A Mathematical Framework for Calculating Employee Compensation

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While the framework for determining the compensation of a new employee is well established, the framework for adjusting compensation over a period of time is not. This paper derives a closed-form expression for the minimum amount by which an employee's compensation must be adjusted taking into account changes in economic conditions since the start of employment. It then uses real-world data from the Finance, Insurance and Real Estate industry to demonstrate the practical usefulness of the framework.

INTRODUCTION

It is standard practice for employers to determine a *new* employee's compensation by obtaining survey data for comparable positions and then adjusting it for employer-specific factors such as size, geographic location, etc. (*AFP Compensation Report*, 2013; Murphy, 1999; Newton, 2002; Pomering & Lyon, 2000). The method for adjusting compensation *over a period of time* is, however, less well-established. Many employers use the maturity curve method. This method uses survey data for a particular job-title to estimate the relationship between salary and number of years since bachelor's degree, and then utilizes the estimated relation to adjust salaries for employees in that job title. Unfortunately, the method suffers from several drawbacks. For example, the survey data might be inaccurate since it is self-reported by employers, unrepresentative if the sample size is too small or if labor market conditions are changing rapidly, unavailable for a job-title, or too expensive to purchase (Ch. 9 in Berger & Berger, 2008).

This paper develops an alternative method that is based on an economic principle and uses employee-specific information rather than survey data. The intuition underlying this method is as follows. The starting salary allows an employee to purchase a certain quantity of goods and services. This quantity will not remain constant over time; rather, it will vary over time as prices respond to changing economic conditions. Thus, at the very minimum, compensation should be adjusted so that an employee is able to purchase the same quantity of goods and services at the current price level as at the start of employment. Simply put, an employee's compensation should be adjusted so that his/her purchasing power remains identical to that at start of employment. The paper models this intuition and derives a formula for an employee's cash compensation in any year since the start of employment.

Next, the paper demonstrates the practical usefulness of this method by using it to gauge the appropriateness of compensation packages in the Finance, Insurance, and Real Estate Industry (FIRE). The results suggest that regardless of the frequency of adjustments and year of start of employment, compensation in this industry is appropriate i.e. actual compensation is higher than the one suggested by the method; the exception is employees who started employment during the recent financial crisis.

The remainder of the paper is organized as follows. The next section discusses the different components of compensation. The subsequent two sections derive the formula for the cash compensation and illustrate how it can be used in practice, respectively. The last section concludes.

COMPONENTS OF CASH COMPENSATION

The cash compensation of a new employee typically consists of (i) a starting salary and (ii) an incentive payment. The salary is a guaranteed payment received by the employee each year. The incentive payment, on the other hand, rewards superior performance, if any, by making a one-time lump-sum payment. Every few years, an employee's cash compensation is adjusted to account for various factors. For example, increases in the economy-wide price-level might justify a cost-of-living adjustment.[1] Similarly, changes in an employee's skill set – obtaining an advanced degree, obtaining a professional certification, exceeding a threshold for years of service with an employer, etc. – might justify an increase; this is typically paid in the form of a merit payment, and in contrast to an incentive payment, *permanently* increases the employee's cash compensation. Thus, at any time since the start of employment the cash compensation payable to an employee will consist of not only the starting salary and a possible incentive payment for the most recent evaluation period, but also a cost-of-living adjustment (COLA hereafter), and all merit payments – for all evaluation periods since the start of employment including the most recent evaluation period i.e.

Cash Compensation=StartingSalary + IncentivePayment + COLA + AllMeritPayments

Of the four components, only the incentive payment is not guaranteed. The remaining components are guaranteed and collectively referred to as the annual salary i.e.

AnnualSalary =StartingSalary + COLA + AllMeritPayments

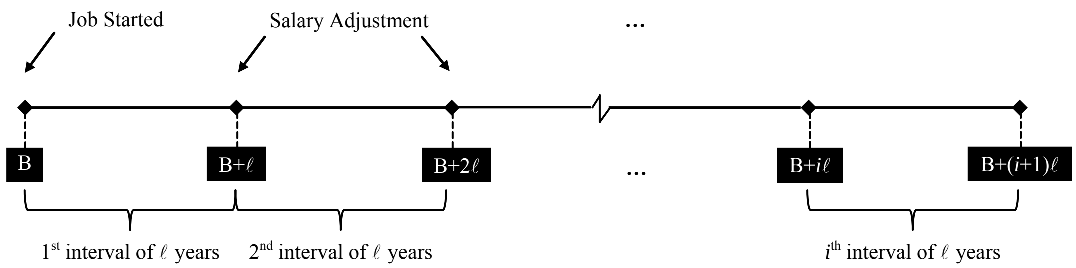
The next section derives a closed-form expression for what the annual salary *should be* in any year since the start of employment (normative salary hereafter). The actual salary received by the employee could be higher or lower.

MODELING CASH COMPENSATION

I begin by deriving formulas for the first and second interval since the start of the job, and then extend these results to a generic interval. The notation is as follows: *S* denotes the *annual* salary. When used with a superscript 'n' it denotes the normative salary ($S^{n}_{\cdot,\cdot}$) and with a superscript 'a' it denotes the actual salary ($S^{a}_{\cdot,\cdot}$) paid by the employer, which need not be identical to the normative salary. π denotes the *annual* realized inflation. Flow variables such as the salary ($S^{\cdot}_{\cdot,\cdot}$), inflation ($\pi^{\cdot}_{\cdot,\cdot}$) and adjustment terms ($A^{\cdot}_{\cdot,\cdot}$) have two subscripts to indicate the interval over which the said variable applies. Level variables such as price level ($P_{\cdot}$) have a single subscript to indicate the point in time the said variable applies. Finally, a superscript 'e' denotes the expected value of the variable under consideration.

