

**EXPERT REBUTTAL REPORT**  
**of**  
**HENRY S. FARBER**  
**In Connection With**

**Chen-Oster v. Goldman Sachs**  
**July 29, 2014**

## **I. Introduction, Assignment and Summary of Conclusions**

1. I previously submitted a report in connection with class certification.<sup>1</sup> In my Initial Class Certification report I presented the results of analysis of pay differences between men and women in the proposed classes. I also described my qualifications and my understanding of the employment setting for members of the proposed classes.

2. Counsel for the proposed classes has asked me to review and comment on a report submitted in connection with class certification by Dr. Michael Ward.<sup>2</sup> In this report, I present my comments on the Ward report.

3. Nothing in the Ward class certification report causes me to change my opinions, which are as follows:

4. Women are paid less than otherwise similar men, on average, and the difference in pay is statistically significant. I calculate that the average pay difference is about 8 percent for Associates and about 21 percent for Vice Presidents when I adjust for differences between men and women in division, year, office, education, affirmative action (“AA”) job group, experience at Goldman, experience at Goldman squared (both from the most recent hire date), relevant experience prior to most recent date at Goldman (including experience in prior employment spells at Goldman), relevant experience squared, whether

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<sup>1</sup> Expert Report of Henry S. Farber in Connection with Chen-Oster v. Goldman Sachs, February 17, 2014 (“Initial Class Certification report.”)

<sup>2</sup> Expert Report of Michael P. Ward, Ph. D. in the Matter of Chen-Oster et al. vs. Goldman, Sachs & Co. and The Goldman Sachs Group, Inc., July 3, 2014. (“Ward Report.”)

a direct hire into the Associate or Vice President position and whether a direct hire into the Associate or Vice President position in the current year.

5. Women receive lower 360-degree review scores on average and are less likely to be ranked in the top quartile than otherwise similar men

6. Women are paid less than similar men on average even when they receive the same quartile score.

7. Among Associates, differences between women's and men's quartile and 360-degree review ratings explain about 4 percentage points of the overall average pay difference or approximately 50 percent of the observed pay difference. Among Vice Presidents, differences between women's and men's quartile and 360-degree review ratings explain about 5 percentage points of the overall average pay difference or approximately 22 percent of the observed pay difference.

8. The remaining pay differences between similar men and women of about 3 percent among Associates and 17 percent among Vice Presidents are statistically significant and reflect differences in average pay between men and women with the same personal characteristics and jobs groups whose performance is the same according to Goldman's measures of performance.

9. I also find that during the period 2004 through 2008 (reflecting promotion decisions in 2003-2007) women were promoted from Vice President to Managing Director at a lower rate than one would expect if they were promoted at the same rate as men with similar measured characteristics. Comparing men and women Vice Presidents in the same year with the same number of years as Vice Presidents and working in the same division, I

also find that during the period 2004 through 2008 (reflecting promotion decisions in 2003-2007) women were promoted at a lower rate than one would expect if they were promoted at the same rate as men with similar measured characteristics. Comparing men and women Vice Presidents in the same year with the same number of years as Vice Presidents and also adjusting for differences in division, office, education, AA job group,<sup>3</sup> experience at Goldman, experience at Goldman squared (both from the most recent hire date), relevant experience prior to most recent date at Goldman (including experience in prior employment spells at Goldman), relevant experience squared and whether a direct hire into the VP position, women experienced 19 fewer promotions than I would expect in the absence of discrimination. This difference is statistically significant.

10. I discuss Dr. Ward's Report in the next section of my report. I first discuss his analysis of earnings as well as his analyses of the differences in scores on the 360-degree review and of the differences in quartile placement. I then discuss his analysis of promotions.

11. I explain the flaws in Dr. Ward's choice to adjust for differences between men and women in Goldman's measures of merit (360 scores and quartiles), guarantees, production and business unit.

12. I also explain why it is not possible to learn about the potential presence or absence of systematic pay discrimination from Dr. Ward's analysis of "gender differences"

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<sup>3</sup> Because promotion is a low probability event, I use a slightly different measure of job group for the promotions analysis than I use in my analyses of earnings. Job groups with fewer than 250 observations in the relevant sample are combined into an expanded "Other" group.

within business units. Finally, I point out that Dr. Ward's apparent concern about the fact that the regression models of earnings do not explain all variation in earnings is potentially misleading.

## **II. Dr. Ward's Analyses of Earnings Based on His Own Model**

13. I discuss Dr. Ward's analyses of earnings based on his own model in this section of my report. I explain the flaws in Dr. Ward's choice to adjust for differences between men and women in Goldman's measures of merit (360 scores and quartiles), guarantees, production and business unit.

14. I show that even assuming that these choices are correct and that Dr. Ward is correct to calculate sixteen separate regression models covering sixteen different groups of Goldman employees, his approach provides additional support for my principal conclusions.

### **A. Summary of Dr. Ward's Methods**

15. Dr. Ward performs his principal regression analyses of earnings separately for four groups within each of Securities (which consists of Fixed Income, Currency and Commodities ("FICC") and Equities ("Equities")), Investment Banking ("IBD") and Investment Management ("IMD") Divisions. In the first two of these divisions, Dr. Ward's four subgroups are those promoted into Associate positions, those hired directly into Associate positions, those promoted into Vice President positions and those hired directly into Vice President positions. In IMD, he also separates these four subgroups of employees into those working in the role of private wealth advisor ("PWA") and those not

working as PWAs. That is, Dr. Ward performs regression analyses on 16 separate subgroups

16. Dr. Ward uses the following set of adjustments in each of his regression analyses of pay differences: highest degree, fiscal year, business unit, quartile, previous quartile, score on the 360 review, previous score on the 360 review, and an indicator for whether the employee had a guaranteed bonus or total earnings in the year in question. In addition, Dr. Ward adjusts for time as an Associate (and its square) in studies of Associates and time as a Vice President (and its square) in studies of Vice Presidents. He uses "Production," converted to quartiles, for Securities and IBD. He also uses an indicator for employees who are client representatives in IBD. Dr. Ward uses a class year variable rather than time as an Associate for Associates in IBD. He uses a variable to indicate job functions for the Securities employees and a division function description variable for the IBD employees. He limits years in the regressions for IBD to 2005 to 2011, for IMB to 2008 to 2011, for MBD to 2007-2011, for Securities to 2007-2011.

17. He reports the results of these analyses in his Tables 4 (promoted into position in Securities), 5 (Promoted into position in IBD), 6 (promoted into position in IMD), 7 (IMD PWAs) and 9 (hired into position in Securities, IBD and IMD).

18. In addition to his regression analyses of pay differences, Dr. Ward presents "gender differences in compensation" between men and women calculated business unit by business unit. (The results of these calculations are presented in his Figures 8 through 12.)

19. While Dr. Ward's report does not explain how he performed these analyses of individual business units, a review of his statistical back up materials indicates that he

used the following procedure. He began with his sixteen regression models. For each person/year included in each of those models he calculated the difference between the individual's actual log earnings in that year and the log earnings that his model predicts for that person. This difference is a standard statistic known as the "regression residual" or "residual." He then adjusts the residuals for female person/years by adding the mean pay difference estimated by his regression model to the actual residual. He makes no adjustment to residuals for male person/years. Dr. Ward does not explain why he follows this procedure. In the final step of his procedure he calculates, for each business unit with at least five person/years, the mean residual for men and compares it to the mean adjusted residual for women and reports the differences in his figures as "gender differences in compensation" in his Figures 8 through 11.<sup>4</sup>

20. He also tests each of these "gender differences" for statistical significance and reports the results of these statistical significance tests in his Figures 8 through 11.<sup>5</sup>

21. He then counts the number of women in business units that fall in each of four categories: "gender difference" favorable to women and statistically significant, "gender difference" favorable to women and not statistically significant, "gender difference" unfavorable to women and statistically significant and "gender difference"

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<sup>4</sup> While Dr. Ward uses regression analyses to compute these means, he does not make any adjustments for differences in the characteristics of the individuals involved and, as a result, the results of these regression analyses are mathematically identical to conventionally calculated means.

