Incorporating Equity Metrics into Regulatory Review

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EO 12866 and Equity

- EO 12866 instructs agencies to be sensitive to equity.

  "[I]n choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including … distributive impacts; and equity) …." §1(a); see also §1(b)(5).

- However, neither the EO, nor Circular A-4, provides much guidance in how agencies should evaluate the equity impacts of regulations

Equity Metrics

- There are a variety of quantitative frameworks for measuring equity, each of which is widely employed in some scholarly literature: (1) Inequality metrics; (2) Poverty metrics; (3) Incidence analysis; (4) Social gradient metrics; (5) Social welfare functions and CBA with distributive weights. See also (6) QALY-based CEA with equity weights

Equity Metrics

- *Inequality Metrics*: Gini coefficient, coefficient of variation, Atkinson index, Theil index. Used to measure the degree of income inequality in a population. Have also been used to measure the inequality of health.
- *Poverty Metrics*: Traditionally used to measure income poverty (as a function of an income threshold, the percent of the population below the threshold, and the distribution of incomes below the threshold). More recently, much work on poverty has focused on non-income "capabilities," e.g., health, housing, nourishment, or environmental quality.
- *Incidence Analysis:* Examines whether the fractional monetary burden of a policy increases ("progressive") or decreases ("regressive") as individual income increases. Traditionally used to study tax policies, but has also been used to study environmental policies.

Equity Metrics

- *Social Gradient Metrics*. Environmental justice measures quantify whether some pollution source has a disproportionately high impact on minority or low-income individuals, as compared to the general population. Similarly, health-equity metrics used in the public health literature look at skews in health across racial or class lines.
- *Social Welfare Functions.* The SWF framework measures individual well-being using a utility function, and then aggregates utilities with an SWF. Non-utilitarian ("equity regarding") SWFs are sensitive to the distribution of well-being. SWFs are the central tool in the field of optimal tax policy, and are also used in environmental economics. Closely related to the notion of "distributively weighted" cost-benefit analysis.
- *QALY-Based CEA with Equity Weights*: Instead of straight CEA, weights are applied to QALY amounts to reflect the health level of individuals affected by health measures.

Equity Metrics

Equity metrics are more fully described, with citations to the literature, in: Adler, *Risk Equity: A New Proposal*, 32 **Harvard Environmental Law Review** 1 (2008); and Adler, **Well-Being and Equity: A Framework for Policy Analysis** (Oxford U. Press, forthcoming 2010). These works specifically argue for SWFs as the most attractive framework for quantifying equity.

Incorporating Equity Metrics into Regulatory Review

- *A Proposal*: The EO should instruct agencies to quantify distributive impacts as part of the regulatory analysis. An OIRA guidance document should provide detailed discussions of existing metrics and, ideally, give guidance in which to use. The regulatory analysis should explain the choice of metric. Where a metric favors some policy option, and an agency ends up choosing a different option, the regulatory analysis should explain the choice.
- *A Precedent:* The UK Treasury guidance document for regulatory analysis recommends the use of distributively weighted CBA

Objections

- *Equity Impacts Can Be Characterized Qualitatively*. Response: There are a huge number of different ways to characterize the distributive impacts of a policy. Equity metrics provide systematic frameworks for doing so.
- *Specifying an Equity Metric is a Value Choice.* Response: The choice of CBA or CEA is also a value choice. OIRA, the EO, and executive agencies are supported by the democratic legitimacy of the President and subject to legislative override.
- *Equity Should Be Handled Through the Tax System*. Response: The supposed optimality of doing so depends on contestable technical assumptions. At a minimum, equity metrics can alert the tax system to the need to correct the inequitable impacts of regulatory policies.

The SWF Approach: A Defense

- The remainder of my slides argue that equity-regarding SWFs are the most attractive tool for quantifying equity, and provide a more detailed description of the approach. See Adler, “Risk Equity” and Adler, **Well-Being and Equity** for a full discussion.