Consider an individual who started working at the end of year B (in the past) at an annual salary of $S^{a}_{B,B+\ell}$ dollars. He received this amount for each of the next ℓ years. Currently, it is the end of the (B+ℓ)th year and the price level is $P_{B+\ell}$; after ℓ years it is expected to be $P^{e}_{B+2\ell}$. These details are shown in Figure 1.

FIGURE 1
TIMELINE FOR SALARY ADJUSTMENTS



Analysis of the First Interval

The normative salary for each of the next ℓ years ($S^{n}_{B+\ell,B+2\ell}$) can be written as the sum of the starting salary ($S^{a}_{B,B+\ell}$), an adjustment term which can be positive, negative or zero, and a merit payment. The adjustment term is required because the individual's purchasing power has changed from the time he/she was hired in year B – he was able to buy $\frac{S^{a}_{B,B+\ell}}{P_B}$ baskets at the time of hire, but might not have been able to buy the same number of baskets in each of the past ℓ years due to changes in the price level.[2] In addition, his purchasing power will change as the price level changes during the *next* ℓ years. The adjustment term therefore consists of two components: the first term represents compensation for *historical* changes in the cost-of-living ($A^{HCOL}_{B,B+\ell}$) and the second term for *expected* changes in the cost-of-living ($A^{ECOL}_{B+\ell,B+2\ell}$). The merit payment term reflects a permanent increase in the starting salary and is determined by events during the past ℓ years, but results in additional compensation for the next ℓ years. Thus, the normative salary can be written as

$$S^{n}_{B+\ell,B+2\ell} = S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{ECOL}_{B+\ell,B+2\ell} + M_{B+\ell,B+2\ell} \quad \ldots(1)$$

Expression for $A^{HCOL}_{B,B+\ell}$

To account for the historical change, the employer must adjust the starting salary. The employer cannot adjust the salary so that the purchasing power would have been $\frac{S^{a}_{B,B+\ell}}{P_B}$ in each year. The reason is that the employer pays the same dollar amount in each year due to which the numerator remains constant; the denominator, however, changes since the price level changed over the last three years. Hence, the adjustment will be such that the *average* number of baskets he could have bought over the last ℓ years equals that in year B:

$$\frac{\left(\frac{S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell}}{P_{B+1}} + \frac{S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell}}{P_{B+2}} + \cdots + \frac{S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell}}{P_{B+\ell}}\right)}{\ell} = \frac{S^{a}_{B,B+\ell}}{P_B}$$

Rearranging the terms gives us the following expression for $A^{HCOL}_{B,B+\ell}$:

$$A^{HCOL}_{B,B+\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell}}{P_B \cdot \left(\frac{1}{P_{B+1}} + \frac{1}{P_{B+2}} + \cdots + \frac{1}{P_{B+\ell}}\right)} - S^{a}_{B,B+\ell} \quad \ldots(2)$$

The summation in the denominator of the first term on the right hand side can be simplified. If we let $\pi_{B,B+\ell} \equiv \left(\frac{P_{B+\ell}}{P_B}\right)^{\frac{1}{\ell}} - 1$ denote the annual inflation during the past ℓ years, the summation can be written as $\left(\frac{1}{P_B \cdot [1+\pi_{B,B+\ell}]} + \frac{1}{P_B \cdot [1+\pi_{B,B+\ell}]^2} + \cdots + \frac{1}{P_B \cdot [1+\pi_{B,B+\ell}]^\ell}\right)$. Factoring out the common term P_B, we are left with the sum of a finite geometric series with a common ratio $\frac{1}{1+\pi_{B,B+\ell}} < 1$. Using the formula for the sum of the first ℓ terms of a geometric series simplifies the summation to $\frac{1}{P_B} \cdot \frac{1}{\pi_{B,B+\ell}} \cdot \left(1 - \frac{1}{[1+\pi_{B,B+\ell}]^\ell}\right)$.[3] Substituting this into Equation 2 gives us the following formula:

$$A^{HCOL}_{B,B+\ell} = \frac{\ell \cdot S^a_{B,B+\ell}}{\frac{1}{\pi_{B,B+\ell}} \cdot \left(1 - \frac{1}{[1+\pi_{B,B+\ell}]^\ell}\right)} - S^a_{B,B+\ell} \qquad \ldots(3)$$

Expression for $A^{ECOL}_{B+\ell,B+2\ell}$

To account for the expected change, the starting salary must be adjusted (in addition to the historical adjustment) so that the average purchasing power during the next ℓ years equals that in year B. In other words, on average during the next ℓ years the employee must be able to purchase the same number of baskets as he/she could at the time of hire:

$$\frac{\left(\frac{S^a_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{ECOL}_{B+\ell,B+2\ell}}{P^e_{B+\ell+1}} + \frac{S^a_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{ECOL}_{B+\ell,B+2\ell}}{P^e_{B+\ell+2}} + \cdots + \frac{S^a_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{ECOL}_{B+\ell,B+2\ell}}{P^e_{B+2\ell}}\right)}{\ell} = \frac{S^a_{B,B+\ell}}{P_B}$$

