Journal of Occupational Psychology (1991), 64, 179–188 *Printed in Great Britain*

Estimating the standard deviation of professors' worth: The effects of frame and presentation order in utility analysis

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This study examined the effects of two cognitively oriented dimensions, framing and anchoring, on estimates of the standard deviation of the overall worth (SDy) of full professors in organizational behaviour. The estimates were produced using the Schmidt *et al.* (1979) procedure in utility analysis. In order to manipulate the framing variable, half of the subjects were presented the estimation task positively, in terms of potentially acquiring a new professor (in order to fill a vacancy); the remaining half were presented a negatively framed task, in terms of potentially losing a professor (thereby creating a vacancy). Different orders of eliciting percentile estimates provided the anchoring manipulations. A significant main effect for framing was obtained. Insignificant effects were found for both the ordering variable and its interaction with framing. Based on previous literature and the current study, it can be concluded that the Schmidt *et al.* procedure is highly susceptible to contextual effects and a multiplicity of estimates of SDy should be expected. Alternative techniques for estimating SDy should be considered by future researchers.

Renewed interest in the decision theoretic equations developed by both Brogden (1949) and Cronbach & Gleser (1965) for estimating utility has been evidenced by increased application in occupational settings. A key component in these equations is the standard deviation of the value of job performance (SDy), and a number of procedures for estimating SDy have been put forward in the last decade or so. The most popular of these methods was proposed by Schmidt, Hunter, McKenzie & Muldrow (1979). This procedure, based on the assumption that job performance is normally distributed, requires supervisors to estimate the overall dollar value of the outputs of 50th, 85th and 15th percentile performers.

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The validity of procedures involving human judgement of overall dollar worth implicitly assumes that judges are cognitively capable of providing such estimates, and that estimates are not affected by minor variations in the estimation task. However, a growing body of literature questions the robustness of judgements of overall worth. For example, although Bobko, Karren & Parkington (1983) found agreement between judgemental estimates of SDy and archival data, DeSimone, Alexander & Cronshaw (1986) concluded that judgemental estimates 'were significantly lower than the actual value of SDy' (p. 93). Alexander & Barrick (1987) found a considerable level of uncertainty surrounding these judgemental estimates, while Shetzer & Bobko (1987) discovered that estimates of SDy were significantly affected by the way the question was asked. Other research suggests that the accuracy of estimates is also affected by the degree to which performance information can be translated into dollar metrics (Reilly & Smither, 1985). While it is true that, for many purposes, variability in SDy estimates may not affect some utility conclusions (e.g. see Burke & Frederick, 1986, or Boudreau, in press), Guion & Gibson (1988) note that more accurate estimates are required for the joint planning of financial, raw material and human resources.

One often noted feature of the Schmidt *et al.* (1979) procedure is the extreme variation in estimates across different supervisors (cf. Bobko *et al.*, 1983; Mathieu & Leonard, 1987; Reilly & Smither, 1985; Schmidt *et al.*, 1979). In the original Schmidt *et al.* data, for instance, the standard deviation of estimates of SDy was actually greater than the mean estimate of SDy. This extreme within-cell variation raises the possibility that different judges were basing their estimates on different factors (Bobko *et al.*, 1983). Burke & Frederick (1984) have suggested that judges may be idiosyncratic in the order in which they provide their estimates, which might also contribute to the large within-cell variation. Further, Reilly & Smither (1985) note that the way in which Schmidt *et al.* (1979) framed the task for their subjects may have introducted confusion and unreliability into the SDy estimates. Specifically, the Schmidt *et al.* (1979) procedure asks subjects to consider both the value of 'overall products and services' and the 'cost of having an outside firm provide these products and services'. One might speculate that the *cost* of having an outside firm provide products and services is analogous to a negative frame; conversely, the *value* of overall products and services is analogous to a positive frame. Boudreau (1983) has also pointed out that, in economic terms, the value of products and services is not equal to the cost of obtaining them from an outside firm.

Shetzer & Bobko (1987) tested the above proposition (that framing affects estimates) using students, who evaluated the worth of professors. While they found a significant effect for framing, their results can only be considered tentative since the judges were not supervisors of academic staff and they (students) do not generally have knowledge about academic salaries, marketplace demands, job descriptions, etc.

This study had two purposes: (1) to investigate the robustness of the Schmidt *et al.* estimation technique to two contextual effects (ordering and framing) using supervisory personnel; and (2) to understand better the judgemental processes underlying any human evaluation of overall worth. The basic underlying hypothesis was that estimates of overall variability in worth would *not* be robust to contextual factors. These goals were accomplished by obtaining the perceived worth of university academic staff from an appropriate sample of judges: chairpersons of faculty search committees.

