are *WB pluralists*: most

³ Occasionally they use the term *monetary-commensurability*. There are also other uses of commensurable in the environmental literature. See, for example, [Centemeri \(2015\)](#).

of us believe there is more than one kind of WB. The legal scholar [Sunstein](#)⁴ (1994) makes a rousing case for WB pluralism. The utilitarian Jeremy Bentham was a WB monist; he assumed the only WB is pleasure (a unidimensional pleasure/pain continuum), a sensation that varies only in terms of magnitude and duration. The philosopher and legal scholar, [Regan](#) (1997, 129) is, I believe, a rare example of a modern WB monist.

Sensations, thoughts, and emotions:

Humans are sentient: we have six senses. A sensation is the awareness of a stimuli through one of the senses, giving us the ability to observe our environment (outside stimuli), so the ability to update our behavior. Some sensations are pleasurable; some are not.

A perception is a type of thought, how one interprets a sensation. It depends on what caused the sensation: pain from a fall, or surgery, or a mobster hitting you with a bat. It also depends on your pain history. If touched, you sense the touch, but how you perceive it depends on who is doing the touching. An elk sees and smells a wolf (sensations) and these sensations cause a perception, danger. A sensation is necessary but only part of what produces the perception.

While a perception is a thought, not all thoughts are perceptions. Thoughts are a cognitive process involving the firing of neurons. They are discrete mental states (they come and go) and differ from sensations. Subjective beliefs are thoughts (thoughts you regard as true) so are subjective probabilities. WB enhancing thoughts include *I'm happy* (content, excited, awed, calm, relaxed, proud, superior, free, liked). So are, *I'm satisfied*; *I'm accomplished*. For many, the thought that they are experiencing the grace of God is a kind of WB.

There is no agreed upon definition or theory of *emotions*. Emotions are viewed from three perspectives: “as experiences, as evaluations, and as motivations” ([Scarantino](#) and [de Sousa](#) 2018). For example, fear is an experience, it's an evaluation of what's going on; it motivates action. Emotions differ on numerous dimensions:

some emotions are occurrences (e.g., panic), and others are dispositions (e.g., hostility); some are short-lived (e.g., anger) and others are long-lived (e.g., grief); some involve primitive cognitive processing (e.g., fear of a suddenly looming object), and others involve sophisticated cognitive processing (e.g., fear of losing a chess match); some are conscious (e.g., disgust about an insect in the mouth) and others are unconscious (e.g., unconscious fear of failing in life); some have prototypical facial expressions (e.g., surprise) and others lack them (e.g., regret). Some involve strong motivations to act (e.g., rage) and others don't (e.g., sadness).

⁴ Text that is underlined is a link.

Some are present across species (e.g., fear) and others are exclusively human (e.g., schadenfreude). (Scarantino and de Sousa 2018).

Emotions have physiological components (e.g. hormonal and cardiovascular) that can be observed and measured, but emotions are more: they're simultaneously physiological and mental states. Some emotions enhance WB, some reduce it. And, the same physiological state can be associated with either a positive or negative emotion depending on what is being experienced (e.g., pursued by lion or watching a horror flick) and who is experiencing it. WB enhancing emotions include happy, content, and relaxed. If loving nature is a unique kind of loving, it's a unique kind of WB. An important issue for environmental economists is whether there exist kinds that are only produced by environmental resources.

WB: a definition

For [Kahneman](#) and [Deaton](#) (2010), WB has two components: *emotional WB* and *life-satisfaction WB*. The first is, “the emotional quality of an individual’s everyday experiences—the frequency and intensity of experiences of joy, stress, sadness, anger and affection that makes one’s life pleasant or unpleasant.”

Life-satisfaction WB, in contrast, is an individual’s thoughts about how well their life is going. It’s the thought component of WB.

A standard survey questions about emotional WB is, “Did you experience a lot of stress (enjoyment, happiness, anger, sadness, stress, worry) yesterday? In contrast, “Rate your life on a ladder scale of 0 to 10.” is a life-satisfaction question.

There is a third component, *sensations WB*: all else constant, WB increases (decreases) with the duration and intensity of pleasurable (dis-pleasurable) sensations. Orgasm is the classic example of a pleasurable sensation. For me, the taste sweet-n-salty is near the top. The sensations associated burning skin and the sensations caused by not being able to breathe are, for most, dis-pleasurable sensations, so is hunger. “All else constant” is important. Gasping for breath could increase overall WB, if it occurs at the end of a run.

The issue for neoclassical choice theory is that it requires that all our sensations, thoughts and emotions are WB-commensurable.

A set of assumption that produce a complete ordering based on WB

A path for an individual is an imaginable life and world as it would unfold through time, starting now. It includes the commodities, activities, and inputs the individual would experience.

consume/use through time on that path, and what others would consume. Each path is associated with an environment (who is now and will be Prime Ministers of England, air qualities, crime rates, etc.). Each path includes a sequence of social, sexual, and work relationships for the both the individual and others. Different paths are associated with different amounts of education, learning, and ignorance. Risks and ignorance are part of every path, so are beliefs.

At every point in time, the number of imaginable paths is huge. A life (existence) is a sequence of paths taken. The goal of neoclassical choice theory is to predict your sequence of paths.

Assumption 1: At every point in time, an individual is on one, and only one, path

This doesn't imply you're always on the same path; that is impossible: paths include uncertainties, and as time passes probabilities turn to certainties, so paths with those uncertainties end and a new path must be started.

Assumption 2: At every point in time, an individual has one, and only one, ordering of all paths—1st, 2nd, An individual has an ordering if for all paths j and k, either Path j is ranked higher than Path k, Path k is ranked higher than Path j, or paths j and k have the same rank.⁵

Assumption 3: An individual's ordering of paths is based on its WB (well-being), WB in some statistical sense. Paths associated with more WB are ranked higher.

