Moderate stake variations for risk and uncertainty, gains and losses: methodological implications for comparative studies

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Abstract. Risk attitudes are known to be sensitive to large stake variations. Little is however known on the sensitivity to moderate variations in stakes. This is important for studies that want to compare risk attitudes between countries or over time. I find that variations of ±20% affect only utility, while larger variations may affect also probability weighting. Surprisingly, the effect on weighting functions is larger for losses than for gains. It is also more pronounced for risk than for uncertainty.

Keywords*:* prospect theory; stake effects; experimental methodology
JEL Classification*:* D03; D81; C9

1. Motivation

Stake levels have been shown repeatedly to matter for risk-attitudes. Binswanger (1980), Hogarth & Einhorn (1990), Kachelmeier & Shehata (1992), and Holt & Laury (2002) all found risk-aversion to increase with stakes in the gain domain. Lefebvre *et al.* (2010) confirmed these findings with between-subject data. Stake levels have also been shown to matter in some tasks involving strategic uncertainty (Johansson-Stenman *et al.,* 2005).

This evidence raises some concerns for comparative studies, since any differences found may stem from inadvertent variations in stake sizes rather than from the elements one wants to investigate. If one wants to compare risk-attitudes between countries or across time, differences in purchasing power may affect outcomes given the sensitivity of risk-attitudes to stakes. Recent evidence showing that stake variations may also affect weighting functions further heightens such concerns (Fehr-Duda *et al.,* 2010).

The evidence cited above shows that stake levels will affect risk-preferences for gains—the evidence being less clear for losses[1] and little being known about uncertainty. However, the stake increases used in the experiments cited are quite large—Fehr-Duda *et al.* (2010) increase stakes by a factor of approximately 14; (Hogarth and Einhorn 1990) in their real-stakes experiment 3 by a factor of 100, although from an extremely low base; (Lefebvre *et al.*, 2010) by factors of 4 and 10; (Holt and Laury 2002) increased stake levels x20 or more. Any variations in stake levels due to inaccurate PPP conversions or due to the inflationary erosion of purchasing power within a country are likely to be small. Unfortunately, there is no evidence on whether such small stake variations make a difference for risk-attitudes. Such evidence is reported in this letter.

2. Method

Subjects. 161 subjects were recruited at MELESSA in Munich. The average age was 24 years and 59% were female.

Tasks. We elicited certainty-equivalents (*CEs*) for monetary prospects using choice lists. The experiment was paper-based. CEs were elicited first for 50-50 prospects with different outcomes, and subsequently for risky and uncertain prospects with different probability levels (for a list see appendix). Probability representations and the implementation of uncertainty followed Abdellaoui *et al.* (2011).

1 There is more evidence on the effect of real versus hypothetical payoffs on losses. This is however a different issue, and a review is beyond the scope of this letter.

Conditions. There were three conditions: baseline (n=69), low-stake (*base–20%; n=44*), and high-stake (base+20%; n=48). All amounts were lowered by 20% in absolute value in base–20% and increased by 20% in base+20%.

Incentives. One choice was played out for each subject—the standard procedure in this type of experiment. The average payoff was €16.99. Losses were implemented from an endowment of €20. Etchart-Vincent & L'Haridon (2011) compared losses from an endowment to real and hypothetical losses and found no difference.

Analysis. Risk-attitudes are divided into utility curvature, probability-weighting, and loss-aversion, following prospect theory. A step-wise estimation procedure is used to estimate first utility and then weighting functions (Abdellaoui *et al.*, 2008). Parameters are estimated at the individual level, and maximum likelihood estimation is used in both steps. Utility is parametrized through a power function. Separate functions are estimated for gains and losses:

$u(x)=x^{\rho\_gains}$ if $x\geq 0$

$u(x)=-\lambda * x^{\rho\_losses}$ if $x<0$

where λ indicates loss-aversion. The Prelec two-parameter weighting function (Prelec 1998) is used for graphical displays:

$$w(p)=\exp(-\beta*(-\ln(p)^{\alpha})$$

with separate parameters for gains and losses. For statistical analysis, the more intuitive indices derived from neo-additive weighting will be used (Chateauneuf *et al.*, 2007; Abdellaoui *et al.* 2010). The function consists in a linear regression line:

$$w(p)=a+b*p$$

The intercept, *a*, indicates overweighting of small probabilities; *1–a–b* indicates underweighting of large probabilities; and *1–2a–b* measures underweighting over the whole probability space.