SWFs versus other Metrics

- *Equity-Regarding SWFs:* Are sensitive to the population-wide distribution of well-being, and provide guidance for balancing equity against overall well-being/efficiency
- *Other Metrics*: Often applied to income, health, or some other component of well-being, rather than to utility as an inclusive measure of well-being. Further (except for CEA with equity weights) do not provide guidance in balancing equity versus overall well-being/efficiency
- *Social Gradient metrics:* Focus solely on distribution between high- and low-status social groups, not within groups

SWFs and their Properties

--A utility function *u* maps each outcome onto a vector of utilities, representing each individual's well-being. A social welfare function *w* maps the vector onto a single "social welfare value," which represents the social ordering of the outcomes

-- Attractive SWFs obey two crucial principles

- -- The Pareto principle
- -- The Pigou-Dalton principle (sensitivity to equity)

-- The "Atkinsonian" SWF satisfies these principles plus has additional attractive properties

Equity-Regarding SWFs

--*The Pareto principle*

$w(3,4,10,12) < w(3,4,10,13)$

--*The Pigou-Dalton principle*

$w(3,4,10,12) < w(3,6,8,12)$

The Atkinsonian family of SWFs:

$w(u_1, u_2, \ldots, u_N) = 1/(1-\gamma)\sum u_i^{1-\gamma}$, or $\sum \ln(u_i)$ for $\gamma=1$

The inequality-aversion parameter γ ranges from 0 to infinity. This is the only family of SWFs that satisfy Pareto, Pigou-Dalton, plus separability, and are invariant to a ratio transformation

Equity-Regarding SWFs

-- *Separability*: The SWF is unaffected by the level of "indifferent" utilities. E.g., $w(4,100,100,12) > w(7,100,100,7)$ iff $w(4,7,7,12) > w(7,7,7,7)$. Separability corresponds to a powerful philosophical account of equity, so-called "prioritarianism"

-- The rank-weighted SWF, related to the Gini coefficient, satisfies the Pareto and Pigou-Dalton principles, but not separability. $w(u_1, u_2, \ldots, u_N) = Nu_1 + (N-1)u_2 + \ldots + 1u_N$, with utilities in ascending order.

--Any SWF that satisfies Pareto, Pigou-Dalton, and separability can be represented as $\sum g(u_i)$, *g* increasing and concave

-- *Invariance to a ratio transformation*: $\sum g(u_i) > \sum g(u_i^*)$ if and only if $\sum g(ku_i) > \sum g(ku_i^*)$, *k* positive.

Three Crucial Questions about Equity-Regarding SWFs

-- *What is the theoretical basis for interpersonally comparable utilities*?

Answer: Utilities represent individuals' "extended preferences," as per John Harsanyi

-- *The Time Slice Question: Do Utilities Measure Lifetime or Sublifetime Well-Being?*

Answer: Lifetime well-being.

-- *Given uncertainty, do we calculate the expectation of the SWF or apply the SWF to expected utilities*?

Answer: Calculate the expectation.

Interpersonally Comparable Utilities

- The economist John Harsanyi shows how to generate interpersonally comparable utilities from "extended preferences."
- Each outcome can be seen as a package of "life histories". Given outcomes *x*,*y*, *z* …, with a population of *N* individuals, (*x*; *i*) means having the attributes of individual *i* in outcome *x*; (*y*; *j*) means having the attributes of individual *j* in outcome *y*; and so forth
- Each individual in the population can, in principle, rank these life-histories and lotteries over the life-histories. These are her "extended preferences." We can measure each such ranking through a cardinal utility function. If all individuals converge in their extended preferences, there is a single cardinal utility function which can function as the input to the SWF. If not, we can use the entire set of utility functions as the input to the SWF.