Rearranging the terms gives us the following expression for $A^{ECOL}_{B+\ell,B+2\ell}$:

$$A^{ECOL}_{B+\ell,B+2\ell} = \frac{\ell \cdot S^a_{B,B+\ell}}{P_B \cdot \left(\frac{1}{P^e_{B+\ell+1}} + \frac{1}{P^e_{B+\ell+2}} + \cdots + \frac{1}{P^e_{B+2\ell}}\right)} - \left(S^a_{B,B+\ell} + A^{HCOL}_{B,B+\ell}\right) \qquad \ldots(4)$$

Once again, the summation in the denominator of the first term can be simplified. If we let $\pi^e_{B+\ell,B+2\ell} \equiv \left(\frac{P^e_{B+2\ell}}{P_{B+\ell}}\right)^{\frac{1}{\ell}} - 1$ denote the expected annual inflation during the next ℓ years, and use the formula for the sum of a finite geometric series, the above equation becomes:

$$A^{ECOL}_{B+\ell,B+2\ell} = \frac{\ell \cdot S^a_{B,B+\ell} \cdot (1+\pi_{B,B+\ell})^\ell}{\frac{1}{\pi^e_{B+\ell,B+2\ell}} \cdot \left(1 - \frac{1}{[1+\pi^e_{B+\ell,B+2\ell}]^\ell}\right)} - \left(S^a_{B,B+\ell} + A^{HCOL}_{B,B+\ell}\right) \qquad \ldots(5)$$

Rearranging this equation gives us the following:

$$S^a_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{ECOL}_{B+\ell,B+2\ell} = \frac{\ell \cdot S^a_{B,B+\ell} \cdot (1+\pi_{B,B+\ell})^\ell}{\frac{1}{\pi^e_{B+\ell,B+2\ell}} \cdot \left(1 - \frac{1}{[1+\pi^e_{B+\ell,B+2\ell}]^\ell}\right)} \qquad \ldots(6)$$

Notice that Equation 6 gives us the sum of the first three terms in Equation 1. Substituting Equation 6 into Equation 1, results in the following expression for the salary that should be paid to the employee for each of the next ℓ years–from years B+ℓ+1 through B+2ℓ:

$$S^{n}_{B+\ell,B+2\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+\ell})^{\ell}}{\frac{1}{\pi^{e}_{B+\ell,B+2\ell}} \cdot \left[1 - \frac{1}{\left(1+\pi^{e}_{B+\ell,B+2\ell}\right)^{\ell}}\right]} + M_{B+\ell,B+2\ell} \qquad \text{…(7)}$$

Analysis of the Second Interval

At the end of year B+2ℓ, the employer has to once again determine the normative salary to be paid in each of the next ℓ years–from years B+2ℓ+1 through B+3ℓ. As before, it can be written as the sum of (i) the base salary, (ii) adjustment terms for the change in historical purchasing power during the first and second intervals, (iii) an adjustment term for the expected change in the employee's purchasing power during the third interval, and (iv) all (past and current) merit payments:

$$S^{n}_{B+2\ell,B+3\ell} = S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{HCOL}_{B+\ell,B+2\ell} + A^{ECOL}_{B+2\ell,B+3\ell} + M_{B+\ell,B+2\ell} + M_{B+2\ell,B+3\ell} \qquad \text{…(8)}$$

The expression for historical adjustment for the first interval ($A^{HCOL}_{B,B+\ell}$) is given by Equation 3. Further, the expected adjustment for the first interval is now the historical adjustment for the current (second) one; thus, the expression can be obtained by simply replacing expected inflation ($\pi^{e}_{B+\ell,B+2\ell}$) with realized inflation ($\pi_{B+\ell,B+2\ell}$) in Equation 5:

$$A^{HCOL}_{B+\ell,B+2\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+\ell})^{\ell}}{\frac{1}{\pi_{B+\ell,B+2\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi_{B+\ell,B+2\ell}\right]^{\ell}}\right)} - \left(S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell}\right) \qquad \text{…(9)}$$

Rearranging this equation gives the sum of all historical adjustments:

$$A^{HCOL}_{B,B+\ell} + A^{HCOL}_{B+\ell,B+2\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+\ell})^{\ell}}{\frac{1}{\pi_{B+\ell,B+2\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi_{B+\ell,B+2\ell}\right]^{\ell}}\right)} - S^{a}_{B,B+\ell} \qquad \text{…(10)}$$

Finally, to account for the expected change in purchasing power during years B+2ℓ+1 through B+3ℓ, the salary must be adjusted (beyond the historical adjustments) such that the purchasing power during these years equals that at the time-of-hire:

$$\frac{\left(\frac{S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{HCOL}_{B+\ell,B+2\ell} + A^{ECOL}_{B+2\ell,B+3\ell}}{P^{e}_{B+2\ell+1}} + \ldots + \frac{S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{HCOL}_{B+\ell,B+2\ell} + A^{ECOL}_{B+2\ell,B+3\ell}}{P^{e}_{B+3\ell}}\right)}{\ell} = \frac{S^{a}_{B,B+\ell}}{P_{B}}$$

Simplifying this expression as before and letting $\pi^{e}_{B+2\ell,B+3\ell} \equiv \left(\frac{P^{e}_{B+3\ell}}{P_{B+2\ell}}\right)^{\frac{1}{\ell}}$ denote the expected inflation, we obtain the following expression for the expected adjustment:

$$A^{ECOL}_{B+2\ell,B+3\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+2\ell})^{2\ell}}{\frac{1}{\pi^{e}_{B+2\ell,B+3\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi^{e}_{B+2\ell,B+3\ell}\right]^{\ell}}\right)} - \left(S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{HCOL}_{B+\ell,B+2\ell}\right) \qquad \text{…(11)}$$