<sup>5</sup> There is a statistical error in Dr. Ward's calculation of these statistical significance tests. His tests do not take account of the uncertainty introduced into his formulas by the fact that he has adjusted female person years by his estimate of the pay difference in the larger group.

unfavorable to women and not statistically significant. He displays the results of these counts in his Figure 12.

B. Dr. Ward's Choice of Adjustment Factors

22. Dr. Ward states in his report (page 30) that "When a statistician or labor economist is asked to do a statistical analysis of compensation, the basic approach is . . . to build a model that, as nearly as possible accounts for the way pay is actually determined in that organization." In fact, this is not the appropriate approach when the goal of the analysis is to determine whether or not there are earnings differences that may result from discrimination. The reason is straightforward. The precise manner in which pay is actually determined is what results in discriminatory outcomes. A finding that the particular process a firm uses to set compensation accounts for an observed pay difference is not evidence that there is not discrimination in pay setting. It may be that elements of the pay process itself are discriminatory.

23. A conceptual example serves to illustrate this point. Consider an organization that ties compensation to performance evaluations. Suppose that the design and/or implementation of this performance evaluation system and its link to compensation are discriminatory in that women are disadvantaged by receiving lower performance ratings in relation to true performance. Women earn less than men in this organization, but a statistical analysis that relies on the discriminatory performance evaluation system will show that the pay gap is "accounted for" by differences in "performance."

24. Another specific example concerns job assignment. It is not appropriate to control for detailed job assignment in a proper analysis of compensation for the purpose of



measuring possible discriminatory pay differences. It may be that particular job assignments are allocated to workers in a discriminatory manner. For example, it may be that, on average, males are given job assignments that offer more profit or productivity potential than those job assignments offered women while not requiring a higher level of skill than the women possess. A finding that controlling for detailed job assignment accounts for an observed pay difference is not evidence that there is not discrimination in pay setting. It may be that the job assignments themselves are made in a discriminatory manner.

25. An appropriate economic analysis of compensation for the purpose of determining whether there are pay differences that may result from discrimination is to use objective factors that are accepted by labor economists as related to skills and market value. These include such factors as education, relevant labor market experience, geographic location, and, broadly speaking, type of work. A pay difference found in an analysis of compensation that accounts for these factors may be the result of discrimination.

26. To summarize, Dr. Ward's approach of trying to mimic the process of pay determination is designed to mask discriminatory pay differences by attributing these differences to a facially neutral compensation process. I turn now to a detailed discussion of Dr. Ward's choice of adjustment factors.

27. Generally speaking, adjustment factors that are in the control of the employer, such as performance evaluation and job assignment, are potentially what are called "tainted variables" in the context of studies of employment discrimination.

28. The 360 Review scores and quartiles are potentially tainted variables in this context. The plaintiffs in this matter allege that these two rating mechanisms are having the effect of depressing women's pay relative to men's pay. By including these factors in his models, Dr. Ward, in effect, assumes that the allegation is false and that it is legitimate to include these performance measures in a compensation model designed to measure discriminatory pay differences.

29. By contrast, I address this issue by showing results that adjust for differences in 360 Review score and Quartile in comparison with results that do not adjust for differences in 360 Review score and Quartile. I found that when I adjust for these potentially tainted factors the estimated average difference in pay is smaller (in absolute value) than when I do not adjust for these factors. (See Tables 16 and 17 of my Initial Class Certification report.) I show below that Dr. Ward's estimates, in fact, lead to the same conclusion. (See Section II.C of this report.)

30. Dr. Ward adjusts for differences between men and women in whether Goldman had guaranteed their bonus or total earnings. Guaranteed compensation is another potentially tainted variable. Goldman may discriminate in pay guarantees. As a result, a compensation guarantee or an indicator of the presence of a compensation guarantee is not an appropriate variable to include in the compensation model.

31. Dr. Ward controls for business unit in his analysis of compensation. Given that Goldman determines assignment to specific business units, business unit is a potentially tainted variable. Controlling for business unit in the compensation model

could reduce the estimated pay difference between women and men if women are systematically assigned less well-paid business units.

32. Business units also appear to be unstable. For example, according to Dr. Ward's data, there were as many as 227 business units in 2003 and as few as 94 in 2005. About 20 percent of business units that existed in one year did not exist one year later. Approximately 11 percent of Goldman Associates and Vice Presidents change business units in each year. As a result, business units do not appear to be measures of either inherent employee characteristics or job characteristics. Therefore, they are not appropriate adjustment factors for a study of pay discrimination.

33. Dr. Ward also controls for measures of production. I discuss problems with the data, statistics, and measurement in what follows. But I start by noting that since Goldman controls job assignments to business units and that production opportunities vary across business units, production itself is a potentially tainted variable for the purpose of estimating discriminatory pay differences.

34. The production data are unreliable for a number of reasons. The two most significant issues are the lack of consistent data across the class and across divisions, and the inconsistent meaning of data across job groups.

35. A large number of employees lack productivity data and Dr. Ward did not study the percentage or number of employees without production data. In fact, there are no such data for employees in one of the three Divisions, IMD, and data are missing for 59 percent for employees in Securities and for 5 percent of employees in IBD. Dr. Ward did not, in fact, compare employees with the same production.

36. Dr. Ward also concedes that one of the “objective” measures of productivity - Sales Credits -- may be “soft” or “hard” – meaning that it may be more or less difficult to generate commissions from particular clients. Consequently, the number of sales credits or dollars associated with client accounts is not a reliable measure of performance.<sup>6</sup> Dr. Ward also explained that there is not an exact relationship between Sales Credits or Dollars and the individual’s “contribution.”<sup>7</sup> Dr. Ward indicates that managers in different Divisions put a different weight or emphasis on alternative performance measures when making manager quartile assignments.<sup>8</sup> Dr. Ward did not take these factors into account in designing his regression model.

37. In another example, some managers consider a "team environment" when allocating production credit. In that situation, Dr. Ward does not know how these production credits were allocated and to what extent these allocations reflect employees’ actual contributions.<sup>9</sup>

38. In short Dr. Ward is incorrect to adjust for Quartile and 360 Degree Review score data without also studying the impact of removing them from his model because they are potentially tainted. His decision to adjust for differences in business unit and Goldman’s measures of production is also flawed both because these measures may be tainted and also suffer from a number of other flaws.

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<sup>6</sup> Deposition of Michael P. Ward , Ph.D., January 6, 2014 (“Ward Tr.”), 148:19-151:2

<sup>7</sup> Ward Tr. 157: 16 -24.

<sup>8</sup> Ward Report, page 37.

