

A compensating variation for a change in the level of an environmental amenity does not exist if the kinds of well-being produced by it are not comparable with the kinds of WB produced by one or more other goods or activities

Edward Morey, University of Colorado, Boulder CO. U.S. Edward.Morey@colorado.edu.
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Abstract: The neoclassical choice-theory that supports the monetary valuation of environmental resources assumes you have a complete ordering of bundles in terms of well-being, *WB*. But there are different kinds of WB (and ill-being): pleasurable and unpleasant sensations, and positive and negative thoughts and emotions. So, the existence of a complete ordering based on a monotonic index of the different kinds of WB (e.g. “utility”) requires that all the different kinds of WB (and ill-being) are WB-commensurable (you can, e.g., compare the pleasures of chocolate with global-warming angst). But many/most people, including ecological economists, don’t believe the kinds of WB produced by environmental amenities are all WB-commensurable with those produced by other goods and amenities. I show that, if they are correct, a compensating variation, CV, for an environmental policy often does not exist: it is a meaningless construct. Then, arguments and findings for and against complete WB-commensurability are presented in the context of the environment.

Keywords: compensating variation (CV), valuation, well-being (WB) and bearers-of-WB, WB-incomparable and WB-incommensurable, WB/bearer separability, neuroeconomics, and the ventromedial prefrontal cortex

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?

From a standard graduate text in microeconomic theory ([Mas-Colell](#), [Whinston](#) and [Green](#) 2006):¹ where X is the set of all conceivable bundles:

In much of microeconomic theory, individual preferences are assumed to be rational. The hypothesis of rationality is embodied in two basic assumptions about the preference relation: completeness and transitivity... Completeness: for all x and $y \in X$, we have that $x \succsim y$ or $y \succsim x$ or (both).

From the environmental philosopher [Alan Holland](#) (Holland 2002), a founder of the journal *Environmental Values*:

[WB-incommensurability refers to] an intelligible choice between feasible options, where there is no appropriate value in terms of which options might be compared as 'better', 'worse' or approximately equal... Happiness is not a homogenous item but a mosaic of heterogeneous elements. There just is no common substance—no utility—by which to compare,

Motivating my investigation is neoclassical economists who estimate monetary values for environmental changes (environmental injuries, less global warming, etc.) take as given that all commodities and activities are WB-comparable. In contrast, ecological economists take as given that the kinds of WB produced by environmental resources are WB-incommensurable with the types of WB produced by market goods, making market goods and environmental resources WB-incomparable.²

My first question is theoretical: under what conditions does a compensating variation, CV, for a change in the level of an environmental commodity have meaning. I first present my findings in terms of a few simple three-dimensional figures.

Neoclassical economics assumes the individual has a complete ordering over all conceivable bundles, and the ordering criteria is the individual's WB. In which case, the complete ordering of all bundles can be represented with a mathematical function, a direct-utility function, that assigns a number to each bundle such that higher-ranked bundles are assigned larger numbers. We call the dependent variable of this function, "utility". As we all know, this function is not unique: if a function $g()$ correctly representing the individual's ordering, then every increasing monotonic transformation of $g()$ does as well. And, if $g()$ correctly represents

¹ Underline text is a link.

² References supporting this characterization of the ecological-economics literature will be provided after WB-comparability and commensurability have been formally defined. *WB-comparability* and *WB-commensurability* are different properties, making it important to not confuse the two.

the ordering, the ordering is also represented by a dual indirect utility function (utility as a function of income, the prices of market goods and activities, and the levels of commodities whose levels are exogenous to the individual)

Assume as is commonly believed, and in contrast to Bentham, that there are different kinds of WB—different ways one can be better off. A complete ordering over all conceivable bundles implies that utility is a meaningful construct and a well-defined monotonic index of all the different kinds of WB.

First, my findings in terms of a three-dimensional figure: Assume a world of three commodities: consumption of the market good chocolate, c , consumption of another market good, o for “other”, and the experienced rate of global warming—a lower rate preferred.

