SAND2017-10003C

Value Oriented Salary Band Structure Design

Most large organizations link employee salaries to an internally defined salary band structure. These structures are typically market-based, representing a simplified conception of external market salary data aggregated into a series of discrete steps. Salary band structure design involves a tradeoff between discretization error, fit to market, simplicity, and expectation setting for employees regarding salary prospects. Frequently, Human Resources fits a geometric growth model adapted from financial future value calculations to the band midpoint salaries. While this approach constitutes an established modern practice, it does not consider personnel job frequency, thereby amplifying the impact of outliers and the supra-geometric growth often seen among top salaried positions. Moreover, mounting evidence suggests that employee perceptions and reactions to corporate salary decisions are guided by their interpretations of fair compensation and expectations regarding employment alternatives, and that these reactions are exaggerated among the lower quantiles. Consequently, asymmetric loss functions may be essential for optimizing salary structures in light of the substantial costs associated with employee turnover and disengagement. A generalized approach is presented here that employs nonlinear modeling to accommodate acceleration of executive salaries while minimizing discretization and market fit errors, and includes asymmetric loss functions based in experimental psychology to explore optimization of net value to the organization.

Introduction

Large organizations typically tie employee salaries to a market-informed internally defined structure. A series of bands is often used, with band midpoint salaries on a fixed-increment geometric progression. The benefits of salary band structures include simplification and stabilization of complex, fluctuating market reference data, and the creation of clear boundaries between salaries by job level. Liabilities include divergence from market norms due to discretization, with roughly half of the jobs positioned below market, leading to retention, hiring and/or salary compression challenges. Standard approaches to salary structure design also fit band structure parameters by the collection of jobs and market references, without consideration of population by job and level, unnecessarily exacerbating these challenges. These populations may be highly variable.

The main premise of this case study is that superior band structures may be designed by considering job-level populations and allowing for varying band-to-band midpoint increments. A further premise is that the best choice of loss function for band structure fitting may not be symmetric if the impacts of the band structure on organizational performance outcomes are considered. Human

perceptions in relation to compensation are demonstrably non-linear, so that the perceived loss associated with a positive excursion may radically differ from that due to an equal but opposite excursion.

A wide variety of factors [1, 2] have been posited as possible antecedents to turnover intent or turnover. Many of these factors do not directly depend on employee compensation (e.g., social ties, leadership, personal fit to job, autonomy, etc.). Individual cultural values play a role as well: organizational commitment for individualistic employees is built upon satisfaction from the work and promotion opportunities, whereas for more collectivist employees it is heavily influenced by the quality of the employee-supervisor relationship [3].

Among the turnover related factors that are impacted by compensation, research indicates that at least under certain circumstances, employees are more concerned with relative standing within the organization than in comparisons to an external reference frame [4]. This tendency may not hold for high income professionals, whose turnover intentions strongly depend on perceived alternative employment opportunities [5]. Assuming such professionals tend toward individualism, this is in keeping with their organizational commitment factors as noted above. On the other hand, highly ambitious, optimistic employees may form unrealistically high salary growth expectations, leading to a propensity for turnover and low long-term job satisfaction [6].

In past decades, the literature on turnover was dominated by studies of turnover *per se*, or intent to quit, with little empirical information regarding the impacts of changes in turnover rate on organizational performance. A 2013 meta-analysis by Park and Shaw [7], however, integrates and summarizes the evidence from 255 scholarly works, for several measures of organizational performance ranging from most proximal (Customer Satisfaction, Employee Work Attitudes) to moderately proximal (Workforce Productivity, Quality) to distal (Financial Performance). The correlations of these outcomes with turnover are all robust, in that over their 95% confidence intervals they maintain directionality (sign).

Employee turnover has been noted as a key driver of organizational performance outcomes, including financial performance. The limits of organizationally sustainable compensation are determined by financial performance, in the long run (i.e., steady state). Turnover is to some extent influenced by compensation. Taken together, these considerations constitute a closed feedback loop (although part of a much more complex system) that may be used to assess the impacts of changes in compensation policy on organizational performance, via turnover.

Mathematical Relationships of Salary Band Structure Design

A fixed-increment geometric progression is recommended practice in the design of salary band structures[8]. The form of this approach is in many respects identical to that used for financial calculations of future value and it is often referred to as the "Future Value" model. The band structure is intended to provide a simplified representation of the assessed and adjusted market rates for each job within the organization. This simplification is produced by collapsing the market reference values for all jobs onto a finite number of geometrically spaced salary band midpoints. Key design variables are presented in Table I.

Table I. Definition of Variables for Salary Band Structure Design.

