Recommended Income Elasticity and Income Growth Estimates: Technical Memorandum

February 5, 2016

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A report by Robinson and Hammitt (2015) was prepared for EPA to support updates to the income elasticity and projected income growth adjustments currently used to estimate the economic value of changes in mortality and morbidity risk.

This memorandum provides supplementary information to the Robinson and Hammitt (2015) report, including (1) options for income elasticity values; (2) an extension of the Robinson and Hammitt (2015) summary table of income elasticities to include one additional study; and (3) a brief summary of recent theoretical findings related to the VSL income elasticity.

1. Identified options for income elasticity values

Income elasticity of VSL: Robinson and Hammitt (2015) review the literature on income elasticity of value of statistical life (VSL) estimates, applying study selection criteria based on 2011 SAB-EEAC advisory (US EPA 2011). The report identifies alternative income elasticity and projected income growth estimates that may be appropriate for updating EPA practices on adjusting the willingness-to-pay (WTP) estimates used to quantify the economic value of reduced mortality and morbidity risk over time.

Based on the findings and recommendations in Robinson and Hammitt (2015) and EPA's own meta-analysis of the VSL (US EPA 2015) we identify two options for choosing a recommended estimate of the VSL income elasticity for use in the Agency's policy evaluations.

The first option is to apply equal weighting to the mean of the primary VSL income elasticity estimates from hedonic wage (HW) studies and stated preference (SP) studies, as is done for VSL estimates in the "balanced approach" described in US EPA (2015). This option includes both strands of the literature and recognizes that those factors that may lead to systematic differences in VSL estimates generated by HW and SP methods may also lead to differences in their respective estimates of the VSL income elasticity. Excluding elasticity estimates of zero—based on our strong prior that health is a normal good and so its demand should increase with income—the balanced estimate (simple mean of the average HW estimate and the average SP estimate) is 0.7.

Two SP studies report very low mean income elasticity estimates, putting them at odds with the available theoretical literature described below. Hammitt and Haninger (2010) report a mean income elasticity of 0.12 and Viscusi, Huber, and Bell (2014) report a mean income elasticity of 0.08. The "balanced approach" central estimate is robust to omitting these two studies.

A second option is to rely solely on results from Viscusi (2015) as it represents a systematic, robust, and peer-reviewed synthesis of the Census of Fatal Occupation and Industry (CFOI) literature on mortality risk valuation.[1] Robinson and Hammitt (2015) identify this as an option for EPA consideration and discuss its advantages and disadvantages (see Hammitt and Robinson, page 21). This option yields a central estimate of 1.1.

Table 1. Options for Estimating Mortality Risk Income Elasticities

Option	Central Estimate	Reasonable Bounds	Notes
(1) Equally weight mean results from HW & SP literatures	0.7[2] (weighted mean)	0.1, 1.4[3] (lowest and highest reported mean values)	Consistent with "balanced" approach to VSL estimation
(2) Use HW meta-analysis solely (i.e., Viscusi, 2015)	1.1 (random-effects model, preferred specification)	0.6, 1.7 (central value +/- clustered standard error)	From Robinson & Hammitt (2015)

Robinson and Hammitt (2015) also discuss a third option based on the midpoint of the range of studies that meet the selection criteria as specified in their report. This option also yields a central estimate of 0.7. However, it does not include the income elasticity estimate reported in Viscusi, Huber and Bell (2014) for reasons described more fully below. Including the Viscusi, Huber, and Bell estimate would lower the midpoint identified in Robinson and Hammitt (2015).

Income elasticity of non-fatal health risks: Given the paucity of reliable income elasticity estimates for morbidity outcomes, and no theoretical guidance on its magnitude relative to income elasticity of VSL, EPA recommends using the mortality income elasticity estimate to adjust both mortality and morbidity WTP values.

2. <u>Income Elasticity Estimates for VSL, including Viscusi, Huber, and Bell (2014)</u>

Robinson and Hammitt (2015) exclude a study by Viscusi, Huber, and Bell (2014) due to concerns about sensitivity to scope. However, the EPA White Paper (2015) meta-analysis includes this study based on results reported in an on-line appendix to the study that provides evidence of validity and a successful weak scope test. Full compatibility across the VSL and income elasticity report would suggest that it be included in both places.

For completeness, the results of Viscusi, Huber, and Bell (2014) are appended here to the values reported in Table 2.2 of Robinson and Hammitt (2015). Please see Robinson and Hammitt (2015) for more information on each study, including detailed footnotes. The EPA

[1] CFOI data is considered the primary source of information for on-the-job fatalities. See US EPA (2011).
[2] Trimming the dataset to remove two very low estimates from Hammitt and Haninger and Viscusi, Huber, and Bell still yields a rounded central value of 0.7.
[3] Omitting the estimates from Hammitt and Haninger and Viscusi, Huber, and Bell changes the reasonable bounds to 0.3 to 1.4.