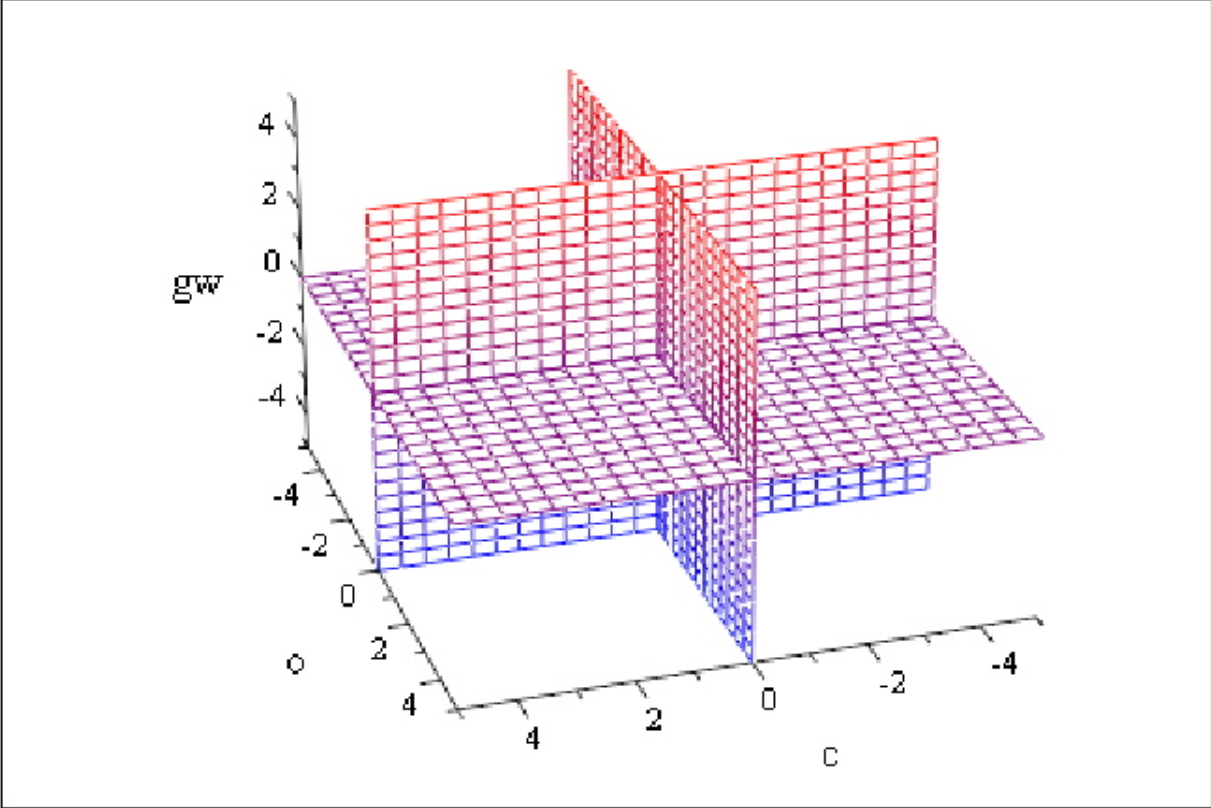


Figure 1: Bundles relative to a randomly-chosen origin bundle

Consider Figure 1: chocolate consumption, c , increases as one moves left, the consumption of the other market goods increases as one moves forward, and the rate of gw decreases as one moves up. The origin is at the intersection of the three planes and represents any randomly-chosen bundle. The axes are in terms of deviations from the origin bundle. Bundles with more of at least some of the three goods but none with less are in the upper-left front quadrant, Quadrant A. Bundles with less of at least some of the three goods, but not more of any, are in the lower-back right quadrant, Quadrant G—(label the quadrants alphabetically going counter-clockwise, starting with A top left). A bundle in Quadrant A is ranked higher than the initial bundle, and a bundle in Quadrant G is ranked lower. [The ordering of bundles is independent of which of the goods are market goods and which are non-market goods.]

Now consider the CV for a shift from the origin bundle to some other bundle. To do this, assume the individual has a fixed money income, that c and o are endogenous market goods, but gw is exogenous. If one assumes the individual has a complete ranking overall conceivable bundles of the three goods—the neoclassical assumption—the CV for a change from the origin bundle to any other bundle exists. [A CV exists if either (I) there exists a finite amount of money (positive or negative) that when subtracted from income in the proposed bundle causes the individual, after the subtraction, to be indifferent between the two bundles (they have the same rank). Or (II) No matter how much is subtracted or added to income in the proposed bundle, the bundle that was initially ranked remains ranked higher (indifference can't be achieved). [Note that II implies the ordering, while complete, has lexicographic properties.] To here, I have simply repeated standard neoclassical theory.

Now drop the neoclassical assumption and consider the case where an individual's consumption of c and o are WB-comparable, but his experience of gw is not WB-comparable with either. In this case, his CV for a change from the origin bundle to another bundle exists only if the rate of gw is the same in both. A CV for any change that includes a change in the rate of global warming does not exist—there is no answer to the question of how much he would pay (or need to be compensated) to be indifferent between the initial state and the proposed state—neither a finite amount nor an infinite amount. It is a meaningless construct.

Now consider an individual where the consumption of o and the experience of gw are comparable, but the consumption of c is WB-comparable with neither—there is just something about how chocolate affects her. For him, the CV for a change from the initial bundle to another

bundle exists only if she consumes the same amount of chocolate in both bundles (a bundle on Figure 1's vertical plane where chocolate consumption remains at its initial level). That is, a CV exists for any change in the consumption of o and gw only if chocolate consumption remains at its initial level. That is, she has no CV for a change in the rate of global warming if the change in the rate of global warming is associated with a change in her chocolate consumption. [Global warming makes me nervous, and when I am nervous, I eat more chocolate.] One might be tempted to conclude that the CV for a decrease in the rate of global warming calculated assuming chocolate consumption does not change must be a close approximation to the CV if chocolate consumption only changes by a bar or two, but this would be misguided: there is no CV for that case: one can't measure how close something is to something that does not exist.

One can put anything one wants on the three axes, so, to generalize my point, consider a world of three distinct experiences: the individual's direct consumption of market goods, the number of souls he saves by making religious donations (more saved is preferred to less), and the experience of global warming. Consider an individual for which his saving souls is not WB-comparable with either the experienced rate of global warming or his direct consumption of market goods. There is no CV for a change that results in him saving more, or fewer, souls. So, for him, a CV for a change in the rate of GW does not exist unless the number of souls he saves remains the same.

One more scenario—but with four axes and two types of environmental experiences: the experience of global warming and experiencing some probability that elephants will soon be extinct, plus experiencing market goods, and experiencing romantic relations. Assume the types of WB produced by market goods are, for this individual, all commensurable with each other and commensurable with the types of WB produced by romantic relations, but the types of WB reductions associated with gw and the types of WB reductions associated with elephant extinction are not commensurable with each other, or any other types of WB. This individual gets to decide how his after-tax income is allocated between improving his romantic relationships and his personal consumption of market goods. But the probability of elephant extinction and the rate of gw are exogenous and a function of government spending such that the more the government spends to preserve elephants the less it has to fight gw . A CV does not exist for either a reduction in gw or for the preservation of elephants, because neither can be changed without changing the level of the other—they are not WB-comparable.

So, at this point, you should have a sense of what I am claiming but might not be convinced. I have not yet presented arguments for, or against, WB-comparability. Those will come at the end of the paper and everyone can see what resonates with them. But now, the details behind my conjecture. I will start with what is well-being, WB, and why there are different kinds.