Contributions from decision-making research

Framing

Decision-making research has shown that problems of estimation or choice which are framed in terms of potential gain often evoke a markedly different response from tasks framed in terms of potential loss. For example, according to Kahneman & Tversky's (1979) 'prospect theory', judges are risk seeking when confronted with loss, but 'risk averse' when faced with gain. The impact of frame appears so pervasive that it can affect choice even when the possible outcomes of the problem are objectively identical. This was illustrated by Tversky & Kahneman's (1981) 'epidemic problem' where, in response to an imminent epidemic, subjects were found to select a risky option when the outcome was expressed in terms of lives lost, but a certain option when the identical outcome was expressed in terms of lives saved. Such an effect for frame has even been extended to a group-level situation (Schurr, 1987).

Based on the framing literature, we hypothesized that estimates of SDy would *not* be robust to framing effects: specifically, judgements of SDy obtained within an explicitly positive frame would be significantly different from estimates of SDy obtained within an explicitly negative frame.

Anchoring

A second application of decision-making research to SDy estimation concerns the effect known as anchoring (Tversky & Kahneman, 1974): that is, judgements can be markedly affected by the initial starting-point provided by a problem. For example, Lichtenstein, Slovic, Fischoff, Layman & Combs (1978) demonstrated that, when subjects were asked to estimate the frequency of death due to various causes, their responses differed significantly depending on whether the task instructions contained a high or low frequency example (e.g. 50 000 deaths due to motor vehicle accidents vs. 1000 deaths due to electrocution). Such judgemental biases occur because the judge places too much weight on the anchor and fails to adjust the estimate in the light of other relevant considerations. Anchoring effects have also been found in preference for gambles (Lichtenstein & Slovic, 1971), sales predictions (Hogarth, 1980), and predictions of spousal consumer preferences (Davis, Hoch & Ragsdale, 1986). Tversky & Kahneman (1974) showed that intuitive numerical estimation tends to be anchored on initially presented values even when those values are selected randomly in the subject's presence.

It should be noted that the Schmidt *et al.* (1979) procedure anchors estimates at the median of the presumed distribution.* That is, the 50th percentile estimate is elicited first, followed by the 85th and 15th percentiles. The present study varied the order of performance levels and, based on the above theory, hypothesized that estimates of overall worth would *not* be robust to variations in ordering. In fact, we hypothesized that estimates of SDy would be significantly greater when the 85th percentiles were provided first (and thus were not constrained by the 50th percentile estimates), compared to using the traditional order.

* In fact, if one assumes that individual worth is always positive, the utility estimates will also be anchored, from below, by zero. As Bobko, Karren & Kerkar (1987) note, this assumption of positive worth does not always hold in the minds of the judges! Indeed, the notion that loss of academic staff might *save* money for the respective university is further noted in the Discussion section.

Method and subjects

The targeted subject population was all chairpersons of search committees which had advertised vacancies for business school faculty positions in organizational behaviour in the continental United States. This population was restricted to include only chairpersons serving on committees during 1985, 1986 and 1987. A list was generated using all issues of the *Academy of Management Placement Roster* (both Spring and Fall) for the three years. In all, 169 such individuals were identified. These individuals are themselves academic staff members, would understand the overall job of 'full professor', and would have first-hand knowledge of the recruiting marketplace.

One of four versions of the questionnaire was randomly sent to each judge. For half of the subjects, the problem was posed in a positive frame. The positive frame instructions are presented in the Appendix. In the negative frame conditions, subjects received identical instructions, except they were asked to estimate the overall loss to the university if various professors were to leave (thus creating, rather than filling, a vacancy). Whenever possible, the wording of the scenarios used paralleled that of Schmidt *et al.* (1979).

The second independent variable was presentation order. Subjects in both the positive and negative frame conditions received one of two presentation orders: a request for their 50th percentile estimate followed by that for the 85th percentile (similar to the traditional ordering), or the reverse. Note that, in order to keep cell sizes sufficiently large, only two percentile estimates were obtained. The 15th percentile was not requested because we felt it was unrealitic to assume that departments would be interested in acquiring a 15th percentile level employee. Thus, there were two levels each for the anchoring/order factor and the framing factor, resulting in an overall 2 × 2 between-subjects design.

Before mailing, each questionnaire was also coded for the city and state to which it was sent. A cost of living index (CLI: American Chamber of Commerce Researchers Association, 1988) was obtained for each city and then merged into the data file. It was felt that regional differences in cost of living, salaries, etc. might spuriously increase the variance of overall worth estimates across different university vacancies. Such data were considered as a preliminary covariate to test for statistically significant differences in SDy.