Hypotheses. Any differences are hypothesized be small to non-existent when stake variations are small (±20%). What variations will occur are hypothesized to show up in the utility function (with

increasing concavity for gains as stakes increase). For losses a tendency towards linear utility for larger stakes is anticipated. There is some evidence that stake variations will also affect weighting functions (Fehr-Duda *et al.*, 2010) . To the extent that such interdependencies will occur, we anticipate that they will be inconsequential for stake variations ±20% but may become significant for larger stake differences.

Statistics. Mann-Whitney tests are used for comparisons between conditions, and Wilcoxon signed-rank tests for deviations from expected values. The p-values reported are always two-sided.

3. Results

Utility. Figure 1 shows utility curves by stake level.

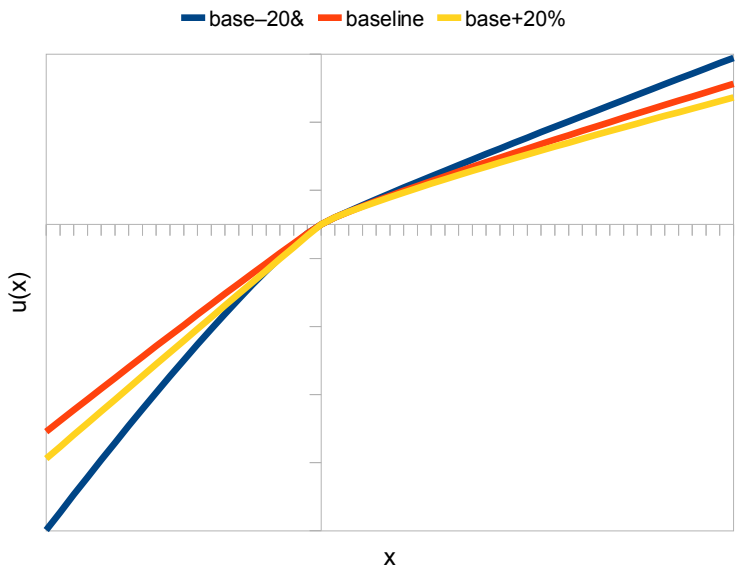

Figure 1: utility curve by stakes

Gain utility becomes more concave as stakes increase. While neither the difference between base–20% and baseline (z=1.21, p=0.22) nor the difference between baseline and base+20% (z=1.21, p=0.23) is significant, a significant difference emerges as hypothesized between the two extreme conditions (z=2.15, p=0.031).

The effect appears less clear for losses at first glance. Stakes, however, have again a clear effect, bringing the median ρ from 1.17 for base–20% to 1.04 in baseline (z=2.66, p=0.008). This is further reduced to 1.01 in base+20% (z=1.70, p=0.09). The difference between base–20% and base+20% is highly significant (z=3.72, p=0.000). The utility function is concave in base–20% (z=3.96, p=0.000) and baseline (z=1.79, p=0.073), but linear in base+20% (z=0.66, p=0.51).

This begs the question why the base+20% curve slopes down between the other two. The answer is very simple—loss aversion. While the median λ is 1.35 for both base–20% and baseline, it is at 1.67 significantly larger in base+20% (z=6.65, p=0.000).

Weighting risk for gains. Figure 2 represents weighting of risky gains.