These three assumptions together imply the individual has a complete ordering of paths based on WB. Critical to neoclassical choice theory and, in turn, non-market valuation (*WTP* and *WTA*) is the adjective “complete”. Consider what is required of you in terms of comparability for you to have a complete ordering of paths based on WB. In parallel, consider whether you always will have a *WTP* and *WTA* to switch from one path to another.⁶

Our concern is only one individual whose WB is no different from their self-assessed WB. I restrict my examples to path components where, *ceteris paribus*, more always increases WB.⁷ I mostly avoid the words *utility* and *preferences*: words fraught with multiple meanings and words that mean different things to different people.

⁵ A complete ordering is, by definition, transitive. Assumption 2, by itself, implies nothing about the ordering criteria.

⁶ Instead of *WTP* and *WTA*, the discussion could be framed in terms of compensating and equivalent variations (CVs and EVs).

⁷ So, we won't need to fret indifference curves with vertical or horizontal segments, or commodities that are WB enhancing at some levels and WB decreasing at others.

Assumptions 1-3 imply neither the existence of indifference curves nor path-commensurability

Having a complete ordering doesn't require that there are any paths between which you are indifferent and doesn't require that WTA the reduction of a path component must be finite. That is, a complete ordering doesn't require path-commensurability. An example demonstrates: assume paths have only two components: the percentage of the population with health care, h , and the expected rate of global warming, g . Picture non-negative h - g space drawn such that moving up increases the percentage of the population with health care, and moving right decreases the expected rate of GW. Consider Lex: Lex associates more WB with paths with more health, independent of the rate of GW. His ordering is complete, and health care is lexicographically preferred. Pick any path and denote it (h_0, g_0) . All paths with more health care generate more WB for Lex; all paths with less generate less. And paths with a lower (higher) rate of GW, but the same level of health care, generate more (less) WB. So, there exists no path such that Lex is indifferent between it and (h_0, g_0) , and there is no finite reduction in GW Lex would accept in compensation for a reduction in health care. Lex's WTA a reduction in health care exists, is meaningful, and is infinite.

For Lex, every path is ordered with respect to every other path. That is, for every two paths, the first generate generates **either** more, less, or the same amount of WB. In this lexicographic example the "same amount of WB" is a meaningful construct; there are simply no examples. Lex's ordering exhibits path incommensurability, but, looking ahead, it's not an example of WB-incommensurability.

Consider the distinction between WB and its *bearers*

Distinguish between kinds of WB and their *bearers*. Feeling safe is a kind of WB whereas door locks are a bearer (producer) of this kind of WB.⁸ A path and its components bear many kinds. Since, for me, the taste sensation sweet-'n-salty is one kind of WB, both bacon covered in maple syrup and caramels with sea salt are bearers of this kind of WB; all else constant, I order paths with more sweet-'n-salty higher. Distinguish between comparing kinds of WB (feeling free vs. sexual pleasure) and comparing bearers (Does Path k generate more WB than Path h ?)

⁸ For some, guns are a bearer of feeling safe, for others, danger. Political philosophers have used *freedom*, *equality*, and *pleasure* as examples of WB and the Bill of Rights as a bearer of freedom and equality. Philosophers concerned with the motivators of choice typically use the word *value* rather than WB. Chang (1997) is responsible for the term *bearers-of-value* to keep clear the distinction between values and the bearers that produce values.

If two bearers aren't comparable, philosophers use the word *incomparable* (Chang 1997). Bearers h and k are incomparable if **none** of the following statements are correct: h generates more WB than k , h generates than k , or h and k generate equal amounts. They are comparable if one, and only one, of these statements is correct. For example, if Path k is identical to Path h , except that Path k has x more pandas in the wild but y fewer teachers in your daughter's school, and if you can determine which path would generate more WB for you, you can compare pandas and teachers—at least at their current levels.

Think back to Lex and his lexicographic preference for health care over reduced GW. These two bearers are, for Lex, comparable.

Now consider Norm, a guy whose h - g space is populated with nicely-shaped downward-sloping indifference curves. For Norm, like Lex, health care and GW are comparable, but Norm, unlike Lex, will accept some finite decrease in the rate of GW in compensation for a decrease in health care. Lex's WTA a reduction in health care exists, is meaningful, and is finite.

Now compare Tex with Lex and Norm; Tex can't, at any amounts, compare health care and GW. Consider again Path (h_0, g_0) . Tex can still order many paths relative to (h_0, g_0) : paths with more of one and not less of the other are ranked higher; paths with less of one and not more of the other are ranked lower. But for paths with more of one and less of the other, "more", "less", or the "same" amount of WB have no meaning, for Tex. Like with Lex, there is no path such that Tex is indifferent between it and (h_0, g_0) , but for a very different reason: Lex always knows whether one path generates more, less, or the same amount of WB as another. Tex doesn't.⁹ Looking ahead if you asked Tex how much of a reduction in GW he would need to be compensated to accept a 10% reduction in health care coverage, his answer would have to be "I can't answer that question."

In contrast to Tex, bearer incomparability can be partial: at some levels you can compare and at others you can't. For example, while I'm not sure I could compare all possible income reductions with all possible reductions in the expected rate-of-global-warming (hereafter, *GW*), I know I could compare some of them, for example ten dollars less income with a 10% less *GW*. All that is needed for incomparability is that there are some income reductions where I wouldn't

⁹ Even if paths h and k are incomparable in terms of overall WB, they still could be comparable in terms of a specific kind of WB (e.g. Path k generates more happiness than h , but less life satisfaction). And, Paths h and k being comparable doesn't imply either is comparable with any other paths.

be able to order the status quo vs. a 10% reduction in GW combined with any of those income reductions.