I = **Fixed Increment**	D_1 = **Lowest Midpoint**
i = **Variable Increment**	D_N = **Highest Midpoint**
N = **Band Count**	D_n = **Midpoint of Band**
n = **Band Number**	D_J = **Market Reference**

As shown in Equation (1), the geometric growth aspect is handled by logarithmic transformation (a log-linear fitting approach). Each job is assigned a band (n) and a band midpoint salary (P_J , equivalent to D_n for the band number assigned to that job) by rounding of the exponent to the nearest whole number between 0 and $N-1$, inclusive.

$$P_J = D_1 \times (1+I)^{Round\left(\left[\frac{\log(D_J/D_1)}{\log(1+I)}\right]\right)} \qquad (1)$$

The elemental loss function for least-squares fit of the salary band structure to the market data is as shown in Equation(2):

$$Loss = \left[\log\left(\frac{D_n}{D_J}\right)\right]^2 \qquad (2)$$

Summation of the elemental loss across the population governed by the band structure yields the total variance, adjusted for the implicit logarithmic transformation. Optimal fit of the band structure to the adjusted market reference data is performed in the usual fashion (*i.e.*, by minimizing aggregate loss), however, minimizing the loss necessitates an increase in the number of bands, with matching reduction in the fixed increment. The increment is usually constrained by

Human Resources organizations as a means of ensuring appropriate progression in salary between, *e.g.*, two consecutive levels of the same job, leaving no further latitude for optimization.

On the other hand, it is well understood that the increments between job levels for less-skilled, generally lower-paid workers are often proportionately smaller than those between levels of higher-paid, more specialized positions. Adaptation of the Future Value model to accommodate variable-increment progression allows additional latitude for optimization of fit, even if the number of bands in the structure is fixed.

The product of all increments must remain constant regardless of whether a fixed or variable-increment implementation is used:

$$\prod_{n=1}^{N-1}(1+I)=\prod_{n=1}^{N-1}(1+i) \qquad (3)$$

For the product of a series of increasing variable increments to match the product of the fixed increments, the initial variable increment must be less than the fixed increment, thus:

$$i_1 = \varepsilon \cdot I \qquad (4)$$

where ε represents the applied reduction factor. It can be shown that the midpoint value for each salary band is then:

$$D_n = D_1 \cdot e^{\varepsilon\cdot(n-1)\cdot\ln(1+I)\cdot e^{\left(\frac{n-1}{N-1}\cdot\ln(1/\varepsilon)\right)}} \qquad (5)$$

In this variable-increment salary band structure design approach, ε is an adjustable fitting parameter. Choosing $\varepsilon = 1$ results in the fixed-increment design. For $0 < \varepsilon < 1$, smaller values preferentially shift the bands of the salary structure toward the lower pay ranges, as shown in Figure 1. In this example, $N = 20$, and the low and high band midpoints are $10,000 and $200,000, respectively.

Data Acquisition and Preparation

Two sets of personnel job, level, and salary data were obtained from the State of Florida website (http://salaries.myflorida.com) on January 30th, 2017 and August 29th, 2017, respectively. A crosswalk table mapping most of those jobs to Florida's Standard Occupation Classification (SOC) based broadband designations was also obtained. Recent salary survey data by SOC code for