Rearranging this equation gives the following:

$$S^{a}_{B,B+\ell} + A^{HCOL}_{B,B+\ell} + A^{HCOL}_{B+\ell,B+2\ell} + A^{ECOL}_{B+2\ell,B+3\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+2\ell})^{2\ell}}{\frac{1}{\pi^{e}_{B+2\ell,B+3\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi^{e}_{B+2\ell,B+3\ell}\right]^{\ell}}\right)} \quad \ldots(12)$$

As before, the above equation gives us the sum of the first four terms in Equation 8. Substituting Equation 12 into Equation 8, we obtain following expression:

$$S^{n}_{B+2\ell,B+3\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+2\ell})^{2\ell}}{\frac{1}{\pi^{e}_{B+2\ell,B+3\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi^{e}_{B+2\ell,B+3\ell}\right]^{\ell}}\right)} + M_{B+\ell,B+2\ell} + M_{B+2\ell,B+3\ell} \quad \ldots(13)$$

Analysis of a Generic Interval

These results can be generalized: the normative salary for an interval starting in year $B+i\ell+1$ and ending in year $B+(i+1)\,\ell$ can be written as the sum of the base salary, all historical adjustments from year B through $B+i\ell$, an expected adjustment for years $B+i\ell+1$ through $B+(i+1)\,\ell$, and all (historical and current) merit payments:

$$S^{n}_{B+i\ell,B+(i+1)\ell} = S^{a}_{B,B+\ell} + \sum_{j=0}^{i-1} A^{HCOL}_{B+j\ell,B+(j+1)\ell} + A^{ECOL}_{B+i\ell,B+(i+1)\ell} + \sum_{j=1}^{i} M_{B+j\ell,B+(j+1)\ell} \quad \ldots(14)$$

To compute the sum of all the historical adjustments, we can generalize Equation 10:

$$\sum_{j=0}^{i-1} A^{HCOL}_{B+j\ell,B+(j+1)\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+(i-1)\ell})^{(i-1)\ell}}{\frac{1}{\pi_{B+(i-1)\ell,B+i\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi_{B+(i-1)\ell,B+i\ell}\right]^{\ell}}\right)} - S^{a}_{B,B+\ell} \quad \ldots(15)$$

Similarly, the expected adjustment for a generic interval is:

$$A^{ECOL}_{B+i\ell,B+(i+1)\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+i\ell})^{i\ell}}{\frac{1}{\pi^{e}_{B+i\ell,B+(i+1)\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi^{e}_{B+i\ell,B+(i+1)\ell}\right]^{\ell}}\right)} - \left(S^{a}_{B,B+\ell} + \sum_{j=0}^{i-1} A^{HCOL}_{B+j\ell,B+(j+1)\ell}\right) \quad \ldots(16)$$

Rearranging Equation 16, gives us the following equation that represents the sum of the first three terms in Equation 14:

$$S^{a}_{B,B+\ell} + \sum_{j=0}^{i-1} A^{HCOL}_{B+j\ell,B+(j+1)\ell} + A^{ECOL}_{B+i\ell,B+(i+1)\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+i\ell})^{i\ell}}{\frac{1}{\pi^{e}_{B+i\ell,B+(i+1)\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi^{e}_{B+i\ell,B+(i+1)\ell}\right]^{\ell}}\right)} \quad \ldots(17)$$

Substituting Equation 17 into Equation 14 gives:

$$S^{n}_{B+i\ell,B+(i+1)\ell} = \frac{\ell \cdot S^{a}_{B,B+\ell} \cdot (1+\pi_{B,B+i\ell})^{i\ell}}{\frac{1}{\pi^{e}_{B+i\ell,B+(i+1)\ell}} \cdot \left(1 - \frac{1}{\left[1+\pi^{e}_{B+i\ell,B+(i+1)\ell}\right]^{\ell}}\right)} + \sum_{j=1}^{i} M_{B+j\ell,B+(j+1)\ell} \quad \ldots(18)$$

The term $(1+\pi_{B,B+i\ell})^{i\ell}$ in the numerator is the value of a dollar compounded at the historical rate of inflation for $i\ell$ years and the term $\frac{1}{\pi^{e}_{B+i\ell,B+(i+1)\ell}}\cdot\left(1-\frac{1}{\left[1+\pi^{e}_{B+i\ell,B+(i+1)\ell}\right]^{\ell}}\right)$ in the denominator is the present value of an annuity that pays a dollar for the next ℓ years at the expected rate of inflation. The value of each of these can be calculated from Future Value Factor tables and Present Value Annuity Factor tables, respectively. Making these substitutions in the above equation gives the following expression for the normative annual salary:

$$S^{n}_{B+i\ell,B+(i+1)\ell}=\frac{\ell\cdot S^{a}_{B,B+\ell}\cdot FVF[\pi_{B,B+i\ell};i\ell]}{PVAF[\pi^{e}_{B+i\ell,B+(i+1)\ell};\ell]}+\sum_{j=1}^{i}M_{B+j\ell,B+(j+1)\ell} \qquad \ldots(19)$$

In the above expression, FVF[r, t] denotes future value of a dollar compounded at *r* percent for *t* years and PVAF[r, t] denotes the present value of an annuity that pays a dollar for *t* years at *r* percent. Accounting for the incentive payment gives us the following expression for the normative cash compensation:

$$Normative\ Cash\ Compsn=\frac{\ell\cdot S^{a}_{B,B+\ell}\cdot FVF[\pi_{B,B+i\ell};i\ell]}{PVAF[\pi^{e}_{B+i\ell,B+(i+1)\ell};\ell]}+\sum_{j=1}^{i}M_{B+j\ell,B+(j+1)\ell}+IncentivePmt \qquad \ldots(20)$$