In contrast, *WB-incommensurability*: WB kind *A* and WB kind *B* are WB-incommensurable if you are incapable of comparing them in terms of overall WB. For example, commensurability requires you can compare the sensual pleasure of music with the relief from finding out pandas won't be going extinct. Complete commensurability means you have a complete ordering over all conceivable packets of different kinds of WB. Incomplete commensurability means you can't order all packets.¹⁰

Feeling safe and the experience of romantic love are WB-incommensurable if you are unable to order all paths that vary only in feeling safe and experiencing love. If you can't compare the grief from the loss of a loved one with the existential angst associated with a warmer planet, they are WB-incommensurable. [Right now, the pandemic is causing both death and a drastic reduction in CO2 emission.]

Commensurability means the individual can order packets in terms of overall WB that differ by kinds and magnitudes of WB. E.g., picture a three-dimensional graph with *satisfaction*, *calm*, and *pleasure* on the three axis. Each point in the figure represents a different packet of WB. If an individual can't order every packet, she suffers from WB-incommensurability.¹¹

Note that when economists discuss and estimate a *WTP* or *WTA*, it's for a change in the levels of a bearer, not for a change in a kind of WB. For example, we consider *WTP* for a 10% reduction in GW, not *WTP* for a 10% reduction in environmental angst.

You can guarantee that WB-incommensurability won't occur if you are willing to assume there is only one kind of WB—what Bentham assumed.

Aristotle, a WB pluralist, argued that many kinds of WB are WB-incommensurable; many modern philosophers agree ([Nussbaum 2012](#))—so do many people. If not all the kinds of

¹⁰ You will still have a partial ordering of packets. For example, if all the kinds of WB generated by eating different types and quantities of chocolate are commensurable, there will an WB ordering over paths that vary only in terms of types and quantities of chocolate eaten. There can also be a partial ordering in that Packet *c* generates more WB than Packet *m*, while there are packets that generate more WB than *c* but less than *m* but can't be ranked relative to each other.

¹¹ WB-commensurability of two packets only implies that they can be ordered in terms of overall WB; it doesn't imply overall WB has cardinal properties. One might deem WB-commensurability with, added, cardinal WB, *cardinal WB-commensurability*. Some authors define the term "value commensurable" to imply value has cardinal properties, what I'm denoting "cardinal WB-commensurability". See [Martinez-Alier](#), [Munda](#), and [O'Neill](#) (1998). Cardinal WB-commensurability isn't required for a complete ordering of paths in terms of WB, so isn't a requirement of neoclassical choice theory.

WB are commensurable, the individual doesn't have a full ordering of paths based on WB (Assumptions 2 and 3 are violated).

A complete ordering of paths based on WB requires complete WB-commensurability

Neoclassical choice theory requires a *complete ordering of paths* (Assumption 3). A necessary condition is *complete comparability*: if you can't compare paths you can't order them, but a necessary for *complete comparability* is *complete WB-commensurability*.¹² So, *incomplete WB-commensurability* → an incomplete ordering of paths.

Explaining: if two kinds of WB are WB-incommensurable, paths that contain different amount of these two kinds aren't comparable; that is, the paths can't be ordered relative to each other. For example, many conceivable paths vary in terms religious freedom, degree of GW, and the availability of cake. If the joy of religious freedom, environmental angst, and the pleasures of cake aren't commensurable at all conceivable levels, the individual can't order all paths that vary in these three components.

WB-incommensurability is an issue for all who adhere to neoclassical choice theory, not just the subset who do non-market valuation. Why? If there isn't complete WB-commensurability, there isn't necessarily a highest-ordered feasible path. The implications of WB-incommensurability are broad:

The possibility of value [WB] incommensurability is thought to raise deep questions about practical reason and rational choice as well as related questions concerning topics as diverse as akrasia, moral dilemmas, the plausibility of utilitarianism, and the foundations of liberalism
(Hsieh 2006)

WB-commensurability is critical to tort law (e.g. can you be compensated with money for the loss of an arm or a cognitive ability),¹³ hedonic price and wage studies, and defining sustainability.

¹² Some philosophers argue that there can be complete comparability of paths in terms of WB without complete WB-commensurability. Hsieh (2016; sec. 3) provides their arguments, arguments that I do not find convincing. One argument is based on "strong comparability" of paths, an assumption I don't make.

¹³ See, Adler (1998), Posner 98) and Sunstein (1994).

If there isn't a complete ordering of paths, the *WTP* and *WTA* for many path changes are either non-existent or irrelevant for policy purposes. If I can't order paths i and j , I can't determine which is associated with more WB, so my *WTP* and *WTA* for shifting from i to j don't exist; they are meaningless constructs. Consider, for example, my *WTP* to reduce GW paid in either religious freedom, cake, or money? If the joy of religious freedom, environmental angst, and the pleasures of cake aren't WB-commensurable, I can't determine whether my WB will increase or decrease with less GW and less money (or less cake), so *WTP* for a reduction in the rate of GW doesn't exist: the individual can't determine whether giving up money for less GW is worth it because she can't compare the pleasure of cake with less environmental angst.

But, even if I can order paths i and j , *WTP* and *WTA* for shifts from one to the other are often still meaningless constructs.

Paths i and j will be ordered relative to each other if either (I) they are identical in terms of their incomparable components but vary in terms of their comparable components, or (II) they are identical in terms of their comparable components, but one has the same or more of each of the positive incomparable components and the same or less of each of the negative incomparable components. An example of I: number of wild rhinos is the only incomparable path component, and there are a thousand wild rhinos on both paths. An example of II: all market goods are comparable and Paths i and j have the same vectors of market goods, there are only two incomparable commodities, number of wild rhinos and the expected rate of GW, Path i has zero wild rhinos and j has one thousand, and j has a lower expected rate of GW, so Path j is ordered higher.

For case I, *WTP* and *WTA* exist for a shift from Path i to j . For example, they exist if i and j are identical except j involves the consumption of more Coke and less cake, and all market goods are comparable.