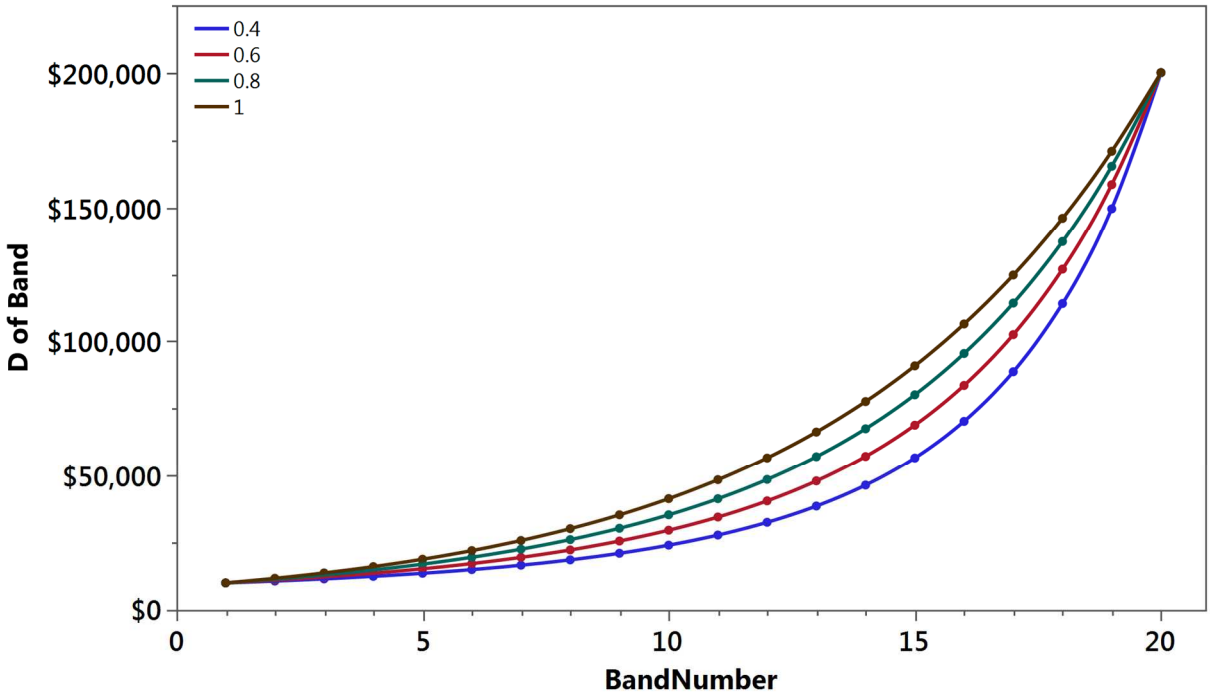

Figure 1: Dependence of band midpoint salary *vs.* band number profile on ε.

Florida were obtained from the U.S. Bureau of Labor Standards (BLS) website (www.bls.gov). Florida's codes were updated to reflect changes between the 2000 and 2010 versions of the SOC system.

Personnel Data Sets

As provided, the personnel data of January 30th, 2017 (primary data set) comprised 112,201 records. Due to limitations in the data and metadata, a substantial portion of those records were eliminated in preparation for analysis. For example, certain State of Florida Agencies are not properly represented in the available salary structure crosswalk file, thus records for those agencies were removed. Also, data necessary for proration of part-time employees were unavailable; therefore, all part time employees were removed. Represented personnel salaries are set by special negotiations and are therefore not appropriate for inclusion in a market-based dynamic construct, so those were removed as well. After removing problematic data, 87,158 records remained.

As provided, the personnel data of August 29th, 2017 (secondary data set) comprised 112,262 records. These data were trimmed in a manner similar to that used for the primary data set.

Combined Data Set

Baseline salary band structure analyses were performed using the primary data set, however, a combined data set was created to assess turnover. Due to the lack of unique personnel identifiers, the primary and secondary data sets were joined using name, surname, and middle initial. Employee transition data are not provided by the State of Florida. Personnel present in the primary data set but absent in the secondary data are assumed to have separated.

Analysis and Results

Range vs. Salary Decile

A key assumption behind this variable-increment salary band structure design approach is that the progression of salaries between levels (or grades) of the same occupation is comparatively modest near the low end of the salary scale, increasing for generally higher-paid occupations. The U.S. Bureau of Labor Standards does not report salaries by job level; however, it does provide certain salary distribution quantiles. Using the median-normalized range between the 10^{th} and 90^{th} percentiles as a rough gauge of salary dispersion within an occupation, the smaller dispersion of lower-paid occupations becomes apparent (see Figure 2).

Aggregate loss vs. ε and band count

The least-squares elemental loss for an individual datum is given in Equation(2). Summation of the elemental loss across the entire population for a range of values for ε and N, respectively, yields the contour map shown in Figure 3. Notably, regardless of N, the value of ε for minimum aggregate loss is less than unity. In other words, in no case did the standard fixed-increment model yield the best fit, as shown more clearly in Figure 4.

Separations Model

Employee turnover was estimated as all personnel present in the first personnel data file who were not present in the second file. The total turnover is simply the quotient of separations and the initial population. Although various forms of turnover are discussed in the literature – voluntary separations, retirements, reductions in force, involuntary separations, *etc.* – the Florida employee data lack indicators enabling further detail regarding turnover type.

Figure 2: Salary dispersion vs. median salary decile of occupation.