The Time Slice Question

- In a given outcome x, with T periods and N individuals, the "sublifetime" approach says that $u(x)=(u_{1,1}, \ldots, {}_{1,N};\ldots;u_{T,1},\ldots,u_{T,N})$, and applies w to this vector of $T\times N$ "sublifetime" utilities.
- By contrast, the "lifetime approach" says that $u(x)=(u_1, \ldots, u_N)$, and applies w to this vector of N lifetime utilities
- The lifetime approach is grounded in the continuity of personal identity over time

The Time Slice Problem

-- Lifetime and sublifetime approaches can diverge for equity-regarding SWFs, even if lifetime utility is just the sum of sublifetime utility

Period:	1	2	3	4	*Lifetime Utility*
Phil	9	16	9	16	50
Sam	12.5	12.5	12.5	12.5	50
Phil	12.4	12.4	12.4	12.4	49.6
Sam	12.5	12.5	12.5	12.5	50

w=$\sum\sqrt{u_{t,i}}$ (sublifetime approach) prefers second outcome, but $\sum\sqrt{u_i}$ (lifetime approach) prefers first

The Time Slice Problem

-- The divergence between lifetime and sublifetime approaches: a more general demonstration

Period:	1	2	3	4	*Lifetime Utility*
Phil	9	16	9	16	50
Sam	12.5	12.5	12.5	12.5	50
Phil	12.5	12.5	12.5	12.5	50
Sam	12.5	12.5	12.5	12.5	50

Any equity-regarding SWF (Pareto and Pigou-Dalton) applied to lifetime utilities is indifferent between the two outcomes, but prefers the second to the first if applied to sublifetime utilities

Equity-Regarding SWFs under Uncertainty

$w=\sum\sqrt{u_i}$

A and B are equiprobable states

Status Quo

	A	*B*	*EU*
Jim	4	9	6.5
June	0	4	*2*
w	*2*	5	

Expected *w* = 3.5

w applied to the vector of expected utilities = 3.96

Policy

	A	*B*	*EU*
	3.5	3.5	3.5
	3.5	3.5	3.5
	3.74	3.74	

Expected *w*= 3.74

w applied to the vector of expected utilities = 3.74

Equity-Regarding SWFs under Uncertainty

A more general demonstration

	Status Quo			Policy		
	A	*B*	*EU*	*A*	*B*	*EU*
Jim	10	200	105	0	200	100
June	20	100	60	30	100	65

For any equity-regarding SWF (Pareto and Pigou-Dalton), if we calculate the expectation the status quo is preferred, but if we apply the SWF to expected utilities the policy is preferred

Equity-Regarding SWFs under Uncertainty

--Applying the SWF to expected utilities, rather than calculating the expectation of the SWF, can violate the sure thing principle

	Status Quo			**Policy**		
	A	***B***	***EU***	***A***	***B***	***EU***
Jim	**10**	**0**	**5**	**10**	**10**	**10**
June	**0**	**10**	**5**	**0**	**0**	**0**

For any equity-regarding SWF, the sure thing principle requires indifference between the status quo and policy, but if we apply the SWF to expected utilities the status quo is preferred

Equity-Regarding SWFs under Uncertainty

-- Applying the SWF to expected utilities, rather than calculating the expectation of the SWF, can also violate a dominance principle

	Status Quo			**Policy**		
	A	***B***	***EU***	***A***	***B***	***EU***
Jim	**10**	**0**	**5**	**5-ε**	**5-ε**	**5-ε**
June	**0**	**10**	**5**	**5-ε**	**5-ε**	**5-ε**

Given any continuous equity-regarding SWF, for a sufficiently small ε the dominance principle requires the policy, but the SWF applied to expected utilities will prefer the status quo

SWFs to Evaluate Risk Regulation

- The difficult question of "optimal simplification": How completely should we describe outcomes, in terms of the attributes that are relevant to individual (lifetime) well-being. Happiness? Health? Social life? Social status? Consumption? Longevity?