For case II, *WTP* and *WTA* don't exist for a shift from i to j : j is better but how much better in money terms isn't a meaningful construct. If rhinos and cake are incomparable, *WTP* for more rhinos and a lower rate of GW isn't defined.

Note that for case I, while the *WTP* and *WTA* for Path i to j exist, they only have policy relevance if the policy doesn't affect the levels of the incomparable components—many real-world policies will affect the levels of the incomparable components.

Summarizing, for the *WTP* for an environmental commodity to be a meaningful construct, the environmental commodity has to be comparable to other commodities, including the one in which *WTP* will be denoted (dollars, cake), and the paths with and without the environmental commodity must be identical in terms of the levels of the incomparable components. In practice they will likely not be identical if the individual has some control over the levels of the incomparable components. Consider a simple example: GW is comparable to most market goods, but chocolate-cake consumption is comparable to nothing. In this case, *WTP* to reduce GW is a meaningful construct but only if the individual chooses, or is constrained, to consume the same amount of cake on both paths. Since the threat of GW makes me anxious, and since when I'm anxious, I eat more sweets, I, personally, would spend less on cake if I expected less GW.

As environmental economists, we can reject all the arguments against complete comparability and complete WB-commensurability, but we still should be aware of them and be able to articulate why we reject them. In addition, we should also be aware of the neurological in support of WB-commensurability.

The environmental literature on whether different kinds of WB are WB-commensurable with the kinds generated by market goods, or even with each other

For three reasons there isn't much. (I) Neoclassical environmental economists never question whether environmental kinds of WB and their bearers are comparable with other kinds and their bearers because they "just are". (II) While many others interested in the environment know they just aren't". Researchers, like me, whose training and models are steeped in the neoclassical assumption that we all have a complete ordering of paths, leave it at that. [E.g., every environmental valuation I have done assumes every individual has a complete ordering of paths.] Speaking loosely, label economists in my group *neoclassical*, those in the second group *ecological* (Martinez-Alier, Munda, and O'Neill 1998). Neither group is motivated to investigate a question that is, for them, already answered. And (III), WB-incommensurability is threatening to non-market valuation, and, more generally, neoclassical choice theory.

There are a few papers in non-market valuation on path-incommensurability (lexicographic orderings); but no literature on WB-incommensurability.

A common occurrence in *CVM* (contingent valuation-method) environmental surveys is some respondents respond to the WTP or WTA question with a response that suggests that they would pay any amount of money to bring about an environmental improvement and would accept no amount of money to accept a deterioration. This suggests they lexicographically prefer the environmental commodity over market goods. This had led to a narrow literature on non-market valuation and lexicographic preferences (e.g. [Spash](#) and [Hanley](#) 1995, [Pearce](#) 2000, [Rekola](#) 2003, [Aldred](#) 2002, 06 and 13). But with the exception of Spash and Hanley, the word “lexicographic” is replaced with “incommensurable”—what I have called *path incommensurable* to contrast it with *WB-incommensurable*. I’m unclear as to why a new term was needed for lexicographic. But the word switch suggests: (I) environmental economists working in non-market valuation don’t explicitly think in terms of different kinds of WB. [If, implicitly, there is only one kind of WB, WB-commensurability is a non-issue.] (II), they don’t consider that the WB resulting from experiencing a commodity is different from the commodity. And (III) there is little recognition that a complete comparability requires complete WB-commensurability.

Aldred (2006) summarizes arguments for why lexicographic orderings (path-incomparabilities) don’t exist, concluding, “none of them withstand scrutiny.” He critiques and rejects: the individual answers the WTP question with a finite monetary amount, so must be comparing; real-world observed choices imply finite WTP; choice requires one makes tradeoffs; and paths might not be comparable in terms of money but they still might be comparable in terms of some other numeraire. His is a good review. In contrast, I will lay out arguments for incomparability and WB-incommensurability. Note the difference between the arguments for why a CV must be a finite number, and arguments for why paths might not be comparable nor WB commensurable

WB-commensurability requires that all the kinds of WB generated by a bearer can be separated from the bearer

The pleasure from eating chocolate must be separable from the eating, and the pride you have in your children must be separable from what they did to make you proud. If not, different kinds of WB couldn’t be aggregated independent of their bearers. This necessary condition is referred to

as *WB/bearer separability*—think of it as a type of consequentialism (only the consequences of the action matter, not the bearer of those consequences).

Note that complete *WB/bearer separability* is not sufficient for *WB-commensurability*—an example demonstrates: the separation of happiness from the bearers of happiness and the separation of life-satisfaction from its bearers doesn't imply happiness and life-satisfaction are *WB-commensurable*.

The rejection of *WB/bearer separability* goes back to Aristotle. Nussbaum (2012):

Throughout his [Aristotle's] work, he insists on the tremendous importance of qualitative distinctions among the diverse constituent parts of human life;... pleasure is something that comes along with, supervenes on, activity, 'like the bloom on the cheek of a young person.' it is so closely linked to the relevant activities that it cannot be pursued on its own, any more than bloom can be adequately cultivated by cosmetics... what Aristotle has in mind is that pleasure is a kind of awareness of one's own activity,...

She argues that J.S. Mill rejected *WB/bearer separability* and so do contemporary philosophers (2012, p 338).

Consider your ability to separate a sensation such as pain from the activity or circumstance that produced it. The same chest pain could be because you just ran your best marathon, you're getting divorced, or you're having a heart attack. Whether it increases or decreases different kinds of *WB* depends on whether you chose it, whether you think it will be gone in the morning, what you imagine is causing it, and whether experiencing it helped you achieve an important goal. Humans think about the causes of their sensations: this suggests difficulty in separating the feeling from its cause.