<sup>9</sup> Ward Tr. 173:23-174:25

C. Analysis of Dr. Ward's Pay Regression Models

39. As I described earlier, Dr. Ward performs his principal regression analyses of earnings separately for four groups within each of Securities and IBD. In these two divisions, Dr. Ward's four subgroups are those promoted into Associate positions, those hired directly into Associate positions, those promoted into Vice President positions and those hired directly into Vice President positions. In IMD, he also separates these four subgroups of employees into those working in the role of private wealth advisor ("PWA") and those not working as PWAs. That is, Dr. Ward performs regression analyses on 16 separate subgroups. (Dr. Ward's analyses of pay differences at the business unit level do not calculate separate regression models by business unit. I discuss these analyses in Section II. D below. He reports the results of these analyses in his Tables 4 (promoted into position in Securities), 5 (Promoted into position in IBD), 6 (promoted into position in IMD) and 9 (hired into position in Securities, IBD and IMD).

40. Dr. Ward claims on the basis of these analyses of compensation that there is not a consistent pay differential within rank (Associate or Vice President) across the 16 groups he identifies. As I explained in the previous section of my report, Dr. Ward's choice of adjustment factors is not appropriate. In this section of my report I provide direct statistical evidence based on Dr. Ward's flawed model on the question of whether Dr. Ward is correct to say that he has provided statistical evidence that "There is no pattern of pay differences adverse to women."<sup>10</sup>

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<sup>10</sup> Ward Report, page 31.

41. To the contrary I find that Dr. Ward's models do not provide evidence of statistically significantly different pay gaps among the 5 largest of his groups of Associates, which include 91 percent of all women included in Dr. Ward's regression analyses of Associates. (The five groups I include in this analysis are [REDACTED] [REDACTED]. The three excluded groups are [REDACTED].) I also find that these models do not provide statistically significant evidence of different pay gaps among the 5 largest groups of his groups of Vice presidents, which include 92 percent of all women included in Dr. Ward's regression analyses of Vice Presidents. (The five groups I include in this analysis are [REDACTED] [REDACTED] [REDACTED].)

42. In short, Dr. Ward's models provide statistical evidence of a difference in the male/female pay gap only for groups comprising less than 10 percent of women in his regression samples.

43. I conclude from this analysis that Dr. Ward's evidence, even with the inclusion of some potentially tainted measures, is generally consistent with there being a consistent pay gap across his groups of Associates and across his groups of Vice Presidents.<sup>11</sup>

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<sup>11</sup> Ward Report, Tables 4, 5, 7 and 9.

44. Given these findings, I then calculate the common pay gap implied by Dr. Ward's models. (I do the calculations I describe here separately for Associates and Vice Presidents and exclude the three smallest groups among Associates and Vice Presidents.) I then calculate the common pay gap Dr. Ward would have found had he calculated his models without including adjustments for scores on the 360 Degree Review and Quartile. That is, I repeat Dr. Ward's analysis exactly (for his largest groups) except that I exclude his adjustments for those two factors. I find that women are paid statistically significantly less than men who are the same in terms of the factors included in Dr. Ward's models when I do not include the tainted variables by adjusting for differences in 360 Degree Review score and Quartiles. I also find that when I include adjustments for differences in 360 Degree Review score and Quartiles, these differences in pay diminish but are not eliminated. That is, even using Dr. Ward's approach, I find support for my principal conclusions.

45. I report the results of my analyses of Dr. Ward's regression models in Tables R1 and R2 (attached). Table R1 covers my analyses of Associates. Table R2 covers my analyses of Vice Presidents. The tables have the same format and can be read in the same way.

46. I report my analysis of Dr. Ward's actual results in the first row of these tables. In the second row, I show the outcome of my analysis of what Dr. Ward would have found had he repeated his analysis without adjustments for differences in 360 Degree Review score and Quartiles.

47. I report the results of my tests that Dr. Ward's differences in pay are different in his various groups in the second column of each table. These results are expressed as marginal significance levels from a Chi Square test.<sup>12</sup> (The t-ratio is not an appropriate statistic in this situation.) Marginal significance levels (or "p-values") of 0.05 or less indicate that Dr. Ward's pay differences are statistically significantly different from one another. Marginal significance levels greater than 0.05 indicate that Dr. Ward's pay differences are not statistically significantly different from one another.

48. All four of the marginal significance levels reported in Tables R1 and R2 are above [REDACTED]. I conclude that the statistical evidence is consistent with there being a common pay difference across Ward's groups of Associates and across Ward's groups of Vice Presidents who are not PWAs.

49. The third column of each table reports the mean of Dr. Ward's adjusted pay differences in the five largest groups weighted by the number of women in each group expressed in log points. The fourth column of the table provides the t-ratio for a test that the weighted mean differences are statistically significant. The fifth column of the table presents the weighted mean difference in pay expressed as a percentage.

50. The estimates in the second row of Table R1 indicate that without adjustments for 360 Degree Review score and Quartile, the pay difference among Associates is [REDACTED] log points ([REDACTED] percent) and that this difference is statistically significant. Once adjustments for these factors are returned to Dr. Ward's models, the pay

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<sup>12</sup> Based on a Wald Test. See Greene, William H. *Econometric Analysis*, 5<sup>th</sup> edition, Prentice Hall, 2003, pp. 486-488.



difference falls to [REDACTED] log points ([REDACTED] percent). This difference is not statistically significant.

51. Table R2 indicates that without adjustments for 360 Degree Review score and Quartile, the pay difference among non-PWA Vice Presidents is [REDACTED] log points [REDACTED] percent) and that this difference is statistically significant. Once adjustments for these factors are returned to Dr. Ward's models, the pay difference falls to [REDACTED] log points [REDACTED] percent) and remains statistically significant.

52. In short, my analysis of Dr. Ward's principal regression models of pay confirms my conclusion that without adjustments for 360 Degree Review score and Quartile females are paid statistically significantly less than males who are the same in terms of the factors included in the model. The size of this difference falls once one adjusts for differences between men and women in 360 Degree Review score and Quartile, indicating that that these factors are one potential cause of the sex based differences in pay among these workers.

D. Dr. Ward's Analyses of Pay Gaps in Individual Business Units

53. Dr. Ward indicates "if there were in fact a systematic pattern of pay discrimination as Plaintiffs allege, I would expect to find the women in all Business units similarly disadvantaged and that the differences would be statistically significant for most of the parts of the organization ...".<sup>13</sup>

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<sup>13</sup> Ward Report, p 55.

54. In fact, Dr. Ward's procedure is so constructed that Dr. Ward should not expect to see the results he indicates even in the presence of systematic discrimination against women. The flaw in Dr. Ward's procedure results from the small size of many of his business unit groupings. Counting all of his analyses of groups in Securities, IBD and IMD the median size of his business unit groupings is eleven person/years. (Twenty five percent of his business unit groupings include four or fewer person/years.)

55. In order to be statistically significant a pay difference must normally have a t-ratio of 1.96 or larger.<sup>14</sup> The t-ratio is calculated as the ratio between the pay difference and the standard error of the pay difference. (The standard error is a measure of how precisely the pay difference is measured.) That is, to be statistically significant, a pay difference must normally be larger than its standard error multiplied by 1.96. The standard error multiplied by 1.96 is sometimes referred to as the margin error for the pay difference.<sup>15</sup> Other things being equal, larger sample sizes lead to smaller margins of error and smaller sample sizes lead to larger margins of error.

56. Dr. Ward's small sample sizes cause Dr. Ward's measures of the "gender difference" to have large margins of error relative to even quite substantial pay differences. For example, the median margin of error among Dr. Ward's analyses is plus or minus 0.184 log points (at least 16.5 percentage points). As a result, he should not necessarily expect a "gender difference" as large as 15 percent to be statistically significant since this

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<sup>14</sup> If the sample size is small, the critical value, the value that divides significant results from results that are not significant, for the t-ratio can be larger than 1.96.