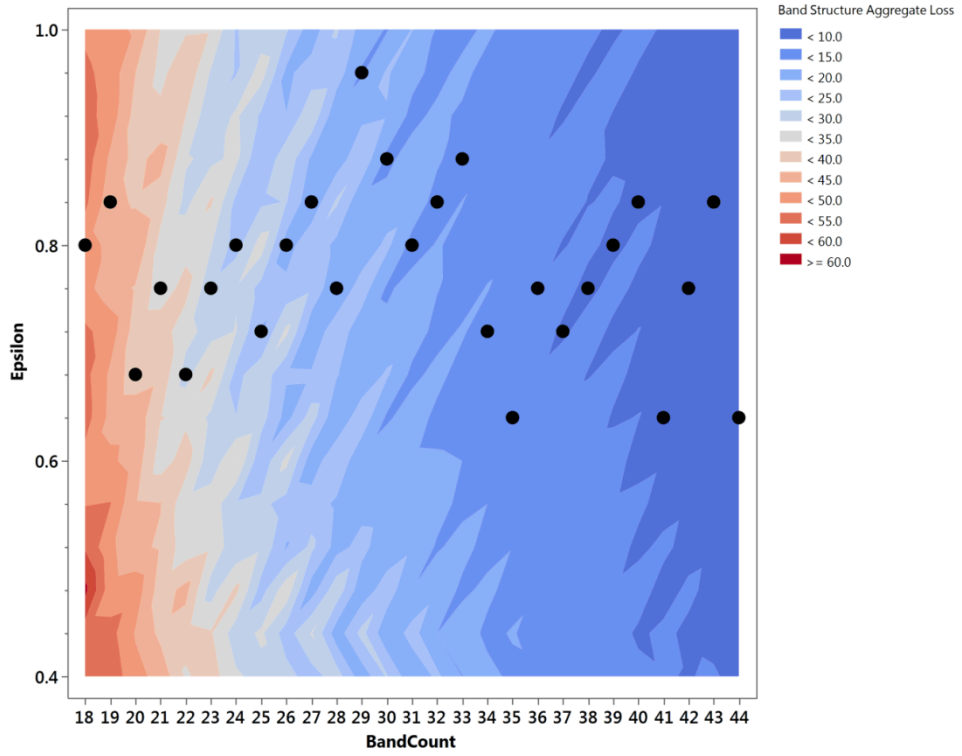

Figure 3: Aggregate loss vs. band structure design parameters. Based on Florida personnel salary data of January 30th, 2017. Black dots indicate minimum aggregate loss by band count.

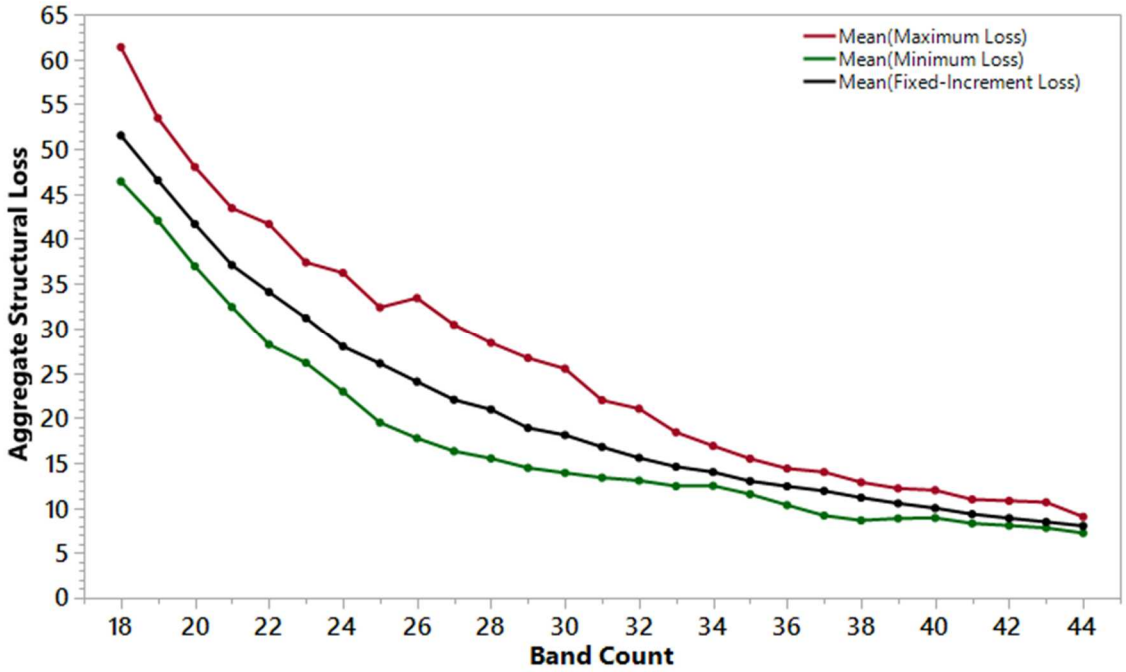

Figure 4: Aggregate band structure loss by band count. The fixed-increment loss is obtained for $\varepsilon = 1$.

The literature cites many antecedents to turnover. Many of these are subjective criteria such as relationship with supervisor, relationships with colleagues, personal values, etc., that are not captured in the available data. Among the cited factors, years of service and salary are available. Salary position relative to peers has also been cited as an important criterion, but nonlinear in that it is tied to significant increase in turnover intentions and turnover among the lower quantiles, but there is no significant decrease in turnover for those paid above the median.