Consider the environment: first distinguish between environmental kinds of *WB* and bearers of those specific kinds. More wilderness, less *GW*, and saving a species from extinction are examples of bearers. The first question is are there, in fact, kinds of *WB* that only the natural environment can provide? I'm not going to fully-answer, but many people believe there are. Examples include the special freedom that can only be experienced in wilderness, experiencing environmental self-reliance, experiencing animals and plants in their natural state, experiencing the unity of the natural world, including our place in it, and experiencing the wonder and awe evoked by sights such as lightening at night illuminating ragged mountain peaks.

The issue is whether everyone can separate these kinds of *WB* from their bearers. Sunstein (1994) says they can't. The *awe* (an emotion) produced by viewing a mountain is different from the awe produced by viewing a skyscraper, which is different from the awe

produced by a remarkable musical or athletic performance, and since these awes can't, in his view, be separated from their bearers, they are WB-incommensurable. And, in addition, they are, according to him, incommensurable with the kinds of WB produced by the consumption of conventional goods and services.

Many environmental bearers generate kinds of WB that are public goods in that everyone experiences the existence of the bearer (e.g., if GW is reduced for you it's reduced for everyone, same for saving a species from extinction). An issue is whether it's more (or less) difficult for you to separate the WB generated by a public-good bearer than from a bearer that only you consume. I don't have an answer. Related is whether one has the right to compare public and private bearers—discussed below.

I have sympathy for WB/bearer inseparability, but suspect it depends a on the specific bearer and the specific kind of WB, and the extent to which that it has a significant cognitive component.

Other arguments against complete WB-commensurability include:

You can't compare certain kinds of WB because it would be morally unacceptable to even imagine such comparisons.

How much money you would have to be paid to push the button that would extinct elephants, or dump a million tons of PCBs in Lake Michigan, or eliminate equal rights. Many normal people would find it off-putting and wrong to even consider such tradeoffs, making comparing impossible. It's wrong to compare the WB one might obtain from market goods with the kinds of WB produced by the existence of elephants and equal rights.

Harping back to the distinction between WB-incommensurabilities and lexicographic properties, note the distinction between an environment kind of WB being WB-incommensurable with the kinds of WB produced by market goods, and providing a survey answer that suggests your WTA, in money, for the demise of an environmental amenity is huge, maybe even infinite. If I correctly answer I would pay millions, I have made the comparison (they are comparable). But if market goods and this environmental amenity are incomparable, I can't correctly indicate my WTA, unless the survey allows me to answer, "I can't make this comparison." If it doesn't allow me to do this, my best option might be to say, "No, I wouldn't accept millions for its

demise.” In this case, my answer makes it look like I have a lexicographic ordering when in fact I don’t have an ordering.

Inability to compare because of moral or cultural sanctions varies drastically by culture and religion. Research indicates high socioeconomic-status secular Westerners (Europeans and North Americans) are more likely to make certain comparisons than are non-Westerners and Western religious conservatives ([Haidt and Graham \(2007\)](#) and [Graham, Haidt and Nosek \(2009\)](#)). The two latter groups, but not the first group, morally require in-group/loyalty, authority/respect, and purity/sanctity, making it difficult for them to compare violations of these sanctions with money. [Loyalty, respect, and purity are not something one compares with cake.] For many North-American First Peoples, the kinds of WB born by their culture and natural surrounding are likely WB-incommensurable, on moral grounds, with the kinds of WB resulting from market goods and services.¹⁴

Even among secular Westerners, there are many who believe we have a moral obligation to the environment, a preservation ethic. Consider the famous quote by [Aldo Leopold](#) in his 1940’s essay “The Land Ethic”,

A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

Summarizing, humans don’t stand alone but are part of the community of plants, animals, lands, and waters (collectively, the “land”), and, as community members, we must respect its other members. They have the right to exist and prosper, and it’s our responsibility to see that they prosper—we play the role of the parents, and parental responsibility is inconsistent with sacrificing one’s children for money.

Two kinds of WB are WB-incommensurable if comparing them is incompatible with experiencing one or both of them

Experiencing some kinds of WB is inconsistent with an ability to compare them with other kind. Consider the kinds of WB produced by a meaningful relationship ([Joseph Raz 1986](#)). Raz argues you can’t compare a loving relationship with cake because if you or your partner can, it isn’t a loving relationship. Of course, some people do compare companionship and cake, but they are not in love, or so the argument goes. And, God is unlikely to shed his graces on you if you are able to compare the Grace-of-God and cake—at least I wouldn’t if I were God.

¹⁴ And they are often trustees in NRDA cases.

This argument is compelling for religious and personal-relationship kinds of WB. If correct true for you, you can't order all paths that vary in terms of religious, personal, environmental, and chocolate-cake kinds of WB.

Are there environmental kinds of WB such that experiencing them is incompatible with being willing to compare them with the market-goods kinds? Unlike friends, family, and sexual partners, environmental bearers are not human; many aren't even alive. It would seem you can't have a human-type relationship with an environmental amenity. [A mountain might cause me to experience awe but it but does not respond to my aweing it].

Valuation, in dollars is negated if, for you, a willingness to trade the environmental kinds of WB for the market-goods kinds of WB negates your ability to experience those environmental kinds of WB.

What if my relationship with environmental bearers is religious, spiritual, or personal? There is a long, and continuing, history of humans believing some environmental resources are sacred (e.g., specific species and certain geographical features and places). Many secular Westerners poo-poo sacredness, but such beliefs are common elsewhere and in other groups. Even among Westerners, there are many individuals who believe nature has sacred components. A synonyms for "sacred" is "inviolable"—"secure from assault or trespass"—Merriam-Webster. Sacred is a belief, and if one believes an environmental component is sacred, its existence evokes reverential awe, a kind of WB. The argument is that an individual who is capable of comparing the reverential awe of sacredness with the WB from cake is, in fact, not capable of experiencing that awe: if you are willing to compare it with market goods, it can't be sacred to you. Of course, for some people nothing is sacred.