<sup>15</sup> This is similar to the margins of error reported with political polls.

difference is smaller than the margin of error for half of his tests. That is, he should only expect that "... the differences would be statistically significant for most of the parts of the organization ..." <sup>16</sup> if the systemic difference is very large indeed.

57. What is more, given the size of his margins of error, rather than expecting "...the women in all Business units [to be] similarly disadvantaged ...", he should expect a wide range of estimated "gender differences." That is, even in the presence of systemic discrimination he should expect his results to fall in a very large range.

58. As a result, it is not possible to learn about the presence or absence of systemic discrimination from these analyses. Dr. Ward has constructed them in such a way that if statistical evidence of systemic discrimination exists in these data, it would not be detected by his tests because his tests have so little statistical power.

### **III. Dr. Ward's Analyses Based on My Model**

59. Dr. Ward presents three analyses based on my model in Sections I, II, and III of his report: an analysis of pay differences, an analysis of differences in scores on the 360-degree review and an analysis of differences in quartile placement. He follows a similar procedure in these three analyses. He first extracts results from an analysis I presented in my Initial Class Certification report. <sup>17</sup> He then disaggregates these results by

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<sup>16</sup> Ward Report, p 55.

<sup>17</sup> In his analyses of pay and 360 review scores, Dr. Ward uses an identical model to a model I presented in my Initial Class Certification report. In his analysis of quartile placement Dr. Ward uses the same adjustment factors as I used. However, he uses an ordered probit analysis to compute his results while I used a standard binomial probit analysis. The two approaches give broadly similar results.

division, business unit, and rank (Associate/VP). Finally he looks to see whether there are statistically significant differences between man and women within the groups defined by division, business unit, and rank. He states that: “If such adverse patterns existed or if the pay or performance processes commonly worked to the detriment of women, I would expect to see a significant percentage of the analyses yield adverse outcomes that were statistically significant (large enough to be distinguishable from random chance).”<sup>18</sup>

60. In fact, Dr. Ward’s study is constructed in such a way that Dr. Ward should not expect to see “... a significant percentage of the analyses yield adverse outcomes that were statistically significant ...” even in the presence of systematic discrimination against women. The flaw in Dr. Ward’s procedure results from the small size of many of his business unit groupings. For example, in his analyses of pay differences the median size of his business unit groupings is 13 person/years for his analyses of Associates and 23 for his analyses of Vice Presidents.

61. The sizes of the groups Dr. Ward analyzes are important because with such small sample sizes, he would not be able to observe statistical significance even if there were very substantial pay differences between men and women. A difference must normally have a t-ratio of 1.96 or larger to be statistically significant. The t-ratio is calculated as the ratio between the pay difference and the standard error of the pay difference. (The standard error is a measure of how precisely the pay difference is measured.) That is, to be statistically significant, a difference must normally be larger than

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<sup>18</sup> Ward Report, page 5.

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its standard error multiplied by 1.96. The standard error multiplied by 1.96 is sometimes referred to as the margin of error for the difference. Other things being equal, larger sample sizes lead to smaller margins of error and smaller sample sizes lead to larger margins of error

62. I display data on Dr. Ward's margins of error for his analyses of pay differences in Table R3. I present data for Associates on the first line and data for Vice Presidents on the second line of this table. The second data column gives the median margin of error expressed in log points for his division/business unit/rank groupings. This can be compared to the mean difference in pay (expressed in log points) between men and women from Dr. Ward's regression analysis of all employees of the indicated rank, which appears in the first data column.<sup>19</sup> I present the median margin of error expressed in percentage points in the fourth column of the table and the regression adjusted mean difference in pay expressed in percentage points in the third column of the table.

63. These data indicate that the medians of Dr. Ward's margins of error are larger than the mean differences in pay. Among Associates the mean pay difference is [REDACTED] log points ([REDACTED] percentage points). By contrast, the median margin of error is [REDACTED] log points [REDACTED] percentage points). That is, Dr. Ward would be unable to detect a pay

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<sup>19</sup> Dr. Ward's regression is based on a model I presented in my Initial Class Certification Report. (See model 2d in Table 16.) It compares the earnings of men and women at Goldman Sachs who are the same in terms of work experience at Goldman Sachs, work experience at Goldman Sachs squared, relevant experience prior to working at Goldman Sachs, relevant experience prior to working at Goldman Sachs squared, education, year, office, division, whether a direct hire into the Associate (or VP) position with an adjustment for fiscal year being the year of hire, the AA job group, the CRS quartile and the average 360-review score with the effects of the score varying for appropriate periods according to its scale. It is limited to only those employees for whom the CRS quartile and the 360-scores are available.

difference of [REDACTED] percentage points or smaller among Associates in half of his division/business unit/rank groupings.

64. Among Vice Presidents the mean pay difference among Associates is [REDACTED] log points ([REDACTED] percentage points). By contrast, the median margin of error is [REDACTED] log points ([REDACTED] percentage points). That is, Dr. Ward would be unable to detect a pay difference of [REDACTED] percentage points or smaller among Vice Presidents in at least half of his division/business unit/rank groupings. Overall, there are 250 women employed in the 21 business units that have statistically significant pay differences favorable to women. This is only 5 percent of total female employment in both Associate and VP positions in 221 business units considered by Dr. Ward. Moreover, 17 of the 21 business units are comprised of less than 10 women – with 8 of the 21 business units having only one female employee. .

65. I display data on Dr. Ward's margins of error for his analyses of 360 Review scores in Table R4. I present data for Associates on the first line and data for Vice Presidents on the second line of this table. The second data column gives the median margin of error for his division/business unit/rank groupings for the period 2003 through 2009 (when the scale ranged from one to five). This can be compared to the mean difference in scores between men and women from Dr. Ward's regression analysis of all employees of the indicated rank, which appears in the first data column.<sup>20</sup> I present the

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<sup>20</sup> Doctor Ward's regression is based on a model I presented in my Initial Class Certification report. (See Model 360-2 Tables 14 and 15.) It compares the scores of men and women at Goldman Sachs who are the same in terms of work experience at Goldman Sachs, work experience at Goldman Sachs squared, relevant experience prior to working at Goldman Sachs, relevant

median margin of error for the period 2010 through 2011 (when the scale ranged from one to nine) in the fourth column of the table and the regression adjusted mean difference in scores from 2010 through 2011 in the third column of the table.

66. As with Dr. Ward's analysis of pay difference, the table shows that his margins of error for 360 scores are typically larger than the differences in scores in the population as a whole, with the differences in scores ranging from -0.04 through -0.08, while the median margin of error is never less than 0.16. Dr. Ward would be unable to detect a difference in 360 scores as large as 0.16 in at least half of his division/business unit/rank groupings.

67. I display data on Dr. Ward's margins of error for his analyses of quartile placement in Table R5. I present data for Associates on the first line and data for Vice Presidents on the second line of this table. The second data column gives the median margin of error for his division/business unit/rank groupings. This can be compared to the mean difference in the probability that men and women will be ranked in the top quartile from Dr. Ward's ordered probit analysis of all employees of the indicated rank, which appears in the first data column.<sup>21</sup>

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experience prior to working at Goldman Sachs squared, education, year, office, division, whether a direct hire into the Associate (or VP) position with an adjustment for fiscal year being the year of hire and the AA job group.