-- Given current data, it is feasible (at least) to focus on consumption, health, and longevity as determinants of lifetime well-being

-- An outcome is a profile of life-histories, one for each of the *N* individuals in the population. A life-history describes an individual's longevity, her consumption during each year alive, and her health during each year alive

-- For simplicity, I assume the population to be the same size, *N*, in all possible outcomes. (SWFs *can* be extended to the variable-population case, see Blackorby et al, 2005).

SWFs to Evaluate Risk Regulation

L_i is a possible life-history for individual *i*

A possible outcome *x* is a population profile of life-histories, $(L_1,L_2,\ldots,L_N)$

The status quo plus each policy should be characterized as a probability distribution across possible outcomes

Use a utility function *u* to transform each *x* into a vector of lifetime utilities $(u_1, u_2, \ldots,u_N)$

Use the Atkinsonian SWF *w* to map each vector onto a social welfare value $w(u_1, u_2, \ldots,u_N)$

Calculate the *expected* social welfare for the status quo and each policy. In other words, if u_i is a random variable representing each individual's utility, calculate $\boldsymbol{E}(w(u_1, u_2, \ldots u_N))$ for the status quo and each policy.

Calibrating a Utility Function

- It is a tractable simplification to see lifetime utility as the (possibly discounted) sum of period (annual) utility. $u(L_i)=\sum D(t)v(c_{i,t}\ ,\ h_{i,t})$
- If we ignore health, we can assume that $v(c_{i,t})$ has the CRRA form and use existing data on utility for consumption gambles to calibrate

Calibrating a Utility Function

- If we ignore consumption, we can use QALY survey data to calibrate $v(h_{i,t})$

- More ambitiously, we can assume that $v(c_{i,t}, h_{i,t})=r(c_{i,t})q(h_{i,t})$. We can use data on consumption gambles to calibrate $r(.)$, QALY surveys to calibrate $q(.)$, and infer relative scaling of $r(.)$ and $q(.)$ from CV surveys or new surveys focusing on gambles over health *and* consumption

Calibrating the Atkinsonian SWF

-- The Atkinsonian SWF is $w=1/(1-\gamma)\sum u_i^{1-\gamma}$. We need to estimate the inequality-aversion parameter γ. If $\gamma=0$, we have the utilitarian SWF. If $\gamma=\infty$, we have the leximin SWF

Surveys asking individuals to adopt a social-planner perspective, and posing "leaky bucket" or "equalization" questions, are needed. Some of these have been undertaken.

Generating an Equality Metric from the SWF

- The approach I have described here, i.e., calculating an expected social welfare value for each policy, is an *integrated* assessment, combining both overall-well-being and equity concerns

-- However, SWFs also allow us to separately measure the impact of policies on overall well-being and the distribution of well-being

Overall well-being: Set γ=0 (or do CBA)

Equality of well-being: Each SWF generates an inequality metric w^E. Calculate the expected value of w^E for each policy.

How SWFs Generate an Inequality Metric

For any utility vector (u_1, u_2, …,u_N), calculate the value u^+ such that

$w(u_1, u_2, \ldots, u_N) = w(u^+, u^+, \ldots u^+)$

Then $w^E(u_1, u_2, \ldots, u_N) = 1 - Nu^+ / \sum u_i$

This is Atkinson's measure of inequality, widely used by economists in measuring the inequality of incomes. Also recently used in work by Jonathan Levy and co-authors on the equity impacts of air pollution

We can calculate the expected value of w^E for each policy

Should We Use SWFs or Distributively Weighted CBA?

--Since an SWF would be needed to generate weights, it's not clear why evaluating policies with weighted CBA is more attractive than using SWFs directly

-- CBA sums compensating variations (CVs). CVs are usually calculated on an ex ante basis, i.e., the state-invariant change in an individual's income needed to make him ex ante indifferent between the policy and status quo. VSL is based on the ex ante CV for a change in the risk of premature death. CBA using ex ante CVs, even with distributive weights, can deviate from the expectation of an SWF. *A topic for future research*: characterizing when CBA with ex ante CVs and distributive weights deviates from the expectation of an equity-regarding SWF