Kinds of WB

They are generated by the sensations, perceptions, thoughts, and emotions the individual experiences. Many people, including most philosophers and the Nobel laureates in economics [Daniel Kahneman](#) and [Angus Deaton](#), are *WB pluralists*: most of us believe there is more than one kind of WB, more than one way to be better off. Aristotle was a WB pluralist. The legal scholar [Sunstein](#) (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) is, I believe, a rare example of a modern WB monist.³

Sensations, perceptions, thoughts, and emotions:

Humans are sentient: have six senses. A sensation is the awareness of a stimulus 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.

In contrast, 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. 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.

A perception is one type of thought. Thoughts are a cognitive process: each is a discrete mental state (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* (or content, excited, awed, calm, relaxed, proud, superior, free, or liked). So are, *I'm*

³ See [Mason](#) (2018) for a general discussion of value pluralism. Major contributors to the discussion include [Nagel](#) (1979), [Williams](#) (1981), and [Stocker](#) (1990). WB-pluralism is just one type of value pluralism: there are notions of value unrelated to WB.

satisfied; I'm accomplished. For the religious, the thought that they are experiencing the grace of God is a kind of WB, and sacrilegious acts cause loss of another 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, anger and arousal are experienced, they are evaluations of what’s going on; they motivate 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). 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 a lion or watching a horror flick) and who is experiencing it. WB enhancing emotions include content, pleased, 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 trichotomy

For Kahneman and Deaton (2010), kinds of WB fall into two categories: *emotional WB* and *life-satisfaction WB*, for me, three categories. Their 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 question about emotional WB is, “Did you experience a lot of stress (enjoyment, happiness, anger, sadness, stress, or worry) yesterday? In contrast, “Rate your life on a ladder scale of 0 to 10.” is a life-satisfaction question.

My third category is *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 of sweet-n-salty is near the top. The sensations associated with burning skin and the sensations caused by not being able to breathe are, most often, dis-pleasurable sensations, so is hunger. “All else constant” is important. Gasping for breath could be pleasurable if it occurs at the end of a run ran in your best time.

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

Consider the distinction 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 so are security services.⁴ A bearer is a producer of one or more kinds of WB. A bundle can be viewed as a bearer, where each component of that bundle is also a bearer. 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 bundles with more sweet-‘n-salty higher. An ice-cream cone is, for example, a bearer of multiple kinds of WB, including pleasurable taste, gustatory, 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: *I’m depressed because my diet is ruined.*

Distinguish between comparing kinds of WB (feeling safe vs. sexual pleasure) and comparing bearers (door locks vs. a willing sexual partner)

WB-comparability is a property that two bundles either have or don’t have. If two bearers aren’t WB-comparable, they are *WB-incomparable* (Chang 1997). Bundles *h* and *k* are WB-incomparable if **none** of the following statements are correct: *h* is ranked higher than *k*, *k* is ranked higher than *h*, or *h* and *k* have the same rank. They are WB-comparable if one, and only one, of these statements, is correct.⁵ For example, if Bundle *k* is identical to Bundle *h*, except

⁴ For some, guns are a bearer of feeling safe, for others, they are bearers of fear. Political philosophers have used *freedom*, *equality*, and *pleasure* as examples of kinds 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 adjective *bearers* to keep clear the distinction between kinds of WB and the bearers that produce the different kinds of WB.

⁵ In terms of utility, Bundles *h* and *k* are WB-incomparable if **none** of the following statements are correct: *h* generates more utility than *k*, *k* generates more than *h*, or *h* and *k* generate equal amounts. They are WB-comparable if one, and only one, of these statements is correct.

Bundle k has x more pandas in the wild but y has fewer teachers in your daughter's school, and if you can determine which bundle you rank higher, these two bundles are WB-comparable. [Note that WB-(in)comparability is a pair-wise property:⁶]

WB-comparability is also a property that two components of a bundle have or don't have. Commodities s and c are pair-wise WB-incompatible if increasing the amount of one while decreasing the amount of the other makes this new bundle WB-incomparable with the initial bundle. For example, skiing, s , and eating chocolate, c , are not WB-comparable if increasing s or c while decreasing the other makes this new bundle WB-incomparable with the initial one.

In contrast, *WB-incommensurability*: WB of kinds A and B are WB-incommensurable if you are incapable of comparing them in terms of WB ([Wiggins](#) 1997 and [Hsieh](#) 2016). 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 the WB-packets.⁷ In philosophy, the practice is to use the words "comparable" and "incomparable" when comparing goods, activities, and bundles, and to use the words "commensurable" and "incommensurable" when comparing kinds of WB (Chang 1997).

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

⁶ A few additional things to note about pairs of bundles not being WB-comparable: (I) If Bundles j and k are incomparable, that does not imply either is incomparable with some third bundle. (II) When one or more pairs of bundles are not WB-comparable, the ordering is incomplete, but many bundles are still ordered. For example, return to Figure 1 and the case where gw is not comparable with either market good. All pairs of bundles on the horizontal plane through the origin bundle (gw constant) are ordered relative to each other. In addition, starting with any bundle, bundles that have at least as much of the three goods as that bundle and strictly more of at least one of them are ranked higher than it. And (III), Figure 1 further demonstrates the ranking of two bundles is necessary, but not sufficient, for a CV to exist for switching between them. For example, compare the origin bundle in Figure 1 with a bundle strictly above it (less gw and same amounts of c and o). The second bundle is strictly preferred, but a CV associated with switching to it does not exist.

⁷ 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 packets 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.

Complete WB-commensurability implies the individual can order all packets in terms of utility, with packets differing by kinds and magnitudes of WB. E.g., picture a three-dimensional graph with *satisfaction*, *pleasure*, and *gw angst* on the three axes. Each point in the figure represents a different packet. If an individual can't order every packet, she suffers from WB-incommensurability.⁸

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.