<sup>21</sup> The differences in the probability of being placed into the top quartile (Quartile 1) are obtained from the ordered probit model reported by Dr. Ward in his report. This model estimated the probabilities of placement into the following quartiles: Quartile 1, combined Quartiles 2 and 3, and combined Quartiles 4 and 5 (as in Dr. Ward's report.) The original model I presented in my Initial Class Certification report considered placement into Quartile 1 only. The estimated changes in probability are parallel to but not identical with those presented in Tables 10 and 11 of my Initial Class Certification Report. The model compares probabilities of placement into the top quartile of

68. Once again the table shows that Dr. Ward's margins of error are typically larger than the differences in outcomes in the population as a whole, with the differences in probabilities of being ranked in the top quartile being -0.05 for both Associates and Vice Presidents, while the median margin of error is 0.23 for Associates and 0.25 for Vice Presidents. Dr. Ward would be unable to detect a difference in the probability of being in the top quartile as large as 0.23 in at least half of his division/business unit/rank groupings.

69. These data show that it is not possible to learn about the presence or absence of systemic discrimination from Dr. Ward's analyses. By breaking the observations into such small groups, Dr. Ward has constructed his analysis to have such large margins of error that if statistical evidence of systemic discrimination exists in these data, even evidence of substantial magnitude, it could not be reliably detected by his tests.

#### **IV. Dr. Ward's Discussion of Variation in Pay at Goldman.**

70. Dr. Ward discusses the fact that pay varies from individual to individual in several contexts. He discusses the overall level of variation in pay in his Section XIII. He also discusses this in his Section XIV.E where he comments on the Root Mean Square Error of the regression analyses and his "matched pair" analysis. I am sure that Dr. Ward is aware that the t-ratios (or to use Dr. Ward's words "numbers of standard deviations") we both report take full account of the degree of unexplained variation in the data. If, as Dr.

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men and women at Goldman Sachs and includes work experience at Goldman Sachs, work experience at Goldman Sachs squared, relevant experience prior to working at Goldman Sachs, relevant experience prior to working at Goldman Sachs squared, education, year, employee's office and division, whether a direct hire into the Associate (or VP) position with an adjustment for fiscal year being the year of hire, and the AA job group.



Ward hints, the data are so noisy that the models cannot generate estimates of the pay difference that are precise enough to support my conclusion, then this fact would appear as a t-ratio that is too low to support the conclusion that my results are statistically significant. This is, in fact, not the case. The pay differences I measure are statistically significant. Therefore, the degree of variation in the data is not relevant to my conclusions.

71. Dr. Ward presented an illustrative analysis of variation in pay based on comparisons of pairs of workers with the same observable characteristics but with sharply differing compensation. He then talks with supervisors who provide ex post justification for the pay levels. There are two problems with this analysis. First, it illustrates simply that there is unexplained variation in pay, nothing more. The statistical tests I use are designed to account for this. Second, these matched pairs of individuals are not selected randomly. See Ward Tr. at 266. Dr. Ward testified in his deposition that defense counsel selected and contacted the managers to be interviewed. See Ward Tr. at 266; 305-06. This has the strong potential to result in a biased set of cases designed, perhaps unconsciously, to “prove a point”.

#### **V. Dr. Ward’s Misuse of An Ordered Probit**

72. Dr. Ward’s analysis of quartile placement is unreliably computed. In this analysis, Dr. Ward makes use of a statistical technique known as “ordered probit,” which is a type of maximum likelihood (or ML) procedure. Unlike conventional regression analyses, his technique only works correctly in large data samples. One econometrics text states this as follows:

In the typical ML estimation procedure, one would want to have a large sample size because the desirable properties of the MLE<sup>22</sup> (to be discussed below) are justified only in large sample situations.

and

It is usually not specified how large a sample size is “large enough.” For models with few parameters to estimate (i.e., 1 to about 5), a sample size of more than 60 is usually large enough.<sup>23</sup>

73. Dr. Ward analyzes 190 division/business unit/rank groupings. 62% of these groupings have sample sizes of less than 60. The prevalence of such small samples provides a second reason to disregard the results of Dr. Ward’s analysis of this issue.

#### **VI. Dr. Ward’s Promotion Analysis.**

74. Dr. Ward presents an analysis of promotions.<sup>24</sup> His analysis cover various periods of time for the three relevant divisions: 2007-2011 for Securities, 2005-2001 for IBD and 2008-2011 for IMD. I understand that the relevant period of time for the plaintiffs’ allegation of discrimination ends in 2008. As a result, Dr. Ward has not addressed the relevant question and these analyses, therefore, shed no light on the plaintiffs’ allegations.

75. Note also, that the model he uses for his analysis of promotions includes controls for Quartile and 360 Degree Review score. As I have explained, the plaintiffs’ allegations center on a claim that the Quartiles and the 360 Degree Review disadvantage

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<sup>22</sup> “Maximum likelihood estimation” or “MLE” is the mathematical technique used to compute binomial and ordered probits

<sup>23</sup> Eliason Scott R., Maximum Likelihood Estimation: Logic and Practice, Sage Publications, 1993, p. 8 and p. 83 (Notes: 2)

<sup>24</sup> Ward Report, Table 10, page 76.

women. It is therefore not legitimate to explain differences in promotion rate by differences in these two factors.<sup>25</sup>

76. In short Dr. Ward's analysis of promotions assumes that the plaintiffs' allegations are wrong and does not cover the relevant period of time.

77. Since I submitted my Initial Class Certification report, Goldman Sachs had produced documents (Bates stamped GS0164972 and GS0242506) that I reviewed. These documents provide further support for my statement in the Initial Class Certification report that "The final list of candidates is submitted to a firm-wide committee for review."



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Henry S. Farber  
July 29, 2014

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<sup>25</sup> Dr. Ward's model also included controls for production. As I explained above (see Section II), this variable may be tainted and it suffers from numerous other flaws.

**TABLE R1**  
**ANALYSIS OF DR. WARD'S REGRESSION MODELS OF EARNINGS DIFFERENCES**  
**Dr. Ward's Five Largest Groups of Associates†**

(1)	(2)	(3)	(4)	(5)
Model	Marginal Significance Level	Mean Log Point Difference	T-Ratio	Percentage Difference
Dr. Ward's Models	■	■	■	■
Dr. Ward's Model Without Adjustments for 360 Review Scores and Quartiles.	■	■	■	■

† Direct and non-direct hires in Securities and IBD, plus non-direct hires in IMD. These groups include 91 percent of women included in Dr. Ward's regression analyses.

(1) Results reported in this first row of the table refer to Dr. Ward's as reflected in his Tables 4, 5, 6, 7 and 9 and include all Associates both promoted and hired into position in Securities, IBD and IMD. The results reported in the second row of the table are parallel to those in the first row and reflect analyses that are identical to Dr. Ward's except that they do not include adjustments from 360 scores and managers' Quartile.

(2) The marginal significance level provides a test of whether the pay differences in Dr. Ward's six groups are different from one another. It is based on a Chi Square test. Marginal significance levels of 0.05 or less indicate that Dr. Ward's estimated pay differences are statistically significantly different from one another.

(3) The mean of the log pay differences in Dr. Ward's eight groups, weighted by the number of female person/years in his analyses.

(4) The absolute value of the T-Ratio ("number of standard deviations") for a test that the mean log point difference is statistically significant. Generally speaking a T-Ratio of 1.96 or larger indicates that the pay difference is statistically significant.