Subjects were also asked to indicate the number of full, associate and assistant professors in their current departments. It was felt that these variables might be surrogates for familiarity with overall worth differentials (e.g. salary) across academic staff grades. However, none of these indicators showed significant correlations with any of the percentile estimates and are not considered further in these analyses.

Results

Sixty-nine questionnaires were returned, giving a response rate of 41 per cent (69/169). Eighteen of these 69 questionnaires contained only qualitative responses (see Discussion) and were removed from analysis, leaving 51 usable questionnaires.

Estimates of SDy were obtained by computing the difference between the 50th and

Table 1. Mean estimates, by search committee chairpersons, of SDy according to type of frame and presentation order

	Frame	
Order of estimate	Positive	Negative
85th, then 50th		
M	$101 667	$46 098
SD	$125 921	$51 915
N	9	21
50th, then 85th		
M	$57 667	$29 222
SD	$53 222	$31 292
N	12	9

85th percentile estimates. Cell means for SDy, within-cell standard deviations and cell sizes are reported in Table 1. While approximately equal numbers of questionnaires were mailed out for each condition, the cell sizes for returned questionnaires ranged from nine to 21. Note that the mean estimates of SDy ranged from \$29 222 to \$101 667.

The correlation of the CLI index with estimates of the overall worth of a 50th percentile professor was $r = .390$ (significant at $p < .05$, with CLI data available for 31 of the 51 cities). This positive relation is as expected, i.e. regional cost-of-living differences probably affected marketplace salaries (and, hence, perceived dollar value) of individual academic staff members. However, when the *difference* between 50th and 85th percentiles (i.e. SDy) was correlated with CLI values, the correlation dropped to $r = .087$. It appears that the cost of living elevates both percentile estimates, but to the same degree, so that the difference between percentiles is relatively unaffected. Thus, the use of CLI as a covariate was dropped in subsequent analyses.*

It should be noted that the within-cell distributions exhibited extreme heteroscedasticity across conditions. Following the suggestion of Neter & Wasserman (1974), a series of graphic plots revealed that within-cell standard deviations were approximately linearly related to cell means – implying the need to use a logarithmic transformation in order to stabilize variances (Neter & Wasserman, 1974, ch. 15). Thus the analysis of variance reported in Table 2 is based upon log-transformed data; the statistics reported in Table 1 are based upon untransformed data.

Table 2. Analysis of variance of the effects of frame and presentation order on estimates of SDy[a]

Source	Sum of squares	d.f.	Mean square	*F* ratio	Omega^2
Frame (F)	5.69	1	5.69	4.21*	.06
Order (O)	0.88	1	0.88	0.65	.00
F × O	0.02	1	0.02	0.01	.00
Residual	63.29	47	1.35		

* $p < 0.05$.

[a] This analysis is conducted on log-transformed data. Also, cell sizes were unequal. Consequently, model III ('unique') sums of squares are reported.

The analysis of variance indicates a significant main effect for frame ($F(1, 47) = 4.21$, $p < .05$), and insignificant effects for order and the interaction of order and frame. The significant main effect for frame indicates that a positive (filling a vacancy) frame results in significantly higher estimates of SDy ($M = \$76\ 524$) than does a negative (creating a vacancy) frame ($M = \$41\ 035$).

* While not the focus of the current study, Hunter & Schmidt (1982) recommend that SDy can also be conservatively estimated by computing 40 per cent of the average salary across job incumbents (the so-called '40 per cent of salary rule'). The finding that CLI is correlated ($r = .39$) with estimates of 50th percentile professor worth has implications for the 40 per cent rule as well. For example, let us assume that the average salary in a geographical region is somewhat correlated with the CLI for that region. If this is so, then CLI values will be related to estimates of SDy (if the '40 per cent of average salary' rule is invoked). Thus, these estimates of SDy will be contaminated by the geographical location in which the study is conducted.

Discussion

The hypothesis that differential framing would significantly effect estimates of SDy was supported. The effect of order, as well as its interaction with frame, was insignificant. Thus, one contextual variable had a clear effect on estimates of SDy, the other did not.

Regarding frame, individuals who fill vacancies are valued differently from individuals who are leaving (and will thereby create a vacancy). More generally, we have shown that estimates of SDy using the Schmidt *et al.* (1979) estimation procedure are not robust to framing effects. In our study, the mean estimate using a positive frame was 86 per cent greater than the estimate under the negative frame! In judging the dollar value of performance, gain is not the cognitive equivalent of loss.