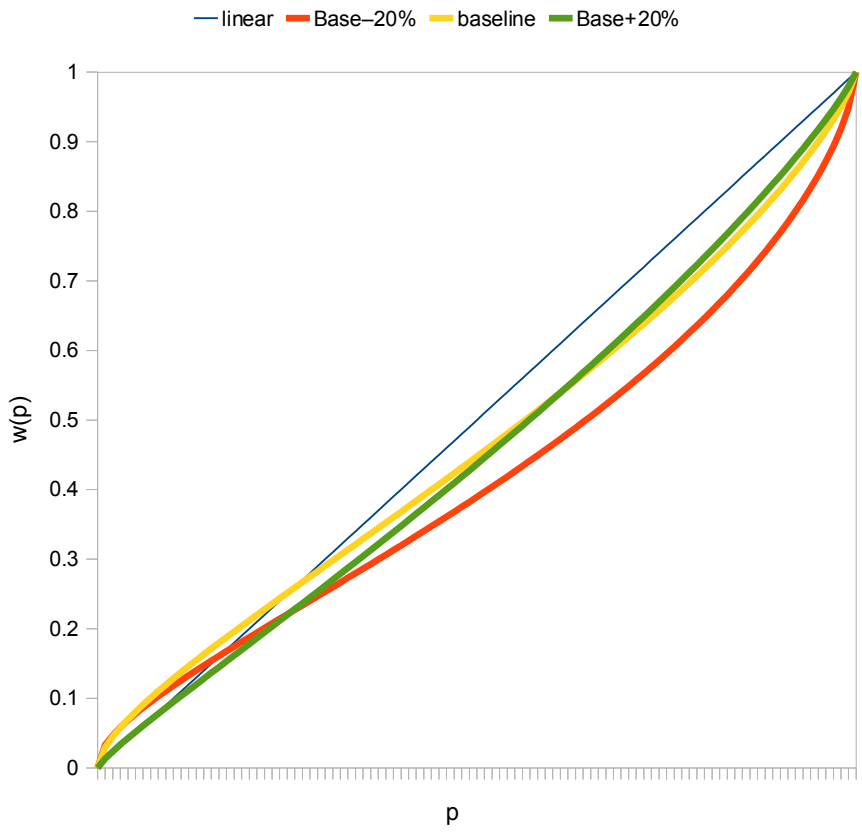

Figure 2: weighting function for risky gains by stakes

There is no difference in overweighting of small probabilities between base–20% and baseline (z=0.11, p=0.92). The difference between baseline and base+20% is also insignificant (z=1.34, p=0.18), as is the extreme comparison (z=0.98, p=0.33). The difference in underweighting of large probabilities between base–20% and baseline is significant (z=1.98, p=0.048). There is, however, no difference between baseline and base+20% (z=0.94, p=0.35), nor between the two extreme stake levels (z=1.10, p=0.27). This effect is thus an odd one. Pessimism seems to be *larger* in the low stakes condition, which flies in the face of virtually all the evidence accumulated on larger stake variations, which all indicate increased risk-aversion under high stakes. Since the effect is furthermore not consistent, I am inclined to dismiss this effect as a result of chance.

Weighting risk for losses. Figure 3 shows probability-weighting for losses. The direction of effects is again clear, moving from optimism for low stakes to pessimism under high stakes. The effects are slight, with no statistically significant difference in global pessimism either between base-20% and baseline ($z=1.36$, $p=0.17$), or baseline and base+20% ($z=1.13$, $p=0.36$). The difference between base-20% and base+20% is significant ($z=3.12$, $p=0.002$). This corresponds with our hypotheses—while there is no difference for ±20%, for larger variations of 50% we do find significant differences.