A logistic model was generated featuring years of service (log transformed), regional median relative salary (salary divided by the Florida median of $31,810), and negative rectified internal relative salary (absolute value of salary relative to internal median by SOC, treating salaries above the median as zero). A weighting factor was used to annualize the model. The effect of the rectified internally referenced salary is modest but significant. By contrast, when the unrectified salary was used the effect was not significant $(p \approx 0.27)$. The model fit reports for these alternatives are shown in Figure 5. The model based on the Log YOS, RM Relative Salary, and NRI Relative Salary was chosen for further analysis and simulations.

A.

Nominal Logistic Fit for Employment Status

Effect Summary

Source	LogWorth	PValue
Log YOS	421.336	0.00000
RM Relative Salary	18.390	0.00000
NRI Relative Salary	4.780	0.00002

Converged in Gradient, 4 iterations
Freq: Weighting Factor

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1383.334	3	2766.669	<.0001*
Full	41289.196			
Reduced	42672.531			

RSquare (U)	0.0324
AICc	82586.4
BIC	82623.8
Observations (or Sum Wgts)	85729.9

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	72265	33848.154	67696.31
Saturated	72268	7441.042	Prob>ChiSq
Fitted	3	41289.196	1.0000

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	-0.7816655	0.0276458	799.43	<.0001*
Log YOS	-0.2624587	0.0059469	1947.8	<.0001*
RM Relative Salary	-0.1771557	0.0203244	75.98	<.0001*
NRI Relative Salary	0.44596711	0.1028378	18.81	<.0001*

For log odds of Separated/Continuing

Effect Likelihood Ratio Tests

Source	Nparm	DF	L-R ChiSquare	Prob>ChiSq
Log YOS	1	1	1932.3072	<.0001*
RM Relative Salary	1	1	79.8329747	<.0001*
NRI Relative Salary	1	1	18.5459525	<.0001*

B.

Nominal Logistic Fit for Employment Status

Effect Summary

Source	LogWorth	PValue
Log YOS	430.913	0.00000
RM Relative Salary	15.536	0.00000
Internal Relative Salary	0.574	0.26689

Converged in Gradient, 4 iterations
Freq: Weighting Factor

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	1374.678	3	2749.356	<.0001*
Full	41297.853			
Reduced	42672.531			

RSquare (U)	0.0322
AICc	82603.7
BIC	82641.1
Observations (or Sum Wgts)	85729.9

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	72406	33908.488	67816.98
Saturated	72409	7389.365	Prob>ChiSq
Fitted	3	41297.853	1.0000

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept	0.67731899	0.0474222	204.00	<.0001*
Log YOS	0.26619032	0.005959	1995.4	<.0001*
RM Relative Salary	0.18357047	0.0229169	64.16	<.0001*
Internal Relative Salary	0.06180103	0.0556856	1.23	0.2671

For log odds of Continuing/Separated

Effect Likelihood Ratio Tests

Source	Nparm	DF	L-R ChiSquare	Prob>ChiSq
Log YOS	1	1	1976.3864	<.0001*
RM Relative Salary	1	1	66.8627324	<.0001*
Internal Relative Salary	1	1	1.23266724	0.2669

Figure 5: Logistic separations model comparison. The negative rectified internal relative salary is significant (A), whereas the unrectified internal relative salary (B) yields a comparatively poor fit.

The R Square(U) (McFadden's pseudo R^2) value of the model is low, indicating that the model is not capable of accurately predicting specific cases. More importantly for the purposes of this analysis, however, from a probabilistic perspective the model does represent the general turnover behavior of the population reasonably well (see Figure 6). The turnover probability contours and population scatterplot are shown in Figure 7.

Aggregate Turnover

Given the importance of turnover to organizational performance, examination of aggregate turnover probability versus band structure design parameters seems worthwhile. The resulting estimated separation rate contour plot is shown in Figure 8. This map is based on convergence of the salary distributions by SOC code to their respective band midpoints instead of on the salaries directly, and thus represents a plausible long-term outcome if employee salaries were normalized to the band structure. Notably, the impact of band structure design parameters on turnover is very modest, with no obvious trend in relation to either $\boldsymbol{\varepsilon}$ or $\boldsymbol{N}$.