(5) The mean log point difference expressed as a percentage.

**TABLE R2**  
**ANALYSIS OF DR. WARD'S REGRESSION MODELS OF EARNINGS DIFFERENCES**  
**Dr. Ward's Five Largest Groups of Vice Presidents†**

(1)	(2)	(3)	(4)	(5)
Model	Marginal Significance Level	Mean Log Point Difference	T-Ratio	Percentage Difference
Dr. Ward's Models	■	■	■	■
Dr. Ward's Model Without Adjustments for 360 Review Scores and Quartiles.	■	■	■	■

† Direct and non-direct hires in Securities and IMD, plus non-direct hires in IBD. These groups include 92 percent of women included in Dr. Ward's regression analyses.

(1) Results reported in this first row of the table refer to Dr. Ward's as reflected in his Tables 4, 5, 6 and 9 and include all Associates both promoted and hired into position in Securities, IBD and IMD except PWAs. The results reported in the second row of the table are parallel to those in the first row and reflect analyses that are identical to Dr. Ward's except that they do not include adjustments from 360 scores and managers' Quartile.

(2) The marginal significance level provides a test of whether the pay differences in Dr. Ward's six groups are different from one another. It is based on a Chi Square test. Marginal significance levels of 0.05 or less indicate that Dr. Ward's estimated pay differences are statistically significantly different from one another.

(3) The mean of the pay differences in Dr. Ward's six groups, weighted by the number of female person/years in his analyses.

(4) The absolute value of the T-Ratio ("number of standard deviations") for a test that the mean log point difference is statistically significant. Generally speaking a T-Ratio of 1.96 or larger indicates that the pay difference is statistically significant.

(5) The mean log point difference expressed as a percentage.

**Table R3 : Median Margin of Error for Pay Differences by Business Unit**

Rank	Log Point Difference*	Median Margin of Error for Log Point Difference**		Percentage Difference*	Median Margin of Error for Percentage Difference**
		Point	Percentage		
Associate	█	█	█	█ %	█

\* The log point difference in earnings and the corresponding percentage difference in earnings are obtained from Model 2d (Tables 16 and 17 in the Farber Initial Class Certification report). This model compares the earnings of men and women at GS and includes work experience at GS, work experience at GS squared, relevant experience prior to working at GS, relevant experience prior to working at GS squared, education, year, employee's office and division, whether a direct hire into the Associate (or VP) position with an adjustment for fiscal year being the year of hire, the AA job group, the CRS quartile and the average 360-review score with the effects of the score varying for appropriate periods according to its scale. It is limited to only those employees for whom the CRS quartile and the 360-scores are available.

The sample for the difference in earnings includes 1,756 person-years observations on female and 4,527 person-year observations on male Associates (2,613 and 9,811 respectively for female and male Vice Presidents).

\*\*The sample for the margin of error includes 1,567 person-years observations on female and 3,946 person-years observations on male Associates (2,368 and 8,700 respectively for female and male Vice Presidents). This is the sample used by Dr. Ward in his Expert report. Dr. Ward's sample is smaller as he excludes data prior to 2005 and he is unable to compute the differences in earnings for a number of business units that have a small number of employees and/or no female employees in a given business unit.

**Table R4: Median Margin of Error for the 360-Score Differences by Business Unit**

Rank	Median Margin of Error**		Median Margin of Error**	
	Difference* 2003-2009	2005-2009	Difference* 2010-2011	2010-2011
Associate	-0.05	0.18	-0.08	0.28
VP	-0.05	0.16	-0.04	0.22

\*The differences in the average 360-review scores are obtained from Model 360-2 (Tables 14 and 15 in the Farber Initial Class Certification report). This model compares the average 360-review scores of men and women at GS and includes work experience at GS, work experience at GS squared, relevant experience prior to working at GS, relevant experience prior to working at GS squared, education, year, employee's office and division, whether a direct hire into the Associate (or VP) position with an adjustment for fiscal year being the year of hire, the AA job group for the periods when the 360-scores were respectively 1 to 5, and 1 to 9.

The sample for the difference in the 360-review scores includes 1,756 person-years observations on female and 4,527 person-year observations on male Associates (2,613 and 9,811 respectively for female and male Vice Presidents).

\*\*The sample for the margin of error includes 1,547 person-years observations on female and 3,758 person-years observations on male Associates (2,351 and 8,566 respectively for female and male Vice Presidents). This is the sample used by Dr. Ward in his Expert report. Dr. Ward's sample is smaller as he excludes data prior to 2005 and he is unable to compute the differences in the 360-review scores for a number of business units that have a small number of employees and/or no female employees in a given business unit.

**Table R5: Median Margin of Error for Differences in Probability of Top Quartile Placement**

Rank	Difference in Probability for Top Quartile Placement*	Median Margin of Error for the Difference**
Associate	-0.05	0.23
VP	-0.05	0.25

\*The differences in the probability of being placed into the top quartile (Quartile 1) are obtained from the ordered probit model estimated by Dr. Ward in his Expert report. This model estimated the probabilities of placement into the following quartiles: Quartile 1, combined Quartiles 2 and 3, and combined Quartiles 4 and 5 (as in Dr. Ward's Expert report.) The original model estimated by Dr. Farber in his Initial Class Certification report considered placement into Quartile 1 only. The estimated changes in probability are parallel but not identical to those presented in tables 10 and 11 of the Farber Initial Class Certification report. The model compares probabilities of placement into the top quartile of men and women at GS and includes work experience at GS, work experience at GS squared, relevant experience prior to working at GS, relevant experience prior to working at GS squared, education, year, employee's office and division, whether a direct hire into the Associate (or VP) position with an adjustment for fiscal year being the year of hire, and the AA job group.

The sample for the difference in the 360-review scores includes 1,756 person-years observations on female and 4,527 person-year observations on male Associates (2,613 and 9,811 respectively for female and male Vice Presidents).

\*\*The sample for the margin of error includes 1,518 person-years observations on female and 3,782 person-years observations on male Associates (2,349 and 8,598 respectively for female and male Vice Presidents). This is the sample used by Dr. Ward in his Expert report. Dr. Ward's sample is smaller as he excludes data prior to 2005 and he is unable to compute the differences in the probability for the top quartile placement for a number of business units that have a small number of employees and/or no female employees in a given business unit.



**APPENDIX A**

**Henry Stuart Farber**  
**January 2014**

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**Office Address:**

Industrial Relations Section  
Firestone Library  
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Princeton, NJ 08544-2098  
**Phone:** (609) 258-4044  
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**Date of Birth:** January 29, 1951

**Education**

Rensselaer Polytechnic Institute, BS (Economics), 1972  
Cornell University, MS (Industrial and Labor Relations), 1974  
Princeton University, Ph.D. (Economics), 1977

**Current Employment**

Princeton University

Professor of Economics, 1991-1995.

Hughes-Rogers Professor of Economics, 1995-present.

**Other Current Appointments**

Faculty Associate, Industrial Relations Section, Princeton University, 1991-present.

Research Associate, National Bureau of Economic Research, 1982-.

Research Fellow, Institute for the Study of Labor (IZA), Bonn, 2006-.

Faculty Associate, Program in Political Economy, Princeton University, 1993-.

Faculty Associate, Program in Applications of Computing, Princeton University, 1996-.

Faculty Associate, Program in Law and Public Affairs, Princeton University, 1999-.

Faculty Associate, Center for the Study of Social Organization, Princeton University, 2008-.