What if you love nature? Consider two kinds: (1) I love the bears in the woods and believe they love me. My loving them and them me is inconsistent with either of us comparing the other to a jar of honey. (2) I love them but know they don't love me. My willingness to sell bear-skin rugs would mean I actually don't love them; I'm incapable of experiencing bear-love WB: for me, it and money WB are incommensurable.

For some people, animal suffering reduces their WB because our relationship with animals is fundamentally different from our relationship with goods and services. If I'm willing to trade animal suffering for money, I don't have the ability to experience this kind of WB loss. The same argument can be made for human suffering.

If you have no control over how much of some bearers you experience, so you don't compare them with other bearers

Put simply, you don't sweat what you can't influence. [Anderson](#) (1997) articulates this argument more generally by saying there is often no reason to think about how you would compare one bearer for another, and besides it being a waste of your time, it would, for many, be something to avoid. Economists, in contrast, assume you have a complete ordering over all conceivable paths so reject the idea that the ordering of two paths only happens when there is a choice between them. Economists, like me, who value in dollars environmental resources assume you have a well-defined, and finite, WTP for less GW even if you can't affect its rate—and have a WTP even before some environmental economist asks you what it is. Economists of my ilk would say a CVM survey is simply a way for the researcher to find out your *WTP* to reduce GW (less GW is a bearer). In contrast, Anderson would say you don't show up at the survey center with a *WTP* for panda-preservation because, for one, it never crossed your mind that you would ever be comparing panda-preservation with beer and cake. And, you won't compare them during the survey unless you are convinced by the survey that panda preservation is something you can influence. Those of us in the actual business of creating and using CVM surveys worry, some, about the “hypothetical” in hypothetical choices.

Most of us can't influence the environment, so don't compare environmental bearers with those we can influence (Bill G. and Jeff B. are exceptions).

Inadequate processing skills

Imagine I have full information about two paths in that I know the specifics of each, including probabilities, so my ignorance isn't an issue. But the paths have more moving parts than a human can cognitively compare, making it impossible to order them in terms of WB. I think this is a possible cause of WB-incommensurability, but don't want to make too much of it because this inability causes broader issues for choice theory.

You might counter that this is an example of inability to compare because of ignorance and not WB-incommensurability. It's ignorance in that I'm ignorant of the WB effects of each path, but I'm not ignorant of the properties of each path, so it isn't lack-of-knowledge ignorance.

Saying *A* and *B* are WB-commensurable (or not) doesn't make it so

A flawed argument for the existence of WB-incommensurables is people often assert that they can't compare some kinds of WB (Judge [Richard Posner](#) 1998). The is we often have an incentive to say we can't compare even if we could have. We might not want to convey that we

are of the sort who can compare the WB from saving polar bears with the WB from beer, even if we are. Admitting to your spouse that the pleasure of their love is WB-commensurable with the pleasure from extra-marital sex would reduce their love for you, so you lie.

If you think you can compare apples and oranges in terms of WB simply because you ate the orange rather than the apple, you are wrong. Eating the orange doesn't imply you "chose" the orange: you had to eat something (Morey 1997).¹⁵

Path incomparability is sometimes mandated by law

The U.S. *Endangered Species Act* says species aren't comparable. The Delaney Clause forbids carcinogenic substances, meaning cancer is not comparable with market goods (Sunstein 1994, p.835). And, the U.S. Federal Courts have ruled that even if dollar damages from the degrading of an environmental resource is less than the cost of restoring the resource, the destroyer is responsible for the higher restoration costs, meaning environmental damages are not comparable with market goods.

Your WB from learning about an environmental process is incommensurable with the WB associated with a change in that process

This argument resonates with me. Consider the acquisition of knowledge and information, particularly knowledge about the environment and the natural world. If you are living without full information, one way to affect your WB is to allocate time and money to education. For example, consider learning about GW (the process and its effects). I chose GW for this example because it's a global public process and it can/will cause a lot of ill-being, and because many are GW ignorant and seem to want to stay ignorant.

Education leads to knowledge, and knowledge can be a kind of WB (of course more knowledge might decrease my WB).¹⁶ Reading, studying, and listening are bearers. At issue is whether knowledge WB is commensurable with other kinds of WB. Knowledge, once acquired, can't be traded away. You can sell your house and car, but you can't unlearn things, even if what you learned decreased your WB. Another aspect of knowledge is that before you acquire it, you

¹⁵ The flip side of Posner's point is the common and illogical reasoning for complete comparability: People make choices and given that most people are WB pluralists they must be making tradeoffs between all the kinds of WB associated with each alternative. This is circular. Distinguish between behavior, a choice, and the correct choice. Economists make two assumptions: most behaviors are chosen (you drank Coke rather than Pepsi because you chose to), and it was the best choice given your options. If you start by assuming people make choices and those choice are based on overall WB, then WB commensurability is assumed. See Morey (2020).

¹⁶ One subset of emotions are *epistemic emotions*: emotions with a knowledge component (Scarantino and de Sousa 2018). Examples include curiosity, validation, the knowing, and the bliss of ignorance.

are ignorant so can't have a good prior as whether its acquisition will increase or decrease your WB. These two aspects of knowledge suggest it might be difficult to compare education with other bearers of WB.

Consider my education level with respect to GW. For simplicity, assume paths vary only in terms of your education about GW and the expected rate-of-GW. Can I compare these two bearers? There are inherent difficulties. I know, my GW ignorance constant, that less GW would increase my WB, but because I'm uneducated on the topic, I don't know how much it will increase. Imagine that my uneducated prior is while GW is a bad, it isn't much of a bad. Given all this, how would I determine whether I would have more WB in a world where I'm more educated about the effects of GW and there is a different expected rate-of-GW? I don't know that I could make all such comparisons.