WB-commensurability gives a second, and equivalent, way of defining pair-wise WB-incompatibility for two components. Commodities *s* and *c* are WB-incomparable if the kinds of WB produced by *s* are incommensurable with the kinds produced by *c*.

Incomparability of a bearer can be discontinuous: at some levels, you can WB-compare, and at other levels, you can't. For example, while I'm not sure I could compare all possible income reductions with all possible reductions in the rate-of-global-warming, I know I could compare some of them: for example, ten dollars less income with a 10% less gw is ranked higher than my current bundle. All that is needed for WB-incomparability is that there are some income reductions where I wouldn't be able to order the current bundle vs. a 10% reduction in gw combined with any of those income reductions.

[Note that when economists discuss and estimate a CV it is for a change in bearers, not for changes in kinds of WB. For example, we consider the CV for a 10% reduction in gw, not the CV for a 10% reduction in gw angst.]

A complete ordering of bundles based requires complete WB-commensurability

Neoclassical choice theory assumes the individual has a complete ordering of all feasible bundles. A necessary condition for this is *complete WB-comparability*: if you can't WB-compare two bundles, you can't order them, but a necessary condition for *complete WB-comparability* is

⁸ WB-commensurability of two packets only implies they can be ordered in terms of utility; it doesn't imply utility 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 bundles in terms of utility, so isn't a requirement of neoclassical choice theory.

complete WB-commensurability. So, *incomplete WB-commensurability* → an incomplete ordering of bundles.

For example, many conceivable bundles vary in terms of the bearers: the degree of religious freedom, rate of global warming, and consumption of cake. If the joy of religious freedom, gw angst, and the pleasures of cake aren't WB-commensurable at all conceivable levels, the individual can't order all bundles that vary in terms of these three bearers, so her ordering is incomplete.⁹

A flawed argument for complete WB-comparability: flawed because it is circular

In terms of common economic vernacular, the argument goes as follows: everyone makes choices involving trade-offs over different kinds of WB, so everyone must be able to compare them. What makes this logic circular is saying everyone makes trade-offs over different kinds of WB requires that, for everyone, all bundles are WB-comparable, which requires that, for everyone, there is complete WB-commensurability. Put another way, the argument starts by assuming what it is they want to demonstrate. [*circulus in probando*: quoting Wikipedia, “the reasoner begins with what they are trying to end up with. Circular reasoning is not a formal logical fallacy but a pragmatic defect in an argument where the premise (in this case, everyone makes tradeoffs over different kinds of WB) is just as much in need of proof or evidence...”

⁹ If the ordering of bundles is incomplete, choice theory becomes less specific in its predictions. It predicts the individual will choose a bundle that is not ranked lower than any other feasible bundle (“maximizing”, but not “optimizing”) but there could be multiple bundles with this property (Sen 1979, Hsieh 2007 and 2016). In which case, one can't say exactly which one will be selected. Consider again Figure 1 assuming c and o are WB-comparable, but neither is with gw . Assume the origin bundle is feasible. Consider two cases: (I) The individual has a fixed income and faces exogenous prices for c and o , and the level of gw is exogenous at the level represented by the horizontal plane through the origin bundle. Assume the origin bundle exhausts his budget. In Case I, the feasible set is the horizontal gw plane on and to the right of the c/o budget line through the origin; its slope in the horizontal plane reflecting the relative prices of c and o . It goes from right front to back left (as the consumption of c increases the consumption of o must decrease. Case II: There is a tax on gw , and each tax rate is associated with a specific rate of gw , and this individual gets to choose the tax rate (like a CVM question). In Case II, there is a budget plane with an off-vertical tilt. It includes the Case I budget line and tilts to the left front (right back) as gw decreases (increases). The feasible set is all bundles on or to the right of this plane, so there are feasible bundles in all of the quadrants except A.

In Case I, the neoclassical result holds: this individual selects the highest-ranked bundle on the budget line: income will be exhausted, and the chosen bundle might, or might not, be the origin bundle.

In Case II, much less can be predicted. The individual will select a bundle on the budget plane that is not in Quadrant A or G: bundles in A are not feasible and all bundles in G are ranked lower than the feasible origin bundle. We also know the selected bundle will be not be ranked lower than any other feasible bundle, but all that implies is it will be a one of the feasible bundles in B-F or H.

One way to prove the premise that all bundles are WB comparable would be to prove what? That everyone always is experiencing their highest-ranked feasible bundle in terms of WB? If so, no one has proven that, and many psychologists believe they have demonstrated that is not the case.

At this point, you might find it useful to distinguish between *behaviors* and *chosen behaviors*—we all do things (behave in certain ways) but this does not imply that all of our behaviors are chosen behaviors I hope everyone would agree that if there are N alternatives on the table and the individual must experience one, and only one, of those alternatives, the individual will experience one of those alternatives—they behave in a certain way. So, what is the best word to neutrally describe the alternative experienced? I am inclined to go with the *alternative experienced*; the term *alternative chosen* suggestively implies what one is trying to demonstrate.

One defense of the premise that all bundles are WB-comparable is that people will tell you that they chose the alternative they are experiencing by consciously trading off all the kinds of WB that would have been generated by the different alternatives. And most of us believe we do this much of the time. Of course, this is more convincing than if one said, “I have no clue as to why I do what I do.” But saying something does not make it true. There are hundreds of psychological studies that indicate our reasons for why we do what we do are often made up, post hoc, to justify what we are doing.

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 2020a).

I am not suggesting that some individuals do not, some of the time, tradeoff different kinds of WB; here I am simply suggesting one avoids circular reasoning when defending WB-comparability.

Can one compensate in-kind when it is not meaningful to compensate in terms of money?

Yes.