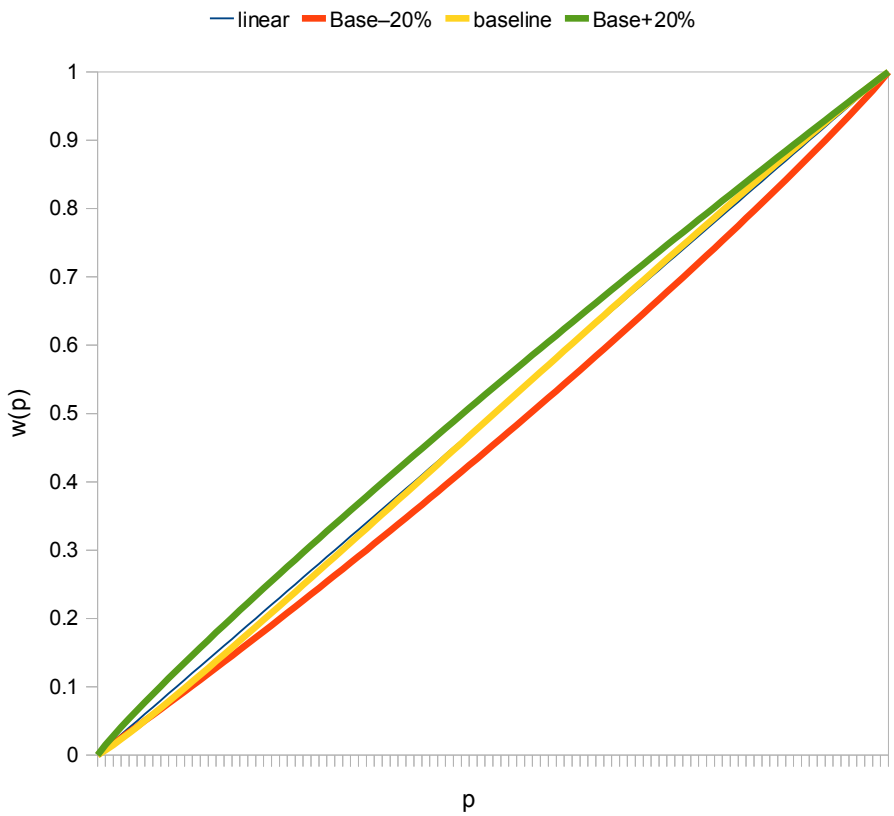

Figure 3: Probability-weighting for risky losses

Weighting-functions for uncertain gains. Figure 4 shows the weighting-functions for uncertain gains. Differences appear small to non-existent for moderate to large probabilities, and they do not reach statistical significance at the lower intercept where they appear most pronounced (base+20% versus baseline: $z=1.18$, $p=0.24$; base+20% versus base–20%: $z=1.38$, $p=0.17$).

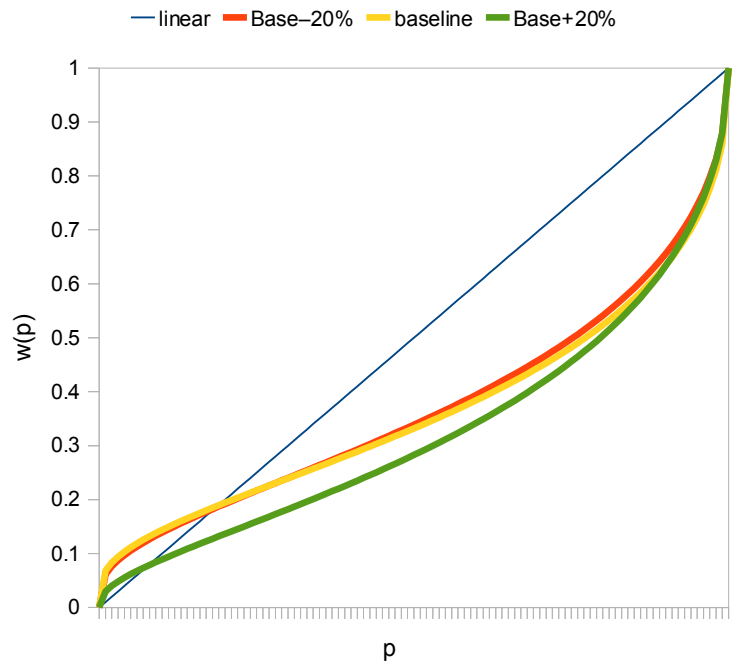

Figure 4: weighting-functions for uncertain gains

Weighting-functions for uncertain losses. Figure 5 shows the weighting-functions for uncertain losses. There appears to be a clear tendency of pessimism increasing with stakes, but this fails to reach significance (although narrowly for base–20% versus base+20%: z=1.59, p=0.11).