Now flip the example, and imagine I'm already educated about GW (so know how it works and its effects). Then I'm asked to decide whether I would experience more WB if I were more ignorant and there was some different expected rate-of-GW. How do I assess not knowing what I already know?

In summary, many people are ignorant about physics, chemistry, and biology, in particular in terms of the environmental sciences, ecosystem dynamics, and the health effects of chemicals in the environment. And the kinds of WB we experience when our environment changes (species go extinct, GW changes, there is less (or more) PCB contamination) are a function of our personal level of knowledge—ignorance is often bliss. But once knowledge is acquired it isn't freely disposable, suggesting that comparing environmental kinds of WB with knowledge about the environment is difficult, causing me to imagine I'm incapable of ordering some paths in terms of their environmental effects and my knowledge about those effects.

[A few additional qualms about the WB-commensurability of environmental kinds of WB:](#) The fact that many environmental amenities are public goods makes some people incapable of comparing the personal WB they would get from different amounts of private goods with the WB losses everyone would get from dirtier air or more GW—they feel they don't have the right to make such comparisons, so they don't.

Imagine comparing the WB relief from less GW with the relief from treating your anxiety disorder. Comparison is complicated because being less anxious, in general, will affect how much relief you get from less GW.

Personal responsibilities and personal commitments can also complicate WB-commensurability. [Contrast personal responsibilities and commitments with religious and cultural mores.] Consider the responsibilities and commitments of a rancher whose ranch has been in the family for generations. Typically, such ranches provide wild-life habitat which is a bearer of environmental kinds of WB for both the ranchers and many others. In addition, many ranchers are committed to, and feel responsible for, both maintaining the ranch in its current state and keeping it in the family (both of these responsibilities motivating conservation easements). It wouldn't be surprising that some of these ranchers would have difficulty comparing the WB associated with maintaining the ranch habitat with the WB obtained by retiring to a condo in Florida.

One final qualm about a world of complete WB-commensurability and complete comparability: most the richness and variety of life would be beside the point. No one would care, at the end of the day, what caused their WB. Many people would hope they don't live in such a world, but this doesn't prove they don't.

Neurological evidence in support of comparability and WB-commensurability

In opposition to the above philosophical arguments that some kinds of WB aren't commensurable is recent findings on the neurobiology of choice. These findings that are consistent with WB-commensurability (don't contradict it) Quoting [Levy](#) and [Glimcher](#) (2012)

Indeed, there is now broad consensus in the neuroscience of the decision-making community that reward magnitude is represented in a small number of well-identified areas. Here we conduct a meta-analysis using evidence from human functional magnetic resonance imaging (fMRI) studies conducted over just the past few years that suggest that one of these reward magnitude encoding areas, the ventromedial prefrontal cortex/orbital frontal cortex (vmPFC/OFC), can be thought of as representing the value of nearly all reward-types on a common scale that predicts behaviorally observed comparison and choice.

The striatum and the ventromedial prefrontal cortex together are your *valuation circuit* (Glimcher 2014). Picture a two-dimensional topographical map of neurons, where each alternative in the current choice set is a different point on the map.¹⁷ The third dimension is the firing rate of the neurons. The alternative that achieves the highest peak will be selected. The

¹⁷ "... most classes of information recorded in the cerebral cortex are topographically encoded on anatomically two-dimensional 'maps.'" "The cortex is made of dozens of these small topographical maps" (Glimcher (2014)). It's a map of only the alternatives on the table.

firing rates fluctuate. If a neuron firing rate increases, it increases the firing rates of nearby neurons while inhibiting the firing rates of distant neurons, including those associated with the other peaks. Eventually, one peak dominates.

Getting ahead of the studies I discuss next, it seems that (1) the final selection of an alternative (at least for the sorts of sets of alternatives studied in neuroscience labs) always takes place in the valuation circuit, (2) the variation in firing rates across the neurons in this area determines/predicts which alternative will be selected, and every alternative is compared on only one dimension (firing rate), consistent with complete comparability.

In the studies Levy and Glimcher review, male subjects were asked to choose between different alternatives or simply viewed different alternatives, all while an fMRI machine measured firing rates. Subjects were presented with different amounts of the same reward, different reward types, and both different types and magnitudes. Alternatives included money (magnitude, and when it would be delivered), college trinkets, pain, pictures of females that varied in attractiveness, and, snack foods. It should be noted that in all of the studies that involved choosing—not all did—money was one alternatives.

No matter what options were presented, the valuation circuit was always activated suggesting the valuation circuit always determines which alternative is selected. But! This doesn't imply the firing rates measure WB; and it doesn't imply the individual selects the alternative associated with the most WB. E.g., maybe this part of the brain determines that you go with the alternative you most desire, at that moment, or the alternative that makes you least anxious.¹⁸

Further support for the conjecture that this brain area converts all the alternatives onto the same scale is there is a correlation between how a subject says they would trade one alternative for the other and the activation of different parts of this region (see, in particular, Smith *et al.* (2010) and Levy and Glimcher (2011)).

Summarizing, these findings are consistent with WB and bearer-of-WB comparability but don't prove it.

Those who reject complete WB-commensurability wouldn't be surprised by these finding or disagree with them. Rather, they would note that comparability between money and snacks doesn't imply complete comparability.

¹⁸ For a discussion of desires/wants vs. likes, see Morey (2020).

Levy and Glimcher were looking for a spot in the brain where WB-commensurability occurs, and they found a candidate. However, and repeating, just because you did x rather than y doesn't imply you chose to do x rather than y , and if you did choose to do x rather than y , it doesn't imply there is more WB associated with x .

Summing up

A foundation of neoclassical choice theory is complete comparability of paths in terms of overall WB, which requires complete WB-commensurability. I have reviewed the issues and arguments and present the relevant theory and research.