AN ILLUSTRATION

This section uses the framework developed in the above section to answer the following question: how does the cash compensation of a typical employee in the FIRE industry compare with his/her normative cash compensation? To this end, the actual cash compensation is compared to the normative cash compensation. The data required for this analysis are obtained from various public sources and assembled into a dataset; these details are described in the Appendix. Next, the steps below are followed:

(i) Define the scenario: Each scenario is characterized by the frequency of salary adjustments, year of start of employment, and starting salary, which is assumed to be the actual compensation in the FIRE industry for the year under consideration. For example, consider an individual, say Jack, whose salary was adjusted every three years, and who started working at the end of 1982 at an annual salary of $17,889 – the average cash compensation in the FIRE sector in the year 1982.

(ii) Compute the Normative Cash Compensation: Equation 20 indicates that cash compensation in any year consists of the starting salary augmented by an incentive payment, merit payments (historical and current) and a cost-of-living-adjustment. The scenario under consideration provides all the inputs to compute the first term on the right hand side of Equation 20. Survey evidence suggests that variable pay (incentive plus merit payments) of 8% of base salary is considered competitive (Ch. 18 in Berger & Berger, 2008). In addition, the magnitude of these payments typically varies with the business cycle. For these reasons, the incentive and merit payments are each assumed to be 4% (2%) during business cycle expansions (recessions).

Since Jack's salary is adjusted every three years, the first adjustment will occur at the end of 1985. To compute the normative cash compensation for the years 1986 through 1988, we use the following inputs for the first term in Equation 20 above: ℓ=3, $S^{a}_{1982,1985}$=\$17,889, FVF[3.85; 3]=1.12, and PVAF[4.32; 3]=2.758. The FVF is based on a historical inflation rate of 3.85% during 1983, 1984, and 1985, and the PVAF is based on an expected (at the end of 1985) inflation rate of 4.32% in 1986, 1987, and 1988. These inputs yield an amount of $21,793.71. The NBER business cycle classification indicates that years 1983 through 1985 corresponded to a business cycle expansion. Thus, the incentive and merit payment will each be 4% of Jack's most recent annual salary ($17,889) or $715.56. The incentive component is a one-time payment; hence, his cash compensation for the year 1986 will include the incentive and merit payments (in addition to the COLA and starting salary) for a total compensation of $23,224.83(=$21,793.71+$715.56+$715.56). For the next two years, his compensation will consist of only the merit payment resulting in a total compensation of \$22,509.33 (=\$21,793.71+\$715.56). These calculations are repeated every three years (at the end of 1988, 1991, and so on) and yield the normative cash compensation for the subsequent three years. Thus, at the end, we will have a time series of normative cash compensation.

(iii) Obtain the Actual Cash Compensation: This is the (average) cash compensation in the FIRE sector. Thus, Jack's actual cash compensation for 1986 through 1988 is the cash compensation in the FIRE sector during the same years –\$24,250 in 1986, \$25,991 in 1987, and \$27,691 in 1988. This analysis is repeated for subsequent intervals to obtain a time series of actual cash compensation.

(iv) Compare the Actual and Normative Cash Compensation: Using the time series obtained in steps (ii) and (iii) above, first compute the difference between the actual and normative cash compensation (gap hereafter), and then compute the average of the resulting time series.

Steps (i) through (iv) are repeated for all combinations of frequency of salary adjustments (annual, biennial, triennial, or quinquennial) and year of start of employment (1982 through 2010). The results of this exercise are presented in Table 1 below.

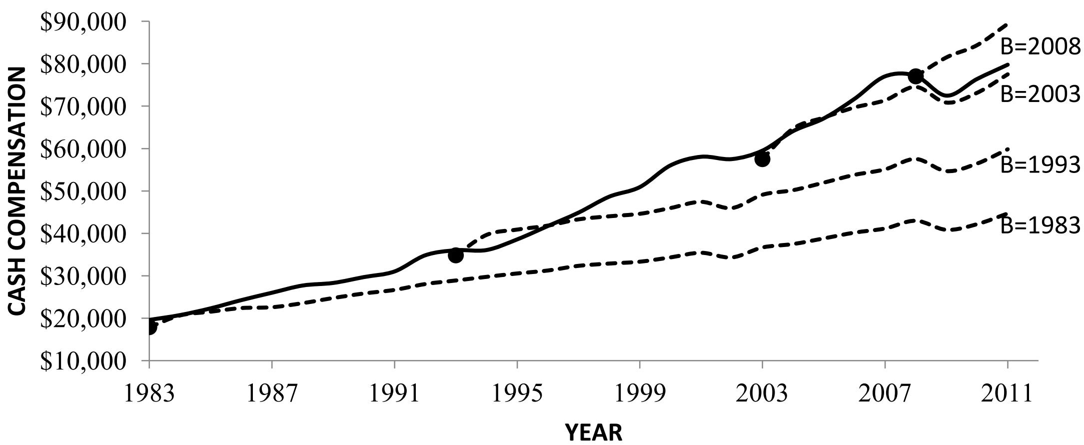
TABLE 1
DESCRIPTIVE STATISTICS FOR THE GAP