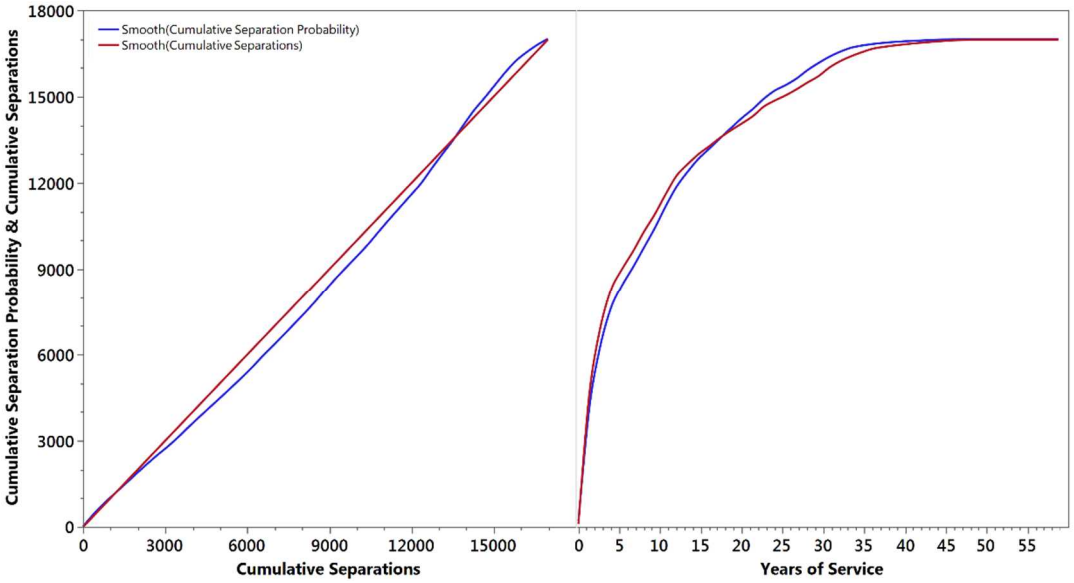

Figure 6: Modeled cumulative separation probability vs. actual cumulative separations. Personnel data ordered by years of service.

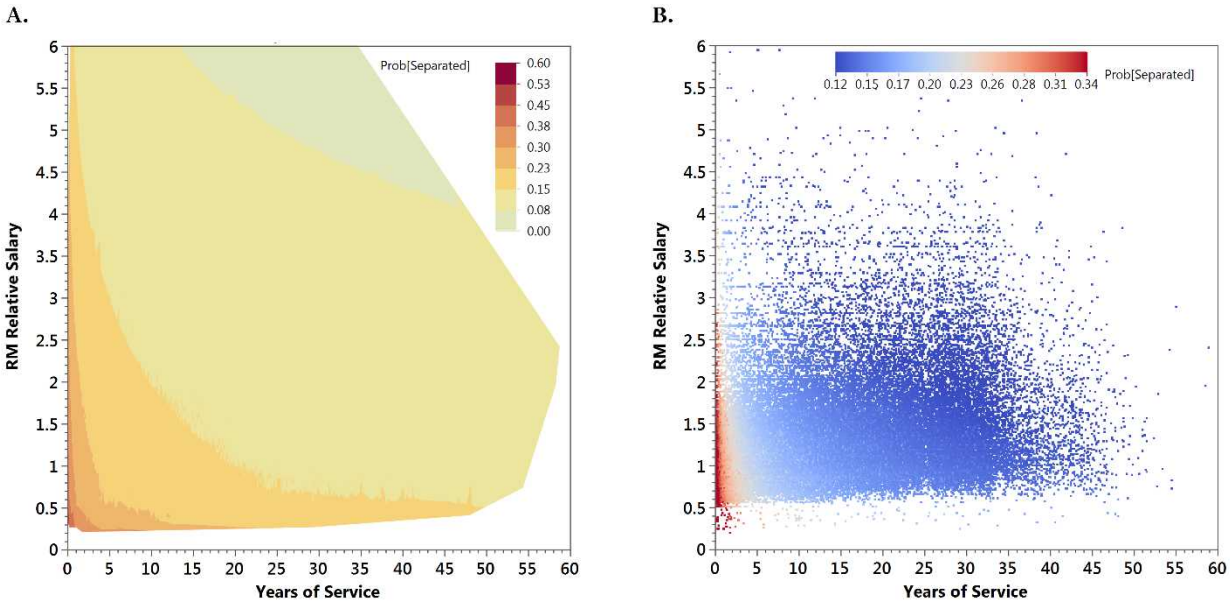

Figure 7: Separation probability by years of service and regional median relative salary. (A) Contour map. (B) Scatterplot of individuals using a 5th to 95th percentile truncated scale to highlight extremes.