While choice theory was originally only about estimating the demand functions for market goods, environmental economists have widened the scope of a bundle to include ecological, and nature-based resources. Resisting this widening are ecologists and environmental ethicists who question whether and why environmental resources are comparable to goods and services in terms of the kinds of WB they provide.¹⁹

I have shown that if there are environmental kinds of WB that aren't commensurable with the kinds of WB produced by market goods, *WTP*, expressed in money, is a meaningless construct if it's for a change in the environmental amenity.

But, even if environmental kinds of WB are commensurable with the kinds of WB produced by some market goods, *WTP* remains a meaningless construct if there are some market goods that produce kinds of WB that are incommensurable with those produced by other market goods. Even a bit of WB-incommensurability is problematic for *WTP* and *WTA*.

References:

Adler, M. 1998. "Incommensurability and cost-benefit analysis". *University of Pennsylvania Law Review*. 146(5): 1371-1418.

Aldred, J. 2006. "Incommensurability and monetary valuation". *Land Economics*. 82(2): 141-161.

_____. 2013. "Justifying precautionary policies: incommensurability and uncertainty." *Ecological Economics* 96: 132-40.

¹⁹ Recently, there has been an inclination/move by government agencies to require in-kind compensation for environmental injuries, motivated, in part, by concerns about incommutability.

Anderson, E. 1997. "Practical reason and incommensurable goods." In: *Incommensurability, Incomparability, and Practical Reason*. R. Chang (ed.), Cambridge: Harvard University Press.

Carson, R. 1962. *Silent Spring*. Houghton Mifflin Harcourt.

Centemeri, L. 2015. "Reframing problems of incommensurability in environmental conflicts through pragmatic sociology: from value pluralism to the plurality of models of engagement with the environment." *Environmental Values* 24(3): 299-320.

Chang, R. 1997. "Introduction". In *Incommensurability, Incomparability, and Practical Reason*. R. Chang (ed.). Cambridge: Harvard University Press.

Glimcher, P. 2014. "Chapter 20: Value-based decision making". In *Neuroeconomics Second Edition: Decision Making and the Brain*. P. Glimcher and E. Fehr (Eds.). Elsevier.

Graham, J., J. Haidt and B. Nosek. 2009. "Liberals and conservatives rely on different sets of moral foundations". *Personality Process and Individual Differences*. 96(5): 1029-1046.

Haidt, J. and J. Graham. 2007. "When morality opposes justice: conservatives have moral intuitions liberals may not recognize". *Social Justice Research*. 20:98-116.

Hsieh, N. 2007. "Is incomparability a problem for anyone?". *Economics and Philosophy*. 23: 65-80.

_____. Spring 2016 Edition. "Incommensurable values". *The Stanford Encyclopedia of Philosophy*. Edward N. Zalta (ed.). <http://plato.stanford.edu>

Kahneman, D. and A. Deaton. 2010. "High income improves evaluation of life but not emotional well-being". *Proceeding of the National Academy of Sciences*. 107(38): 16489-93.

Leopold, A. 1949/1987. *A sand county almanac: and sketches here and there*. New York: Oxford University Press.

Levy, D. and P. Glimcher. 2011. "Comparing apples and oranges: using reward-specific and reward-general subjective value representation in the brain". *Journal of Neuroscience*. 31:14693-14707.

_____. 2012. "The root of all value: a neural common currency for choice". *Current Opinion in Neurobiology*. 22:1027-38.

Martinez-Alier, J., G. Munda, and J. O'Neill. 1998. "Weak comparability of values as a foundation for ecological economics". *Ecological Economics*. 26: 277-286.

Morey, E. 1997. "What is a choice? Choice or the illusion of choice? Should we care? Draft at http://edwardmorey.org/papers/Choice_08072017_Morey.pdf

Morey, E. 2020. *An economist's quirky look at behavior, choice, happiness, and welfare: stuff economists rarely think about*. Draft at http://www.edwardmorey.org/Morey_ChoiceHappinessEthics.pdf

Nussbaum, M. 2012. "Who is the happy warrior? Philosophy, happiness research, and public policy". *International Review of Economics*. 59:335–361.

Pearce, D. 2000. "Cost-Benefit Analysis and Environmental Policy". In *Environmental Policy*, ed. D. Helm. Oxford: Oxford University Press.

Posner, R. 1998. "The strategic basis of principled behavior: a critique of the incommensurability thesis". *University of Pennsylvania Law Review*. 146: 1185-1214.

Raz, J. 1986. *The Morality of Freedom*. Oxford: Clarendon Press.

Regan, D. 1997. "Value, Comparability, and Choice," in *Incommensurability, Incomparability, and Practical Reason*. R. Chang (ed.), Cambridge: Harvard University Press.

Rekola, M. 2003. "Lexicographic preferences in contingent valuation: a theoretical framework with illustrations". *Land Economics*. 79(2): 277-91.

Andrea Scarantino, A and R, de Sousa (Winter 2018) "Emotion". *Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/entries/emotion/>

Schroeder, M. Summer 2012. "Value theory". *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.).

Smith, D.V., B.Y. Hayden T.K. Truong, A.W. Song, M.L. Platt, and S.A. Huettel. 2010. "Distinct value signals in anterior and posterior ventromedial prefrontal cortex". *Journal of Neuroscience*. 30: 2490-2495.

Spash, C.L. and N. Hanley 1995. "Preferences, information and biodiversity preservation". *Ecological Economics*. 12: 191-208,

Sunstein, C. 1994. "Incommensurability and valuation in law". *Michigan Law Review*. 92(4): 779-861.

Wiggins, D. 1997. "Incommensurability: four proposals". In: *Incommensurability, Incomparability, and Practical Reason*. R. Chang (ed.). Cambridge: Harvard University Press