There is neoclassical-economics literature that discusses in-kind compensation to make society whole after an environmental injury. Summarizing, making society whole requires that it

be compensated for the losses it incurs between the time of the injury and when the environmental resource is returned to its pre-injury level. Neoclassical economists denote the required compensation in dollars (the “damages”) and specify as damages the estimated CV associated with the injury. If it is cost-effective, local laws and regulations typically require that the recovered damage dollars first be used to restore the resource to its pre-injury level (a political preference for the restoration of the injured resource). For example, if an oil spill destroys 1000 hectares of duck habitat, a neoclassical economist would estimate the CV associated with the habitat loss, a dollar amount, which the government would then try to collect from the party responsible for the spill. Assume the CV is \$1M given that it will be five years between injury and restoration, that \$1M is collected, and it takes \$750K to restore the habitat. The remaining \$250K reflects the interim loss to society during the five years between injury and full restoration. Law and custom sometimes require the remaining \$250K be used to create duck habitat, but often it ends in general revenue.

Some neoclassical economists (starting with [Unsworth](#) and [Bishop](#) 1994 and [Mazzotta](#), [Opaluch](#) and [Grigalunas](#) 1994) have suggested a procedure that eliminates the need to estimate the CV—in-kind compensation: have the responsible party restore, or pay to restore, the injured resource and have them create, or pay to create, additional, and equivalent resources to cover the interim losses. In terms of ducks, restore or create 100 hectares of habitat and then enough additional hectares to compensate for the interim losses. Determining the correct physical amounts is often referred to as *resource equivalency analysis* or *habitat equivalency analysis*.

One argument for equivalency analysis and in-kind compensation for interim losses is there is already a political, and cultural, preference for restoration in-kind, so why not compensate for interim losses also in kind. Other arguments for in-kind equivalency analysis include it is easier to explain (no one has to explain the CV to a layperson), and sometimes it is easier to do than estimating the CV.¹⁰

However, in my opinion, a primary reason to consider compensation in-kind is when it is the only type of compensation that has meaning: when the CV (the money measure) has no

¹⁰ There are papers on why equivalency analysis might, or might not, lead to over or under compensating for interim losses, but those arguments are not the topic of this paper. See, for example, [Flores](#) and [Thacher](#) (2002) and [Zafonte](#) and [Hampton](#) (2007)

meaning—that is, when the types of WB produced by the environmental resource are incommensurable with the types of WB produced by market goods.

But the economic literature on in-kind compensation does not consider this case: it assumes complete WB-comparability of bundles, guaranteeing that the CV has meaning.¹¹ If the types of WB produced by the environmental resources are not commensurable with the types produced by market goods, compensation in-kind is meaningful, compensation in money is not, making in-kind compensation the only option. It is meaningful to talk about compensation in-kind, either in terms of the same environmental resource (duck habitat for duck habitat) or another resource that produces the same types of WB (maybe trout habitat for duck habitat).¹²

Since ecologists and ecological economists take WB-incommensurability as a given, they are attracted to compensation in-kind. Paraphrasing [Martinez-Alier](#), Munda, and [O’Neill](#) (1998), WB-incomparabilities and WB-incommensurabilities are the “foundation of ecological economics”.¹³¹⁴

¹¹ In addition to Flores and Thacher, examples span [Unsworth](#) and [Bishop](#), and [Mazzotta](#), [Opaluch](#) and [Grigalunas](#), both in 1994, to [Desvousges](#) et al. (2018).

¹² In the neoclassical literature on in-kind compensation, one worries whether restoration costs might greatly exceed the CV associated with the injury. When the CV has no meaning, this is not an issue: there is nothing to compare the costs with.

¹³ This article has been cited almost a thousand times, mostly by ecologists and ecological economists—environmental economists don’t cite it. The article starts from the premise that environmental goods are WB-incomparable with market goods—they provide few arguments for their premise. The literature citing this article typically simply cite it as proof of the premise. Unlike the philosophical literature on incommensurability, this literature does not adopt the distinction between kinds of WB and bearers of WB, which is unfortunate. Martinez-Alier is a past president of the [International Society of Ecological Economics](#). I find “foundation of ecological economics” telling: the title is asserting that all that separates ecological economist from neoclassical environmental economists is ecological economists believe the kinds of WB produced by environmental resources are incommensurable with the kinds produced by market goods. Kapp (1983) might be the first modern economist to state this position. He said, referring to the kinds of WB produced by environmental resources, “they are heterogenous and cannot be compared quantitatively among themselves and with each other, not even in principle.” Three publications that cite Martinez-Alier, Munda and O’Neill and assume incomplete WB-comparability are Spash (2008), O’Neill, Holland and [Light](#) (2008) and Munda (2016). Many of the citing articles are in *Ecological Economics* or *Environmental Valuation*.

¹⁴ Because of incommensurabilities, ecological economists are also attracted to choosing environmental projects based on multiple criteria: “Incommensurability means that there is not a common unit of measurement, but it does not mean that we cannot compare alternative decisions on a rational basis, on *different* scales of values, as in multi-criteria evaluation.” (Martinez-Alier (1995). Another example is [Martin-Lopez](#), [Gomez-Baggethun](#), [Garcia-Llorent](#), and [Montes](#) (2014).

If for an individual WB-comparability is not complete, his ordering of bundles will be incomplete, so, for example, he might rank environmental projects *A* and *B* both higher than the status-quo but *A* and *B* are not ranked relative to each other, so additional criteria are needed for him to decide between them. That is, multiple-criteria are often needed to decide between environmental projects when the kinds of WB produced by each is incommensurable with the kinds produced by the other and incommensurable with the kinds produced by market goods. For example, one might select *B* over *A* if *B* helps poor people more. Of course, there is much debate as to what the additional

The environmental literature on why different kinds of WB are, or are not, WB-commensurable 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 of WB 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 bundles, leave it at that. [E.g., every environmental valuation I have done assumes every individual has a complete of all conceivable bundles.] Neither group is motivated to investigate a question that is, for them, already answered. And (III), WB-incommensurability is threatening to non-market valuation.