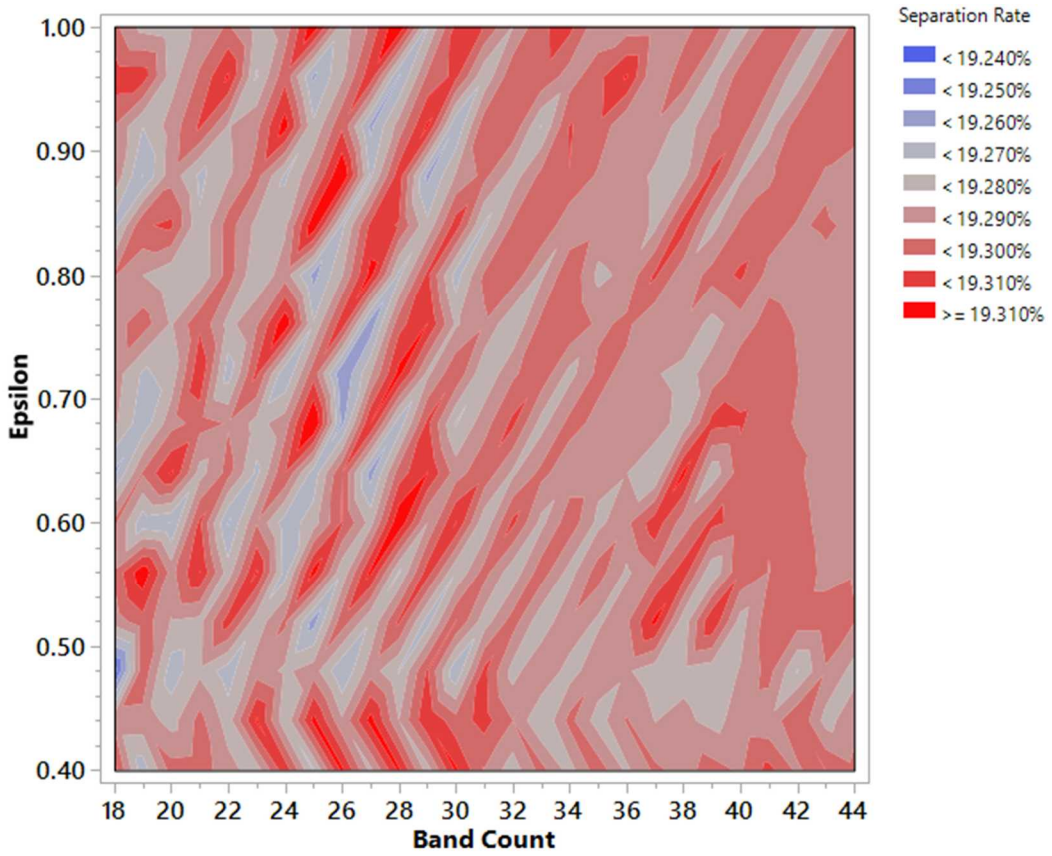

Figure 8: Separation rate vs. band structure parameters.

Impact of Organizational Longevity

The apparent immunity of turnover to band structure design is unsurprising if the strong dependence of the turnover model on years of service is considered. Most of the population have been incumbent long enough for the Log YOS factor to dominate, substantially reducing the impact of modest financial shifts due to accommodation of the band structure. It is possible that turnover would be more susceptible to band structure design in a more recently established organization where the dominance of the Log YOS term is perforce reduced.

In order to evaluate this possibility, the years of service of the actual employee population were prorated to simulate the distribution of the compressed YOS ranges of younger organizations. The maximum YOS is taken as a surrogate for organizational longevity. The resulting profile of separation rate *vs.* organizational longevity (see Figure 9) shows that turnover rate is dominated by longevity regardless of the band structure design parameters.

Total compensation is another lever available to organizations. Broad-based salary increases will not affect NRI Relative Salary, but will impact RM Relative Salary. A sensitivity analysis was performed (Figure 9). Based on this model, the unit cost to improve retention through salary policy is prohibitively high for most organizations.