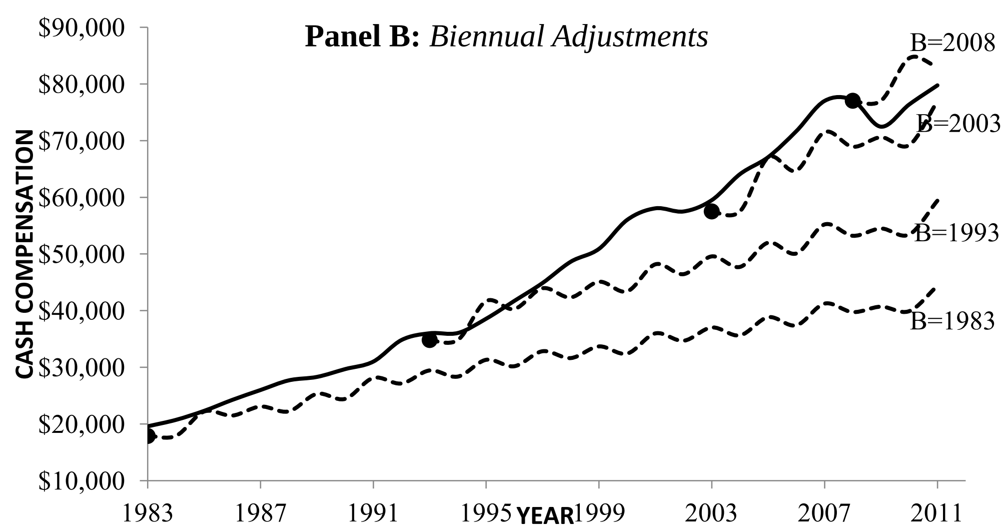
	Frequency of Adjustments (ℓ)			
***Starting Year* (B)**	ANNUAL (ℓ=1)	BIENNIAL (ℓ=2)	TRIENNIAL (ℓ=3)	QUINQUENNIAL (ℓ=5)
	Average Gap	Average Gap	Average Gap	Average Gap
1982	\$15,724	\$16,309	\$16,474	\$16,641
1983	\$14,541	\$15,120	\$15,531	\$15,764
1984	\$14,510	\$15,194	\$15,419	\$15,674
1985	\$13,776	\$14,422	\$14,693	\$14,595
1986	\$11,555	\$12,346	\$12,747	\$12,932
1987	\$11,015	\$11,807	\$12,195	\$12,396
1988	\$10,706	\$11,586	\$11,908	\$12,519
1989	\$12,332	\$13,144	\$13,630	\$14,039
1990	\$13,483	\$14,434	\$14,797	\$14,824
1991	\$13,666	\$14,524	\$14,919	\$15,306
1992	\$10,339	\$11,454	\$11,833	\$11,950
1993	\$10,757	\$11,724	\$12,323	\$13,014
1994	\$12,858	\$14,066	\$14,420	\$14,902
1995	\$11,644	\$12,665	\$13,300	\$13,453
1996	\$10,096	\$11,513	\$11,959	\$12,430
1997	\$7,786	\$8,953	\$9,792	\$10,050
1998	\$4,602	\$6,310	\$6,663	\$8,011
1999	\$4,058	\$5,489	\$6,691	\$7,370
2000	\$308	\$2,363	\$3,125	\$3,448
2001	-\$948	\$956	\$1,839	\$3,650
2002	\$2,067	\$4,595	\$5,428	\$5,972
2003	\$1,778	\$3,780	\$5,508	\$7,358
2004	-\$752	\$2,217	\$2,506	\$5,131
2005	-\$1,044	\$1,292	\$3,685	\$5,416
2006	-\$3,867	-\$497	\$813	\$4,861
2007	-\$6,632	-\$3,954	-\$2,861	-\$583
2008	-\$7,417	-\$4,735	-\$923	-\$923
2009	\$1,071	\$5,615	\$5,615	\$5,615
2010	\$3,372	\$3,372	\$3,372	\$3,372

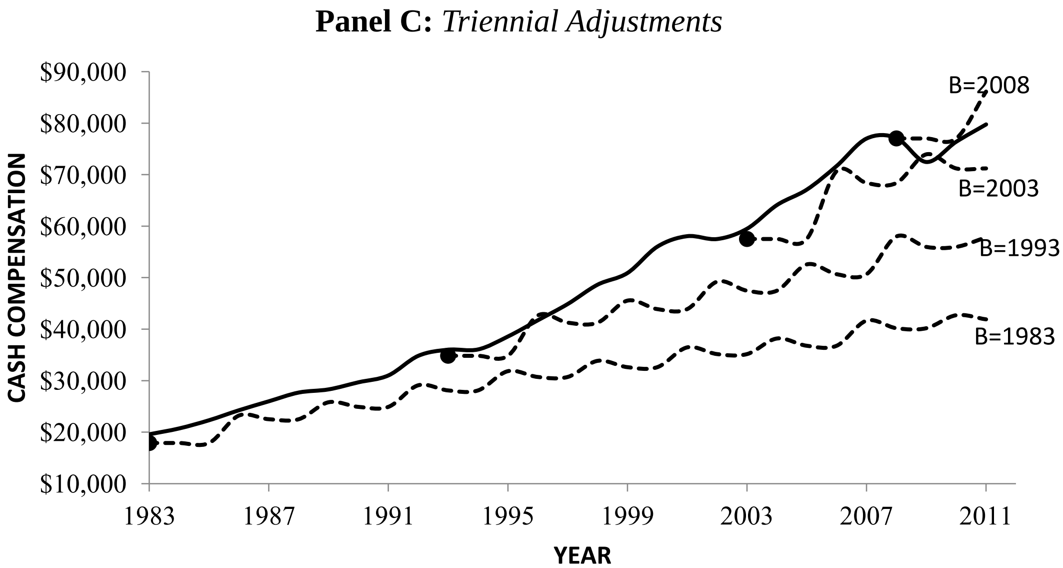
The column labeled *Starting Year* denotes the year in which the individual started working; the subsequent columns report the average gap computed in step (iv) for a given frequency of adjustments. Positive numbers indicate that, on average, the actual cash compensation was greater than the normative one (i.e., the individual is making more than what he should be implying that his purchasing power has increased since he started working). Negative numbers, on the other hand, denote the opposite–the individual is worse off because his purchasing power has decreased. The table indicates that in most scenarios actual cash compensation is higher than the normative one regardless of the frequency of salary adjustments and starting year. The exception is employees who started employment just before or during the financial crisis (2004-2008). To illustrate these results, Figure 2 plots the *Actual Cash Compensation* (solid line) and the *Normative Cash Compensation* (dotted lines) for some values of *Starting Year* (B=1983, 1993, 2003, and 2008) against time. Each panel deals with a specific frequency of adjustment. Consistent with the evidence in Table 1, the actual compensation is higher than the normative one, except for employees who started working in 2008.