White Paper (US EPA 2015) provides more details on the validity of the Viscusi, Huber, and Bell (2014) estimates.

Table 3 (Table 2.2 of Robinson and Hammitt with addition of Viscusi, Huber, and Bell 2014)

Study	Method (scenario)	Income Elasticity (standard error)
Wage-Risk Studies		
Kniesner, Viscusi, and Ziliak (2010, p. 28)[a]	Wage-risk	Mean = 1.44 (NA) Range (from highest to lowest income quantile) = 1.23 to 2.24[b]
Viscusi (2015, p. 38)	Wage-risk meta-analysis	Random-effects model: [c] Mean VSL: 0.829 (0.131)[0.438] Preferred VSL: 1.136 (0.225)[0.572] Fixed-effects model: Mean VSL: 0.763 (0.119)[0.467] Preferred VSL: 1.060 (0.226)[0.616]
Stated Preference Studies: Stronger Evidence of Validity		
Corso, Hammitt, and Graham (2001)[d]	Stated preference (risks from motor vehicle accidents)	0.41 (019)[d] (dot array) 0.00 (0.18) (logarithmic scale)
Hammitt and Haninger (2010, p. 73, 75)	Stated preference (pesticides and motor vehicles, risk to self)	0.123 (0.106)[e]
Cameron and DeShazo (2013, p. 100)[f]	Stated preference (sudden death)	0.66, 0.68 (NA) (depending on income change)[g]
Stated Preference Studies: Weaker Evidence of Validity		
Corso, Hammitt, and Graham (2001)[d]	Stated preference (risks from motor vehicle accidents)	-0.00 (0.19)[d] (linear scale)
Alberini et al. (2004, p. 787)	Stated preference (risks from unidentified causes)	0.26 (0.13), 0.33 (0.14)[h] (depending on model specification)
Chestnut et al. (2012, p. 410, 411)	Stated preference (cancers and heart attacks)	0.3 (0.1), 0.4 (NA)[i] (depending on model specification)
Viscusi, et al. (2014, p. 392)	*Stated preference (cancer)*	*0.08 (NA)*

3. Notes on prior estimates and theoretical expectations for the income elasticity of VSL

As described in our prior white paper *Valuing Mortality Risk Reductions for Environmental Policy: A White Paper* (US EPA 2010), several meta-analyses estimated the income elasticity of VSL from hedonic wage studies using data that predate the CFOI database. With the exception of Bellevance *et al*. (2009) these studies typically found income elasticity to be less than one. Doucouliagos *et al*. (2014) performs an assessment of publication bias and estimates of VSL income elasticity from 14 prior meta-analyses of SP and hedonic wage literature both within and outside of the U.S. This meta-analysis suggests a value ranging from 0.25 to 0.63. We consider these estimates to be superseded by those in the report here that more closely follow SAB recommendations for study selection including being limited to the US, and, for hedonic wages, being based upon data with quality at least as good as CFOI.

Our prior white paper also recognized research concluding that the income elasticity of the VSL should be very close in magnitude to the coefficient of relative risk aversion (CRR). Although estimates of CRR span a wide range, most estimated or assumed values appear to be from 1 to 3, and the most commonly used values in the climate change economics literature are 2 to 3. These theoretic and empirical findings suggest a higher income elasticity estimate than EPA currently uses. Kneisner *et al*. (2010) notes that their findings on income elasticity are consistent with these theoretic expectations.

More recent research by Evans and Smith (2010) has further explored the relationship between income elasticity of the VSL and CRR. Evans and Smith extend the theoretical models of Kaplow to arrive at an alternative explanation of the bounds of the income elasticity of VSL and its relationship with the coefficient of relative risk aversion (CRR). In a model that includes complementarity between consumption and labor supply but holds labor supply fixed (as assumed in prior models) the study suggests (1) lower income elasticity of VSL than under less complex models; and (2) the CRR does not provide a lower bound on the income elasticity for VSL. Relaxing the fixed labor supply assumption suggests a still lower income elasticity for VSL and CRR, and that CRR serves as a lower bound for income elasticity of VSL only under narrow conditions. The empirical analysis by Evans and Smith (2010) supports the relevance of key components of their theoretical analysis, but does not estimate the VSL income elasticity or make a quantitative comparison between the income elasticity and coefficient of relative risk aversion.

As noted earlier, some SP studies included in Robinson and Hammitt provide very low mean estimates of the income elasticity of VSL, sometimes even zero. Such results are at odds with much of the theory described above and may raise questions about construct validity if a reduction in fatal risk is a normal good. The ranges described in our options do not include study results where the mean elasticity estimate is zero, but it is less clear what to do with the very low non-zero mean results.