For money measures of the value of an environmental policy, I sense that the view amongst ecological economists is a CV (or some variation on WTP or WTA) exists that can capture some of the effects of the policy, but not all of them. That is, a money measure exists that includes the effects of the policy that are WB-comparable with market goods but not the ones that are not. I have demonstrated that this view is wrong. A CV for a change in a policy that only captures the effects of the kinds of WB that are commensurable with the kinds produced by market goods only exists if the levels of all the kinds that are incommensurable remain at their initial levels, and this outcome is impossible because their levels, by definition, change. For example, you can't change the rate of global warming without it affecting all of the levels of all the kinds of WB produced by the change, both the commensurable and incommensurable ones. Ecologists who would prefer that money measures never be used to value environmental changes might find this non-existence of a CV result to their liking

Clearing up a possible confusion over the use of the term *incommensurable* in environmental economics

The term *incommensurable* appears in a few older economic papers on environmental valuation (([Pearce](#) 2000, [Rekola](#) 2003, [Aldred](#) 2006 and 13) but in those papers *incommensurable* does not mean *WB-incommensurable*. Rather it means the ordering of bundles has lexicographic

criteria(s) should be. Besides Martinez-Alier (1995) and Martinez-Alier, Munda, and O'Neill (1998), see, for example, Munda (2004), and [Stabell](#) (forthcoming)

properties.¹⁵ 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 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. (III) there is little recognition that complete WB-comparability requires complete WB-commensurability. And (IV) they are not familiar with the centuries-old philosophical literature on the WB-incommensurability.

To avoid confusion, keep in mind that this paper is not about lexicographic properties and that lexicographic properties do not make the ordering of bundles incomplete nor do they imply that some bundles are incomparable.

Neoclassical economists who do non-market valuation want to assume that the ordering of bundles is complete and absent all lexicographic properties, and neither implies the other. Together they imply that the CV exists and is finite in value.

Aristotle and many others

Aristotle, a WB pluralist, believed that many kinds of WB are WB-incommensurable; many modern philosophers agree ([Nussbaum 2012](#))— Unlike neoclassical economists, most people and philosophers don't believe in complete WB-comparability nor complete WB-commensurability. While many 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

¹⁵The motivation for these papers, and [Spash and Hanley 1995](#), is that in *CVM* (contingent valuation-method) environmental surveys, some respondents respond to the WTP or WTA question with an answer that suggests 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, so do not have a finite CV. While there is nothing in neoclassical choice theory that precludes lexicographic properties, many practitioners of non-market valuation find them implausible. Aldred (2006) summarizes arguments for why he believes lexicographic orderings don't exist, concluding, "none of them withstand scrutiny."

If lexicographic properties can't exist, the valuation literature needs to explain why some people act like they have them—maybe they indicates that some respondents to valuation surveys find the types of WB produced by the environmental amenity to be incommensurable with the types produced by market goods. If true for me, for me WTA for the demise of an environmental amenity does not exist, and I can't answer whether I would accept \$X for its demise. I can only correctly respond, "I can't make this comparison." If the survey doesn't allow this option, and I feel compelled to respond, 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'm signaling an incommensurability.

sensations, perceptions, thoughts, and emotions produced by drinking a Coke might be WB-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 remains President, or there's a pandemic? Of course, the beliefs of Aristotle, most modern philosophers, and most people do not prove the existence of WB-incomparabilities—but should give pause to those who believe there is complete WB-comparability.

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 independently 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 also 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.

The WB/bearer separability issue is whether everyone can always separate all these kinds of WB from their bearers. Maybe you can, but Sunstein (1994) says most of us can't. For example, and according to him, 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, besides, they are incommensurable with the kinds of WB produced by the consumption of conventional goods and services. Keep in mind that he is asserting WB/bearer inseparability, not proving it.

Are there kinds of WB that only the natural environment can provide?

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 the wilderness, experiencing the kind of self-reliance that can only be experienced in the wild, experiencing the sites, smells, and interactions that only natural ecosystems and their inhabitants can produce, the joys of learning about plants and animals that can only take place in their habitat, and experiencing the awe that only can be produced by the sight of majestic mountains and rivers. [Of course, you might find nothing unique in terms of the types of sensations, perceptions, thoughts, and emotions nature can produce, but that does not mean others don't] Also included are the kinds of WB produced by recreational activities produced in natural environments, activities such as hiking, skiing, biking, swimming, diving, fishing, hunting, and camping. Also, for indigenous populations, natural environments generate the kinds of WB associated with culture and religion, including the experience of sacredness.¹⁶ Also, there is the argument that the existence of natural environments and an understanding of

¹⁶ 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 synonym 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 significant relationships they produce (e.g., human to human, human to animal, animal to human, animal to animal, animal to plants, and plants to animal) contributes, in a unique way, to a “worthwhile life” (see Holland 2006 and Firth 2008). And many of us aspire to a worthwhile life.¹⁷

I have sympathy for the view that for environmental resources there is not complete WB/bearer separability. I suspect whether there is a WB/bearer inseparability depends on the individual in question, the specific environmental bearer, and the specific kinds of environmental WB it produces. It is harder to imagine separability when the types of WB produced have a large cognitive component, which many do. For example, I imagine it is easier to separate the WB produced by a mountain-bike trail-ride from the specific trail than it is to separate thoughts about one’s way-of-life or its value from the environmental change that engendered those thoughts.

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 is easier or harder to separate the type of WB produced by a bearer from the bearer if the bearer is public. I don’t have an answer.