It is interesting to note that, in the study reported here, chairpersons of search committees tended to attribute greater variance in worth to full professors who might be acquired (positive frame). It is not immediately obvious why the difference is in this particular direction. However, the *acquisition* of a faculty member is precisely the *raison d'être* for the existence of a search committee. Thus, the positively framed task might have greater salience for the chairperson of such a committee and this 'acquisition' frame will then have greater associated variance/risk. (We might even expect the opposite effect for estimates by administrators making merit pay decisions, who want to prevent high performing professors from leaving.)

Given that utility analysis can be modified to assess the impact of a variety of organizational interventions (cf. Boudreau & Berger, 1985; Landy, Farr & Jacobs, 1982), this phenomenon might lead future researchers to employ appropriately *specific* frames, rather than combining frames, as the Schmidt *et al.* (1979) procedure implicitly does (with the terms 'cost' and 'value'). For example, if a utility analysis is focused on organizational programmes which attempt to reduce turnover, an explicitly negative frame (employee loss) might be used for obtaining estimates of SDy. If, however, a utility analysis is focused on selection tests, a positively framed scenario might be appropriate. More research is needed here, however, to determine whether such 'tailoring' of stimuli will provide more accurate estimates. In addition, utility researchers should continue to explore the impact of framing in future research. This is consistent with the advice of Fischoff, Slovic & Lichtenstein (1980) who suggest that deliberately varying such task parameters can reveal just how robust judgements are.

It should be noted that the above suggestion is a fairly radical departure from the way SDy estimation has traditionally been viewed. We are proposing that there is not necessarily a single value of SDy that can be estimated. Rather, multiple values of SDy exist and the choice depends upon the researcher/practitioner's purpose in generating a dollar utility estimate.

This view of multiplicity can also be supported by comparing our results with those of Shetzer & Bobko (1987). Essentially, those researchers asked *students* to estimate the overall worth of professors. While students are clearly not substitutes for on-the-job supervisors, they *are* 'point-of-contact' clients in the educative service provided by universities. Shetzer & Bobko found a significant effect for frame, but in the opposite direction, i.e. negative frame was associated with greater SDy estimates. This differential effect for type of judge indicates that different constituencies may approach the estimation of overall worth in distinct ways and that estimates of SDy using the Schmidt *et al.* (1979) techniques are not robust to this factor.

Thus, users of utility analysis may also need to tailor their estimation procedures and results to particular groups of constituencies (cf. Connolly, Conlon & Deutsch, 1980). As Boudreau's review notes, 'Existing research seldom explores whether utility analysis and SDy measures . . . reflect decision maker objectives and values' (in press, p. 22).

Other issues

It is noteworthy that the within-cell standard deviations for search committee judges are of the same magnitude as the mean estimates of SDy (see Table 1). This is consistent with earlier empirical research noted above. Further, attempts to control for regional differences in wage structure (through the cost of living index) did not change this result. Thus, even expert judges show substantial inconsistency in their estimates of SDy (see also Reilly & Smither, 1985). Again, estimation of SDy using these holistic techniques is questionable and more basic research on human judgement of individual worth is clearly needed.

Finally, there was no significant main effect for anchoring or its interaction with frame in the current study. This finding is consistent with the results of Shetzer & Bobko's (1987) investigation using student subjects. It is true that allowing judges to estimate 85th percentile performance first results in greater mean judgements of overall worth (raw data not reported in the tables). However, these judges also increased their 50th percentile estimate by an equivalent amount, so the difference (SDy) was unaffected by order.

Limitations and future research

There are three other aspects of the study that could also explain why no significant effects were found for anchoring or its interaction with frame. First, the cell sizes in the experimental design ranged from nine to 21 and the loss of statistical power associated with cell sizes as low as nine could explain the lack of significant findings for the order variable. On the other hand, it is noteworthy that frame did significantly affect SDy estimates in spite of these cell sizes. Perhaps future researchers could conduct studies in settings where larger numbers of supervisory-level judges are available.

Second, this study was based on responses to a mailed survey. While the pages of this survey were arranged in a predetermined order, there is no guarantee that respondents completed the survey in that order (e.g. they could have leafed through the entire survey and then responded in no particular order). If so, this could also explain why order effects were not significant for these data. Future researchers might consider more controlled experimental environments if order effects are factors of interest.