Editorial Board, Journal of Labor Abstracts, 1996-.

Associate Editor, Journal of Empirical Legal Studies, 2004-.

Labour Statistics Advisory Committee, Statistics Canada, 2003-.

Executive and Supervisory Committee (ESC) of CERGE-EI, Prague, 2005-2009, 2011-.

International Affiliate, Canadian Labour Market and Skills Researcher Network (CLSRN),  
2011-.

**Honorific Fellowships**

Fellow, Econometric Society, elected 1988.

Fellow, Society of Labor Economists, elected 2004.

Fellow, Labor and Employment Relations Association, named 2009.

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**January 2014**

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**Major Fields of Interest**

Labor Economics      Econometrics      Law and Economics  
Industrial Organization      Political Economy

**Past Positions**

Professor (1986-1991), Associate Professor (1981-1986), Assistant Professor (1977-1981), Department of Economics, Massachusetts Institute of Technology.

Institute for Advanced Study, School of Social Science. Member, September 2006 - August 2007. Visitor, September 2010 - August 2011.

Russell Sage Foundation, Visiting Scholar, September 2002 - July 2003.

Fellow, Center for Advanced Study in the Behavioral Sciences, 1983-1984 and 1989-1990.

Director, Industrial Relations Section, Princeton University, July 1993-December 1993, July 1995-June 1998, July 2003 - June 2004.

Associate Editor, Industrial and Labor Relations Review, 1999-2004.

Associate Editor, Quarterly Journal of Economics, 1984-1989.

Editorial Board, American Economic Review, 1988-1991.

Social Science Research Council Advisory Group on a 1986 Quality of Employment Survey, 1985-86.

Visiting Fellow, University of Warwick, Summer 1982.

Member, Visiting Committee, Department of Economics, Princeton University, 1979-1990.

Member, Nominating Committee, Industrial Relations Research Association, 1990.

Co-Director, Summer Institute on Negotiation and Dispute Resolution, Center for Advanced Study in the Behavioral Sciences, Summer 1992.

John M. Olin Fellow, Cornell Law School, February 1994 and October 1994.

Member, Peer Review Panel, National Science Foundation Economics Program, Spring 1992, Spring 1994-Spring 1995.

Editorial Board, Industrial and Labor Relations Review, 1994-1999.

Member, Peer Review Panel, National Science Foundation Behavioral Sciences Infrastructure Competition, Spring 1999.

Member, Committee on the Status of Women in the Economics Profession, 1996-2000

Technical Review Committee, National Longitudinal Surveys, 1996-2004.

Social Science External Advisory Council, Cornell University, 2006-2008.

**Membership in Professional Societies**

American Economic Association

American Law and Economics Association

American Statistical Association

Econometric Society (Fellow)

Society of Labor Economists (Fellow)

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### Fellowships, Grants, Contracts, and Awards

- National Science Foundation, Grant No. SES-7924880 to Massachusetts Institute of Technology, "Economics of Labor Unions," 1/80-6/82.
- U.S. Department of Labor, Minimum Wage Study Commission, Contract No. J9E-00113 to Massachusetts Institute of Technology, "Union Wages and the Minimum Wage," 9/80-2/81.
- Alfred P. Sloan Research Fellowship, Alfred P. Sloan Foundation, 9/81-8/85.
- National Science Foundation, Grant No. SES-8207703 to Massachusetts Institute of Technology, "An Analysis of the Unionization Process in the United States," 7/82-6/83.
- Edwin E. Ghiselli Award for Research Design, American Psychological Association, Division 14, 1984. (with Max H. Bazerman)
- National Science Foundation, Grant No. SES-8408623 to National Bureau of Economic Research, "Threat Effects and the Extent of Unionization in the United States," 7/84-12/86.
- National Science Foundation, Grant No. SES-8605530 to National Bureau of Economic Research, "The Political Economy of Labor Unions," 8/86-12/88.
- National Science Foundation, Grant No. SES-8912664 to National Bureau of Economic Research, "Empirical Analysis of Inter-Firm Worker Mobility," 7/89-6/92.
- U.S. Department of Labor, Grant No. E-9-J-9-0050 to National Bureau of Economic Research, "Evaluating Competing Theories of Interfirm Worker Mobility," 9/89-1/92.
- U. S. Department of Labor, Office of the Assistant Secretary for Policy, Contract No. B9461588, "Incidence and Consequences of Job Loss," 12/95-4/46.
- U. S. Department of Labor, Office of the Assistant Secretary for Policy, Contract No. B9462164, "Alternative Employment Arrangements as a Response to Job Loss," 7/96-12/96.
- U. S. Department of Labor, Office of the Assistant Secretary for Policy, Contract No. B9492501, "Job Loss and Long-Term Employment in the U.S." 6/99-11/99.
- Richard E. Quandt Teaching Prize, Department of Economics, Princeton University, June 2000 and June 2011.

### Published Papers

- "The Composition of Strike Activity in the Construction Industry," *Industrial and Labor Relations Review*, April 1976: pp. 388-404. (with D.B. Lipsky)
- "The Determinants of Union Wage Demands: Some Preliminary Empirical Evidence," *Proceedings of the Thirtieth Annual Winter Meeting of the Industrial Relations Research Association*, 1977.
- "Bargaining Theory, Wage Outcomes, and the Occurrence of Strikes: An Econometric Analysis," *American Economic Review*, June 1978: pp. 262-271.

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**Published Papers (cont'd)**

- “Individual Preferences and Union Wage Determination: The Case of the United Mine Workers,” *Journal of Political Economy*, October 1978: pp. 923-942.
- “The United Mine Workers and the Demand for Coal: An Econometric Analysis of Union Behavior,” *Research in Labor Economics*, Vol. 2, 1978.
- “Interest Arbitration, Outcomes, and the Incentive to Bargain,” *Industrial and Labor Relations Review*, October 1979: pp. 55-63. (with Harry C.Katz)
- “Unionism, Labor Turnover, and Wages of Young men,” *Research in Labor Economics*, Vol. 3, 1980: pp. 33-35.
- “Why Workers Want Unions: The Role of Relative Wages and Job Characteristics,” *Journal of Political Economy*, April 1980: pp. 349-369. (with Daniel H. Saks)
- “An Analysis of Final-Offer Arbitration,” *Journal of Conflict Resolution*, December 1980: Vol. 24, No. 4, pp. 683-705.
- “Does Final-Offer Arbitration Encourage Bargaining?” *Proceedings of the Thirty-third Annual Meeting of the Industrial Relations Research Association*, 1980: pp. 219-226.
- “The Role of Arbitration in Dispute Settlement,” *Monthly Labor Review*, May 1981.
- “Union Wages and the Minimum Wage,” *Report of the Minimum Wage Study Commission*, Vol. VI, 1981.
- “Splitting-the-Difference in Interest Arbitration,” *Industrial and Labor Relations Review*, October 1981, pp. 70-77.
- “Job Queues and the Union Status of Workers,” *Industrial and Labor Relations Review*, April 1982: pp. 354-367. (with John M. Abowd)
- “Worker Preferences for Union Representation,” *Research in Labor Economics*, Supplement 2, 1983: pp. 171-205.
- “The Determination of the Union Status of Workers,” *Econometrica*, September 1983: pp. 1417-1437.
- “Right to Work Laws and the Extent of Unionization,” *Journal of Labor Economics*, July 1984: pp. 319-352.
- “Analyzing the Decision Processes of Third Parties,” *Sloan Management Review*, Fall 1985: pp. 39-48. (with Max H. Bazerman)
- “Arbitrator Decision Making: When are Final Offers Important?” *Industrial and Labor Relations Review*, October 1985: pp. 76-89. (with Max H. Bazerman)
- “The Extent of Unionization in the United States: Historical Trends and Prospects for the Future,” Presented to M.I.T./Union Conference, June 1983. in *Challenges and Choices Facing American Labor*, Thomas Kochan, ed. M.I.T. Press, 1985.
- “The Analysis of Union Behavior.” In Ashenfelter and Layard, eds. *The Handbook of Labor Economics*, North Holland Publishing Company, 1986.