Other arguments against complete WB-commensurability include:

Ecological systems are prime suspects when it comes to incommensurabilities:

Ecological systems (ES) such as wetlands, forests, coral reefs, estuaries, bays, and rivers integrate biological, hydrological, physical, and human processes providing services to plants, animals, and humans. An ES can be viewed as a bearer of WB or as a vector of bearers of WB, bearers that are inputs into the production of recreation, animal and plant preservation, ways-of-life, water purification, and flood control. And they produce overlapping vectors of different kinds of WB; for example, a reef fishery might maintain, for an indigenous population, the WB associated with the continuation of one’s way-of-life, recreational benefits for the non-indigenous, and knowledge of preservation for distant populations, all while making residents of

¹⁷ Quoting Firth, “A meaningful relationship occurs when the interactions between two entities have significance in their past history and its anticipated continuation.” Examples include our historical relationships, as humans, with nature, animal parent/child relationships, historical relationships between land and human communities, the relationships between humans and the plants and animals they eat, the relationship between a rancher and his herd, the relationship between two wolves in a pack, and the relationship between a wolf pack and its potential prey. This last example is discussed in detail by Aldo Leopold (1949/87). In summary, an understanding and appreciation of nature-based relationships is an important component of a worthwhile life.

the coastline worry less about gw sea rise.¹⁸ One has to question whether these different kinds of WB are commensurable with each other and the kinds of WB produced by other goods and activities. Because of this, there are many articles about ES in the ecological literature, and many of these include a variation on the word “incommensurable”, taking incommensurability as a given. In this regard, the ecological valuation literature is much broader in its scope than is the neoclassical sphere: most of my valuation studies have been limited to a component of an ES such as a catch rate, a fish-consumption advisory, or a ski or mountain-bike trail.

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

How much money would you need to push the button that would extinct elephants or dump a gigaton of PCBs in Lake Michigan or eliminate equal rights? Many people would find it off-putting and wrong to even consider such tradeoffs, so they refuse to compare. Some believe 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, or even the kinds produced by elephants with the kinds produced by equal rights.

An 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.¹⁹ But it is not only cake: for example, for

¹⁸ These types of WB effects vary drastically in terms of their magnitudes: the loss of a sport-fishing opportunity has, for most of us, only a small effect on our WB, whereas the loss of one's culture, community, and way-of-life can be life shattering. [Burke](#) (2010) reports on how the loss of subsistence fishing activities has affected the way-of-life of the Nuxall First Nation of British Columbia. Quoting from [Chan](#), [Satterfield](#) and [Goldstein](#) (2014), “A Kyuquot–Checleset elder (of the northwest coast of Vancouver Island, B.C.), described to one of the authors (pers. comm.) the loss of fishing opportunities as causing a loss of knowledge and cultural identity in the community's youth, which she seemed to attribute to a lack of transformative experiences, all of which were entangled with both self- and other-oriented, group and individual values... a Kyuquot–Checleset fisherman (pers. comm.) suggested the decline of local Chinook ... as triggering loss of inspiration and spiritual benefits...”

¹⁹ And they are often trustees in NRDA cases.

Western religious conservatives, WB-comparability requires that the kinds of WB that are reduced by disloyalty are commensurable with the kinds that are reduced by impure and sacrilegious acts. Complete WB-comparability requires that one be able to WB-compare, for example, desecration of a cross, disrespect for the President, religious freedom, income (in)equality, global warming, animal extinctions, and market goods.

Even among secular Westerners, many 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 this view, 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 (e.g., animal rights), 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. Accepting the right of others to exist and prosper is, arguably, inconsistent with their demise being WB-consistent with market goods.

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 kinds. Quoting [Tetlock](#) (2003), "...incommensurability arises when values are treated as commensurable subverts one of the values in the trade-off calculus." Consider the kinds of WB produced by a meaningful, and symmetric, relationship ([Raz](#) 1986). Raz argues you can't compare a loving relationship with market goods because if you or your partner can, it isn't a loving relationship. [Of course, some people do compare, but they are not in love, or so the argument goes.] It is difficult to argue that experiencing the types of WB associated with personal relationships (feeling love and friendship, feeling trusted, the safety in knowing trusted-others have your back) is consistent with being willing to exchange these feeling for money. Consider one's relationship with God. He is unlikely to shed his graces on you if you can compare experiencing his grace with the taste of chocolate cake—at least I wouldn't if I were God.

In a moment, I will consider whether one can have a personal relationship with an environmental resource. But first, consider this argument for WB-incomparability for sacred environmental resources. It is a compelling argument. Believing an environmental resource is sacred is inconsistent with it being WB-comparable with market goods, given the definition of sacred. Tetlock (2003) defines “sacred values as those values a moral community treats as possessing transcendental significance that precludes comparisons, trade-offs, or indeed any mingling with secular values.” [Note the distinction between your ordering is lexicographic for sacred resources and sacred resources are not WB-commensurable with market good. The former implies your CV for its demise is (in absolute terms) is infinity—so exists—the latter, our topic, implies that a CV does not exist. This distinction is often missed.] Observing an individual experiencing a bundle that violates something sacred rather than one with no violations but more other stuff does not imply the individual can compare the types of ill-being associated with a violation of the sacred with the types of WB associated with the consumption of market goods: the individual had to do something.

If an economist wants all types of environmental WB to be commensurable with the types produced by market goods, she will have to argue that, at the end of the day, nothing is sacred for anyone.

Returning to the argument that the kinds of WB produced by personal relationships are incommensurable with the kinds produced by market goods: Can one have a personal but secular relationship with an environmental resource? And, if so, does this imply an incommensurability? Unlike friends, family, and sexual partners, you can’t have an interactive human-type relationship with an environmental amenity. [A mountain might cause me to experience awe but it but does not respond to my awe].