Thirdly, the reader should be reminded that 15th percentile ratings were not requested from judges. As noted earlier, there were two reasons for this: the experimental design would have been enlarged and cell sizes would have been further reduced; it was deemed unrealistic to consider hiring a full professor at the 15th percentile level of performance. On the other hand, several utility studies have found the estimation of 15th percentile performance to be quite informative, even to the extent that *negative* estimates of worth are given in spite of the demand characteristic to respond with non-negative numbers (see Bobko *et al.*, 1987, for a review of this issue). Thus, future researchers might reintroduce judgements about 15th percentile worth, depending upon the experimental setting. Given that 15th percentile estimates are even closer to 'zero' worth than other percentiles,

our hypothesis would be that anchoring/order effects might be stronger if such percentile estimates were included in the study.

Qualitative comments

While 51 search committee chairpersons sent back analysable responses, it is of interest to note that an additional 18 individuals returned questionnaires with written comments, rather than any numerical estimates of worth. The majority of these verbal responses indicated that the worth of academic staff was difficult to estimate – particularly the 'intangible' research, social and emotional contributions. Indeed, several other written responses dealt with the following possibility: if a 50th percentile full professor left, the vacancy might be filled by a person at the assistant professor level. In turn, the reasoning was that the university would actually *save* money (at least on salary) and therefore the overall worth of a departing 50th percentile full professor would be negative. Of course, this is not the question that was asked of judges. Further, these responses address the notion of marginal cost rather than the absolute worth of an individual staff member.

There are a variety of possible issues here. First, even though the judgemental task was explicitly stated, judges still interpret the estimation of SDy in idiosyncratic ways. For example, in a recent review of approaches to measuring economic effectiveness, Steffy & Maurer (1988) compare the *ex ante* or present value 'valuation base' to the *ex post* or acquisiton cost approach. One might speculate that, when faced with the departure of an employee, the immediate impact on search committee members is the 'cost' in time and expense to recruit, interview and select a replacement. Alternatively, with the hiring of an employee, the most salient consideration may be the value-added worth of the new colleague. Second, these idiosyncratic tendencies may be exacerbated by the fact that the job of 'full professor' is one of those positions where performance information can not easily be translated into a dollar metric (Reilly & Smither, 1985). On the other hand, almost any staff position in a private sector organization will have the same ambiguity associated with estimation of specific dollar worth. Of course, future researchers should attempt to extend these results to jobs where performance criteria can be directly tied to dollar valuation.

In summary, this study has demonstrated that estimates of the standard deviation of human performance using the Schmidt *et al.* (1979) technique are *not* robust to contextual effects. If implemented, this technique should be used with caution and the context of application should help determine how estimates are obtained from judges (e.g. positive vs. negative frame). In addition, other methods for estimating SDy have been proposed which are derived from human resource accounting, cost accounting, economic and salary-based perspectives (e.g. Cascio & Ramos', 1986, CREPID technique or Roche's, 1965, cost accounting procedure). While the convergence of these methods has been examined (Greer & Cascio, 1987; Weekley, Frank, O'Connor & Peters, 1985), as well as the stability of estimates across countries (Smith, 1989), it still remains to be determined if these more objectively based techniques are less susceptible to particular contextual effects. Such systematic study would definitely enhance our basic understanding of the valuation of human worth at work and would also provide increased precision in the application of utility estimates.

Acknowledgements

We wish to thank Rutgers' Coordinating Council of Business Studies for partial support of this project and two anonymous reviewers for their helpful comments.

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Received 6 March 1990; revised version received 29 October 1990

Appendix

Positively framed instructions

Please assume that your current department has a vacancy for a full professor in the area of organizational behaviour. In the two questions on the next page, your task is to estimate the overall gain to your university, stated in dollars, from the addition of an individual professor filling this vacancy. In answering these questions, you will have to make some very difficult judgements. We realize that they are difficult and that they are judgements or estimates. There is probably no way that you can be absolutely certain your estimate is accurate when you do reach a decision. We do not expect your estimate to be accurate down to the last dollar, and will be accordingly averaging your estimates with those of other search committee members.

Based on your knowledge as a search committee member, we would like you to estimate the yearly gain if an *average* full professor were to fill this vacancy. Consider both the quality and quantity of output (including all dimensions of academic performance) typical of the average full professor, and the value of this output to your university.

Based on my experience, I estimate the yearly gain to my university resulting from the addition of an *average* full professor to be _____ dollars per year.

We would now like you to consider the gain resulting from the addition of a *superior* full professor. Let us define a *superior* full professor as one who is at the 85th percentile. That is, his or her performance is better than that of 85 per cent of his or her fellow full professors, and only 15 per cent turn in better performances. Consider both the quality and quantity of output (including all dimensions of academic performance) typical of the superior full professor and the value of this output to your university.

Based on my experience, I estimate the yearly gain to my university resulting from the addition of a *superior* full professor to be _____ dollars per year.