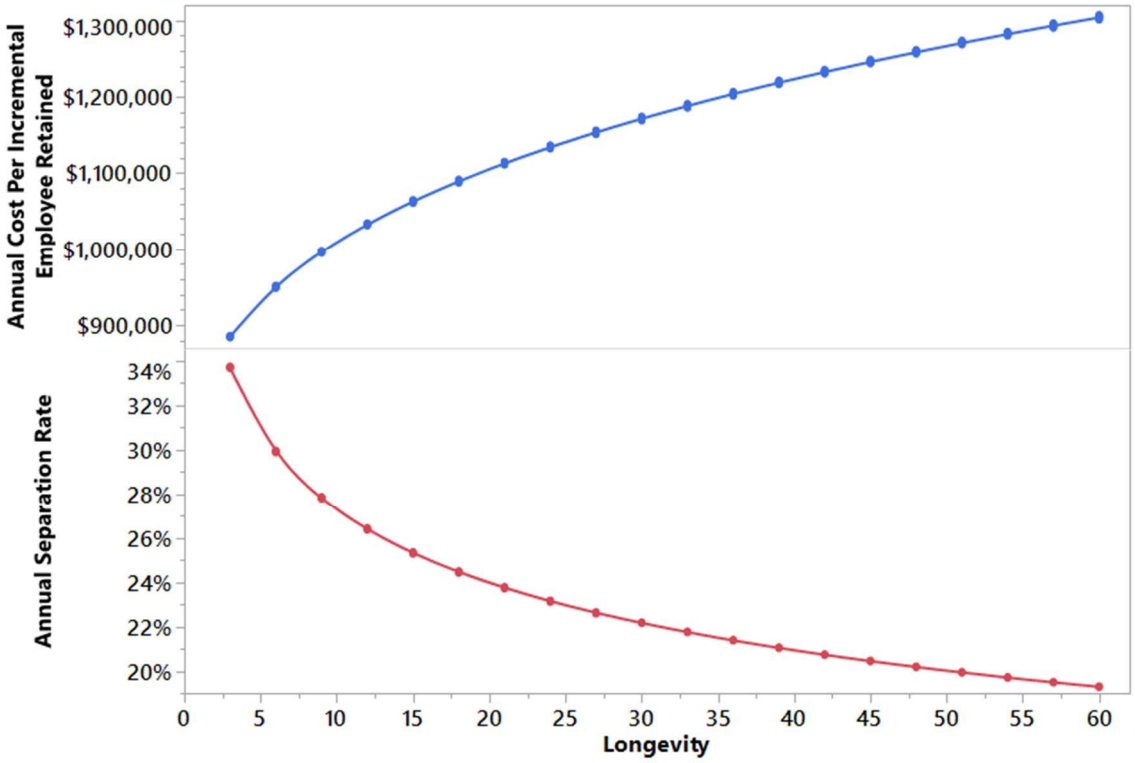

Figure 9: Impact of organizational longevity on separation rate and retention costs.

Discussion and Concluding Remarks

The main premise of this paper has been demonstrated. The aggregate mismatch between employees' market salary estimates and the midpoints of a salary band structure strongly depends on the nature of that structure. Discretization error is substantially reduced by increasing the band count, at the expense of creating a more complicated structure with smaller steps between job levels. The standard fixed-increment approach to band structure design can be improved upon by using an accelerating-increment approach that places a greater number of more closely spaced bands among relatively low-paid jobs.

By contrast, the secondary premise of this paper – the benefit of using asymmetric loss functions tied to organizational outcomes – has been shown to be of limited practical value, at least regarding turnover and its financial levers. Turnover is dominated by duration of incumbency. Turnover rate is impacted by salary, but that impact rapidly diminishes over time. If an employee has not left within the first few years, salary has little net impact across the population. Thus, while targeted salary adjustments may affect the decisions of individuals, broad-based salary policy is a weak lever on turnover in general.

Notably, the logistic separations model developed here corroborates the work of Card, *et al.,* who found that salary relative to peers may be a more powerful influence on turnover intentions than absolute salary or salary in relation to external references [4]. This effect was only significant for employees with salaries below the median of their peers. For those above the median, the effect was negligible. In Card's experiment, the effect was amplified by making the test subjects suddenly aware of their relative salary position. The model developed here indicates that employees have sufficient awareness to be influenced over the long run without external intervention.

The results above are based on compensation data from a single organization that fortuitously uses the SOC system, enabling market referencing without resort to proprietary salary surveys. These limited data have been extrapolated in two substantive ways to offer insights regarding impacts of compensation policies on turnover, a noted lever on organizational performance.

First, a snapshot of turnover between two dates 30 weeks apart was annualized and captured in a logistic model, and this model was assumed to represent typical behavior. Periodic sampling over a longer time frame would enable improved data pre-processing for timely interpretation of roster changes, and the development of parametric survival models for better understanding of the driving factors and stability of hazard rate over time.

Second, the turnover model was assumed to hold for prorated years of service values in order to shed light on how the behavior of employees in more recently established organizations might be affected by band structure or compensation. This approach provides a plausible distribution for examining trends and developing hypotheses but should not be expected to match any specific real-world case. Nor should the logistic model used here – generated from personnel behavior in a large, stable organization with relative job security – be expected to accurately represent separations probabilities for the employees of a recently established developing firm subject to market forces.

With these caveats in mind, this analysis underscores the common finding that salary is generally a modest factor influencing employee behavior. Blanket increases in salary relative to local norms may not be cost-effective for improving employee retention. Targeted salary interventions for employees with few years of service may be more impactful, but such changes may create salary compression that could lead to disengagement of long-term employees.

Given the limited leverage that salary has on employee retention, most organizations may be better served by focusing on other antecedents to turnover. Management can impact employee perceptions by working to develop stronger employee-supervisor relationships, creating an environment that encourages partnership and teamwork, communicating pathways for advancement, encouraging employee development, *etc.* Collectively, these human factors appear to be more influential and are assuredly more cost effective than using compensation policy alone.

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