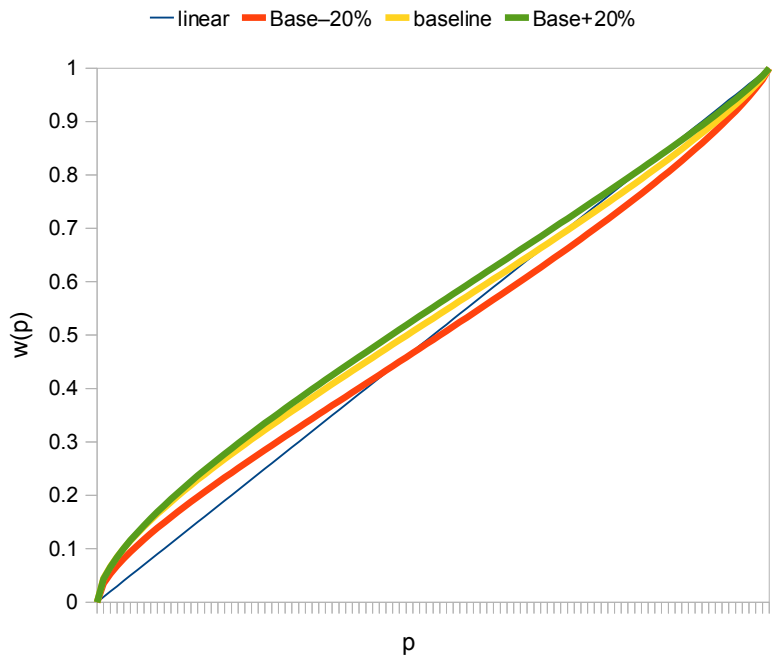

Figure 5: source functions for uncertain losses by stakes

4. Discussion

Overall a clear picture emerges. While there are generally no differences for moderate variations in stakes of ±20%, for twice that variation systematic differences start to emerge. These differences are reflected mostly in the utility function—something that we expected given that utility under prospect theory expresses preference over monetary outcomes. Nevertheless, weighting functions are not unaffected by variations in stake levels, confirming earlier findings (Fehr-Duda *et al.,* 2010; Hogarth and Einhorn, 1990). The weighting for vague probabilities was not found to be affected by the moderate stake increases considered.

The effects found for risky gains seem somewhat erratic, going in the opposite direction of effects previously found and not being consistent across stake levels. I am thus inclined to dismiss this effect. Nevertheless, there emerges a consistent effect for losses, with weights getting more pessimistic as stakes increase, resulting in a significant difference between the two extreme stake conditions. Notice, however, how this tendency of increased pessimism under high stakes is balanced by changes in the utility function, which from concavity under low stakes becomes linear for the highest stakes. For mixed prospects, loss-aversion tends to increase with stake sizes.

Overall, the message is modestly reassuring: small variations in stakes around the order of 20% or less do generally not affect risk attitudes, and where they do this is reflected in the utility function. This may reassure scholars who want to compare data on behavior under risk and uncertainty between countries, or between time periods. Nevertheless, care should be taken to ensure the correspondence in terms of purchasing power of stakes used in experiments if the results are to be compared. Indeed, even moderately larger discrepancies may well result in significant differences.

5. Conclusion

I conducted an experiment to examine the effect of moderate stake variations in the range of 20% on risk and uncertainty attitudes. The effect of such moderate variations is small and mostly reflected in utility functions. Larger stake variations of about 50% on the other hand show up also in weighting functions, especially for losses. This indicates a need for extreme caution when designing comparative studies between countries, cities, or across time.