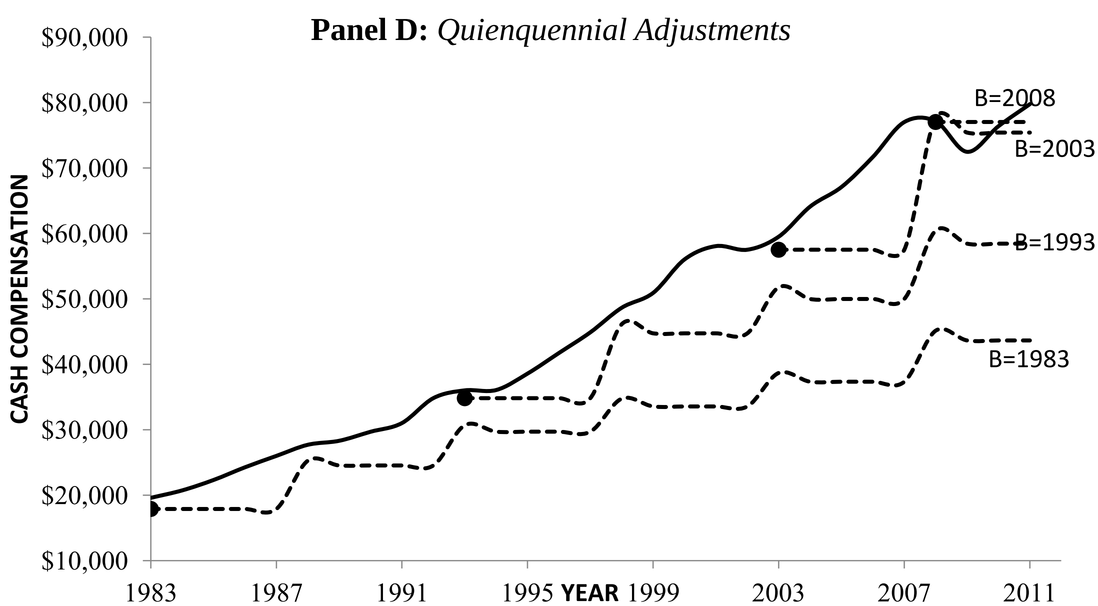
FIGURE 2
COMPARISON OF NORMATIVE AND ACTUAL CASH COMPENSATION

Panel A: *Annual Adjustments*









CONCLUSION

This paper has developed a framework that uses employee-specific inputs–starting salary, length of employment, and frequency of compensation adjustments–to compute the compensation he/she should receive in any year since the start of employment. At a fundamental level, the framework is basically an adjustment for the historical and expected change in price level; it is based on the concept that the purchasing power of an employee must (at the very minimum) equal that at time of hire. Several aspects of this seemingly-trivial framework are worth emphasizing. First, although the concept of a cost-of-living adjustment is intuitive, easily understood and well known, to the best of the author's knowledge it has not been quantified through a formula. Second, the framework models *some* components of the compensation package: it focuses on the cost of living adjustment and assumes the merit and incentive payment to be exogenous. Doing so, however, facilitates integration with an employer's existing compensation system –

the existing performance evaluation method can be used to determine an employee's incentive and merit payment; these payments can then be used as inputs for the framework developed here. Third, the framework is generic and flexible. For example, it can be easily modified to incorporate changes in purchasing power over time. Alternatively, the rate of inflation – historical or expected – can be replaced by one that better reflects an employee's experience. Finally, the framework permits a clear delineation between the quantitative and discretionary aspects of compensation, thereby making compensation adjustment a process based on an economic principle rather than one based on judgment.

ENDNOTES

1. The price level is measured by indices such as the Consumer Price Index (CPI) or Personal Consumption Expenditures Index (PCE).
2. A basket refers to the goods and services consumed by a typical household.
3. The sum of the first *n* terms of a finite geometric series is $S_n = \sum_1^n r^k = \frac{r(1-r^n)}{(1-r)}$, where r is the common ratio and less than 1.

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APPENDIX: CONSTRUCTION OF DATASET

This appendix describes the construction of the dataset used in the empirical analysis. As discussed in the text, the analysis involves comparing the actual cash compensation paid by employers and the normative cash compensation. The data sources for these variables are discussed below.