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

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 can't 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, 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. Neoclassical economists, in contrast, assume you have a complete ordering over all conceivable bundles so reject the idea that the ordering of two bundles is only created when there is a choice between them. Economists, like me, who value in dollars environmental resources assume you have a well-defined, and finite, CV for less gw even if you can't affect its rate—and have it 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 CV to reduce gw (less gw is a bearer). In contrast, Anderson would say you don't show up at the survey center with a CV 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).

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). That 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.

Your WB from learning about an environmental process is incommensurable with the WB associated with changing it

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 the kinds of WB you will experience 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). [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.] 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 are ignorant so can't have a good prior as to how its acquisition will affect you. These two aspects of knowledge suggest that the kinds of WB affected by learning about gw are incommensurable with the types of WB affected by gw.

Consider your education level concerning gw. For simplicity, assume bundles vary only in terms of your education about gw and the expected rate-of-gw. Can you WB-compare these two bearers? How a change in the rate of gw affects your gw angst depends on your knowledge about the gw process, and how a change in your knowledge affects your epistemic emotions depends on the rate of change in the rate of gw. Maybe I'm ignorant about the gw process, and my prior is that it's fake news. Given 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 bundles 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:](#)

1. 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.
2. Imagine comparing the 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.
3. 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. Also, 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 if some ranchers would have difficulty comparing the WB associated with maintaining the ranch habitat with the WB obtained by taking the cash and retiring to a condo in Florida.
4. One final qualm about a world of complete WB-commensurability and complete comparability: most of 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 WB-comparability and commensurability?](#)

In opposition to philosophical arguments that some bearers are not comparable, and some kinds of WB aren't commensurable is how some recent findings on the neurobiology of choice have been interpreted. These are consistent with comparability (they don't contradict it) Quoting [Levy](#) and [Glimcher](#) 2012)

Indeed, there is now a 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 comparisons and choices.

They are claiming that the finding they discuss demonstrate that we all have complete WB-comparability. These are important findings, but they are claiming too much.

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 represented by a different neuron point on the map.²⁰ The third dimension is the firing rate of the neurons. [If desired, I can include a colored pictograph.] The alternative whose neuron achieves the highest peak will be selected. Initially, the firing rates for the different alternatives fluctuate. If a neuron's 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, and you go with that alternative.

Getting ahead of the studies they discuss, it seems that (I) 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, (II) 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), all consistent with complete WB-comparability.

In the studies Levy and Glimcher review, male subjects were asked to choose between different alternatives or simply view different alternatives, all while an fMRI machine measured firing rates. Alternatives 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 alternative.

²⁰ "... 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)). The valuation map is of only the alternatives on the table.

No matter what alternatives were presented, the valuation circuit was always activated suggesting the valuation circuit is always part of the process that determines which alternative is selected. And the firing-rate findings are consistent with which alternative says they would prefer (see, in particular, Smith *et al.* (2010) and Levy and Glimcher (2011 and 12)).

But none of this implies the relative firing rates reflect how each alternative would be ranked in terms of a well-defined monotonic index of all the different kinds of WB, or that such a WB-index even exists. It does not imply complete WB-comparability. Note they use the word “value” but simply define it in terms of highest firing-rate: the alternative with the highest firing-rate is defined as the one with the highest value, and the rest of the alternatives have lower values. Defined this way, value is simply a measure of something that is going on in your head. These findings are consistent with all bundles being comparable in terms of something different from WB, even something inconsistent with WB. For example, they are consistent with selecting the alternative you most desire, or the alternative that makes you least anxious, or most proud, or even different criteria on different selection occasions.²¹

Recollect that incorrect circular argument mentioned early. If you assume the individual has a complete ordering of all bundles in terms of some index of WB kinds, and also assume she chooses the highest-ranked feasible bundle on that index, and then observe the individual selecting the bundle with the highest firing-rate, the alternative with the highest firing-rate must identify the alternative highest on the WB-index. But this does not demonstrate complete WB-comparability, because you started with the assumption of complete WB-comparability.

Summarizing, these findings are consistent with WB commensurability and bearer-of-WB comparability but don’t prove either.

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

Levy and Glimcher were looking for a spot in the brain where WB-commensurability occurs, and they found a candidate.

²¹ For a discussion of desires/wants vs. likes, see Morey (2020b).

Summing up

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

While neoclassical choice theory was originally only about estimating the demand functions for market goods, environmental economists have widened the scope to include the demands for and values of ecological, and nature-based resources. Resisting this are ecologists and environmental ethicists who question whether and why the types of WB provided these resources are WB-commensurable with the types of WB produced by consuming market goods. Ecologists even argue that the types of WB produced by some environmental resources are incommensurable with the types produced by other environmental resources.

I have shown that if there are environmental kinds of WB that aren't commensurable with the kinds of WB produced by all the other things we care about, the CV for a change in the level of an environmental commodity exists only under restrictive conditions. For example, a CV for a policy that reduced the rate of gw does not exist if any of the changes in any of the types of WB (or ill-being) associated with the policy are incommensurable with each other or with anything else whose level the individual can influence, or if it is associated with changes in things that he can't influence but cares about. So, one also has to worry about commensurability with the kinds of WB produced by national defense, friends and family, lovers, freedoms, fairness, and a lot of other stuff.

My intent was not to tell you that there is or is not complete WB-comparability. My goal was to express the CV implications of incomplete WB-comparability and to outline some of the arguments one has to defend against if they want to argue for complete WB-comparability. Of course, if you only have to deal with people who are happy to assume complete WB-comparability, the road ahead is smooth. [I wonder why the issue WB-incomparability has not been raised by lawyers and economists representing the defendant in NRDA litigations (e.g. the BP spill in the gulf). I suspect it is because all the economic-valuation experts on both sides are neoclassical economists, so implicitly assume complete WB-comparability.]

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

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