Appendix A: List of prospects

nr/designation	Baseline	Base–20%	Base+20%
1 (risk only)	(½: €5; 0)	(½: €4; 0)	(½: €6; 0)
2 (risk only)	(½: €10; 0)	(½: €8; 0)	(½: €12; 0)
3 (risk only)	(½: €20; 0)	(½: €16; 0)	(½: €24; 0)
4 (risk only)	(½: €30; 0)	(½: €24; 0)	(½: €36; 0)
5 (risk only)	(½: €30; €10)	(½: €24; €8)	(½: €36; €12)
6 (risk only)	(½: €30;€20)	(½: €24;€16)	(½: €36;€24)
7 (risk)	(1/8: €20; 0)	(1/8: €16; 0)	(1/8: €24; 0)
9 (risk)	(2/8: €20; 0)	(2/8: €16; 0)	(2/8: €24; 0)
10 (risk)	(3/8: €20; 0)	(3/8: €16; 0)	(3/8: €24; 0)
11 (risk)	(5/8: €20; 0)	(5/8: €16; 0)	(5/8: €24; 0)
12 (risk)	(6/8: €20; 0)	(6/8: €16; 0)	(6/8: €24; 0)
13 (risk)	(7/8: €20; 0)	(7/8: €16; 0)	(7/8: €24; 0)
15 (ambiguity)	(1/8: €20; 0)	(1/8: €16; 0)	(1/8: €24; 0)
17 (ambiguity)	(2/8: €20; 0)	(2/8: €16; 0)	(2/8: €24; 0)
18 (ambiguity)	(3/8: €20; 0)	(3/8: €16; 0)	(3/8: €24; 0)
19 (ambiguity)	(5/8: €20; 0)	(5/8: €16; 0)	(5/8: €24; 0)
20 (ambiguity)	(6/8: €20; 0)	(6/8: €16; 0)	(6/8: €24; 0)
21 (ambiguity)	(7/8: €20; 0)	(7/8: €16; 0)	(7/8: €24; 0)
23 (risk)	(½: – €5; 0)	(½: – €4; 0)	(½: – €6; 0)
24 (risk)	(½: – €10; 0)	(½: – €8; 0)	(½: – €12; 0)
25 (risk)	(½: – €20; 0)	(½: – €16; 0)	(½: – €24; 0)
26 (risk)	(½: – €20; – €5)	(½: – €16; – €4)	(½: – €24; – €6)
27 (risk)	(½: – €20; – €10)	(½: – €16; – €8)	(½: – €24; – €12)
28 (risk)	(1/8: – €20; 0)	(1/8: – €16; 0)	(1/8: – €24; 0)
30 (risk)	(2/8: – €20; 0)	(2/8: – €16; 0)	(2/8: – €24; 0)
31 (risk)	(3/8: – €20; 0)	(3/8: – €16; 0)	(3/8: – €24; 0)
32 (risk)	(5/8: – €20; 0)	(5/8: – €16; 0)	(5/8: – €24; 0)
33 (risk)	(6/8: – €20; 0)	(6/8: – €16; 0)	(6/8: – €24; 0)
34 (risk)	(7/8: – €20; 0)	(7/8:– €16; 0)	(7/8: – €24; 0)
36 (ambiguity)	(1/8: – €20; 0)	(1/8: – €16; 0)	(1/8: – €24; 0)
38 (ambiguity)	(2/8: – €20; 0)	(2/8: – €16; 0)	(2/8: – €24; 0)
39 (ambiguity)	(3/8: – €20; 0)	(3/8: – €16; 0)	(3/8: – €24; 0)
40 (ambiguity)	(5/8: – €20; 0)	(5/8: – €16; 0)	(5/8: – €24; 0)
41 (ambiguity)	(6/8: – €20; 0)	(6/8: – €16; 0)	(6/8: – €24; 0)
42 (ambiguity)	(7/8: – €20; 0)	(7/8: – €16; 0)	(7/8: – €24; 0)
44 (risk)	(½: €20; –€20 to –€3)	(½: €16; –€16 to –€1)	(½: €24; –€20 to –€5)

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