(a) Data for Actual Cash Compensation: The ideal dataset would track the compensation of new hires in a given year and for a particular job title over time (e.g., compensation path of all Financial Analysts who started working in 1990). Unfortunately, such data, to the best of the author's knowledge, is not publicly available. Hence, the average annual compensation for an employee in a given year is used to proxy for the actual compensation. The compensation data is obtained from the Quarterly Census of Employment and Wages (QCEW). This program collects employment and wage data from establishments that represent about 99.7% of all wage and salary civilian employment in the U.S. Variables such as Wages, Number of Employees, and Number of Employers are available at quarterly and annual frequency from 1975 through 2011, and are organized by area, industry, and establishment size. Due to the long time period, the classification systems used to organize data by industry vary over time. From 1975-2000, the Standard Industrial Classification (SIC) system is used and from 2001-date the North American Industry Classification System (NAICS) is used. The FIRE sector is chosen since data for these industries

are available in both classification systems. Specifically, the SIC has a *combined/single* category for Finance, Insurance and Real Estate (SICs 60-67) and the NAICS has *separate* sectors for Finance and Insurance (Industry Code 52) and Real Estate (Industry Code 531). Annual data on Wages and Number of Employees for the FIRE sector are used to compute the average compensation of an individual in this sector. The data, which are presented in Table A1 below, indicate an upward trend.

TABLE A1
DESCRIPTIVE STATISTICS FOR DATASET

Year	Cash Compensation	Inflation	Expected Inflation
1982	$17,889	3.83	3.7
1983	$19,583	3.79	3.5
1984	$20,720	3.95	3.3
1985	$22,312	3.80	3.5
1986	$24,250	1.10	3
1987	$25,991	4.43	3.1
1988	$27,691	4.42	3.9
1989	$28,303	4.65	3.5
1990	$29,683	6.11	4.7
1991	$31,013	3.06	2.7
1992	$34,822	2.90	2.8
1993	$36,011	2.75	3
1994	$36,062	2.67	3
1995	$38,577	2.54	2.7
1996	$41,725	3.32	3
1997	$44,884	1.70	2.8
1998	$48,641	1.61	2.5
1999	$50,910	2.68	3
2000	$56,029	3.39	2.8
2001	$58,062	1.55	1.8
2002	$57,508	2.38	2.5
2003	$59,507	1.88	2.6
2004	$64,103	3.26	3
2005	$67,103	3.42	3.1
2006	$71,700	2.54	2.9
2007	$77,027	4.08	3.4
2008	$77,136	0.09	1.7
2009	$72,470	2.72	2.5
2010	$76,399	1.50	3
2011	$79,771	2.96	3.1
MEAN	$46,529.40	2.97	3.00

(b) Data for Normative Compensation: Equation 20 indicates that to compute the normative compensation of an individual in a given year, we require data on the following variables:

1) starting year (B),
2) starting salary (S_B),
3) frequency of salary adjustments (ℓ),
4) historical annual inflation (π),
5) expected annual inflation (π^e),
6) merit payments, and
7) incentive payments.

Variables (1) through (5) are required for computing the first term in Equation 20 – the starting salary adjusted for a *COLA*. Notice that π and π^e have to be obtained from data sources (described below) for given values of B and ℓ. Thus, the first term is determined by only the first three variables. These variables are specific to an individual and fixed at values described in the paper (section titled An Illustration). The historical inflation is calculated using the formula $\pi = \left(\frac{CPI_T}{CPI_{T-n}}\right)^{\frac{1}{n}} - 1$, where $CPI_{(\cdot)}$ is the value of the Consumer Price Index at the end of year $(\cdot)$ and π is the annual inflation from the end of year $T - n$ to the end of year T. The data on the Index (*Consumer Price Index: All Items*; Series CPIAUCNS) is from the Federal Reserve Economic Data (FRED). Notice that the series is *not* seasonally adjusted. The reason is that price changes occurring at the same time in each year are eliminated by a seasonal adjustment; however such changes have to be included in a cost-of-living adjustment. Further, the series represents expenditures of the urban population since it is more representative of the U.S. population.

Estimates of expected inflation can be classified into survey-based or market-based measures. The former obtains estimates by surveying a group of individuals–households, professional investors, or economists. Examples include the *Survey of Consumers* conducted by the University of Michigan and *Survey of Professional Forecasters* and *Livingston Survey* conducted by the Philadelphia Federal Reserve. Market-based measures obtain estimates either from securities that trade in financial markets (e.g. yield on a Treasury Inflation Protected Security) or by estimating models that use market data as inputs such as that provided by the Cleveland Federal Reserve. Expected inflation for one year and five years is obtained from the Survey of Consumers (SC), and expectations for two-year and three-year inflation are obtained from the Cleveland Federal Reserve.

The merit and incentive payments for a given interval are a fixed proportion of the annual cash compensation during the previous interval. The proportion varies with the business cycle – it is 4% if the previous interval was a business cycle expansion and 2% if it was a contraction. The classification of each interval is based on the business cycle dates provided by the National Bureau of Economic Research; an Excel file with these dates is available at http://www.nber.org/cycles/cyclesmain.html#announcements. Specifically, an interval is classified as an expansion (recession) if more (less) than half of the months in it are classified as expansion by the Bureau.

Each of the above data sources–QCEW, FRED, SC, and Cleveland Fed–provide data that begin at different dates in the past. The period from 1982-2011 represents a time frame during which all of the required variables are available and thus, forms the sample period for the analysis.