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**Published Papers (cont'd)**

- “The General Basis of Arbitrator Behavior: An Empirical Analysis of Conventional and Final-Offer Arbitration,” *Econometrica*, November 1986: pp. 1503-1528. (with Max H. Bazerman)
- “Why is there Disagreement in Bargaining?” *American Economic Review*, May 1987: pp. 347-352. (with Max H. Bazerman)
- “Job Duration, Seniority, and Earnings,” *American Economic Review* June 1987: pp. 278-297. (with Katharine G. Abraham)
- “The Recent Decline of Unionization in the United States,” *Science* 13 November 1987, pp. 915-920.
- “The Evolution of Public Sector Bargaining Laws.” in *When Public Sector Employees Unionize*, Richard B. Freeman and Casey Ichniowski, eds., University of Chicago Press, 1988, pp. 129-166.
- “Returns to Seniority in Union and Nonunion Jobs: a New Look at the Evidence,” *Industrial and Labor Relations Review* 42 October 1988: pp. 3-19. (with Katharine G. Abraham)
- “Divergent Expectations as a Cause of Disagreement in Bargaining: Evidence from a Comparison of Arbitration Schemes,” *Quarterly Journal of Economics* 104 February 1989: pp. 99-120. (with Max H. Bazerman)
- “Trends in Worker Demand for Union Representation,” *American Economic Review*, 79(2), May 1989: pp.166-171.
- “The Decline of Unionization in the United States: What Can be Learned from Recent Experience?,” *Journal of Labor Economics* 8(1) January 1990: pp. S75-S105.
- “The Role of Arbitration Costs and Risk Aversion In Dispute Outcomes,” *Industrial Relations* 29(3), Fall 1990: pp. 361-384. (with Margaret A. Neale and Max H. Bazerman)
- “Medical Malpractice: An Empirical Examination of the Litigation Process,” *Rand Journal of Economics* 22(2), Summer 1991: pp. 199-217. (with Michelle J. White)
- “Is Arbitration Addictive? Evidence from the Laboratory and the Field,” *Proceedings of the Forty-fourth Annual Meeting of the Industrial Relations Research Association*, 1992, pp. 402-410. (with Janet Currie)
- “An Experimental Comparison of Dispute Rates in Alternative Arbitration Systems,” *Econometrica* 60(6), November 1992: pp. 1407-1433. (With Orley Ashenfelter, Janet Currie, and Matthew Spiegel)
- “Union Membership in the United States: The Decline Continues,” in *Employee Representation: Alternatives and Future Directions*, Bruce Kaufman and Morris Kleiner, editors. Industrial Relations Research Association, 1993. (with Alan B. Krueger)
- “The Incidence and Costs of Job Loss: 1982-1991,” *Brookings Papers on Economic Activity: Microeconomics*, 1993: pp. 73-132.
- “A Comparison of Formal and Informal Dispute Resolution in Medical Malpractice,” *Journal of Legal Studies*, June 1994: pp. 777-806. (with Michelle J. White)

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**Published Papers (cont'd)**

- “The Analysis of Inter-Firm Worker Mobility,” *Journal of Labor Economics*, October 1994: pp. 554-593.
- “Forming Beliefs about Adjudicated Outcomes: Risk Attitudes, Uncertainty, and Reservation Values,” *International Review of Law and Economics*, 1995 : pp. 289-303. (with Linda Babcock, Cynthia Fobian, and Eldar Shafir)
- “Politics and Peace,” *International Security*, Fall 1995: pp. 123-146. (with Joanne Gowa). Reprinted in *Debating the Democratic Peace*, Michael E. Brown, Sean M. Lynn-Jones, and Steven E. Miller, eds. MIT Press, 1996.
- “Learning and Wage Dynamics,” *Quarterly Journal of Economics* 111 November 1996: 1007-1047. (With Robert Gibbons)
- “Common Interests or Common Politics? Reinterpreting the Democratic Peace,” *Journal of Politics* 59 May 1997: 393-417. (with Joanne Gowa)
- “The Litigious Plaintiff Hypothesis: Case Selection and Resolution,” *Rand Journal of Economics* 28 1997 : S92-S112. (with Theodore Eisenberg)
- “The Changing Face of Job Loss in the United States, 1981-1995,” *Brookings Papers on Economic Activity: Microeconomics*, 1997: 55-128.
- “Trends in Long-Term Employment in the United States: 1979-1996,” in *Third Public GAAC Symposium: Labor Markets in the USA and Germany*, German-American Academic Council Foundation, Bonn and Washington, 1998.
- “Has the Rate of Job Loss Increased in the Nineties?” *Proceedings of the Fiftieth Annual Winter Meeting of the Industrial Relations Research Association*, Volume 1, 1998: 88-97.
- “Are Lifetime Jobs Disappearing? Job Duration in the United States: 1973-1993,” in *Labor Statistics Measurement Issues*, John Haltiwanger, Marilyn Manser, and Robert Topel, eds., University of Chicago Press, 1998. pp. 157-203.
- “Mobility and Stability: The Dynamics of Job Change in Labor Markets.” In Ashenfelter and Card, eds. *The Handbook of Labor Economics*, vol 3B, pp. 2439-2484, North Holland Publishing Company, 1999.
- “Changing Stock Market Response to Announcements of Job Loss: Evidence from 1970-1997,” *Proceedings of the Fifty-First Annual Winter Meeting of the Industrial Relations Research Association*, Volume 1, 1999. pp. 26-34. (with Kevin Hallock).
- “Alternative Employment Arrangements as a Response to Job Loss,” *Journal of Labor Economics*, October 1999. pp. S142-S169.
- “Capital Markets and Job Loss: Evidence from North America,” *Wirtschafts Politische Blatter*, 1999. pp. 573-577. (with Kevin Hallock).
- “Recent Trends in Employer-Sponsored Health Insurance Coverage: Are Bad Jobs Getting Worse?” *Journal of Health Economics*, January 2000. pp. 93-119. (with Helen Levy).



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**Published Papers (cont'd)**

- “Trends in Long-Term Employment in the United States: 1979-1996,” in Estreicher, ed. *Global Competition and the American Employment Landscape As We Enter the 21st Century: Proceedings of New York University 52d Annual Conference on Labor*, pp. 63-98, Kluwer Law International, 2000.
- “Union Success in Representation Elections: Why Does Unit Size Matter?” *Industrial and Labor Relations Review*, January 2001. pp. 329-348.
- “Accounting for the Decline of Unions in the Private Sector, 1973-1998,” *Journal of Labor Research*, Summer 2001. pp. 459-485. Reprinted in *The Future of Private Sector Unionism in the United States* James T. Bennett and Bruce E. Kaufman, eds. Armonk, NY. M. E. Sharpe. (with Bruce Western)
- “Ronald Reagan and the Politics of Declining Union Organization,” *British Journal of Industrial Relations*, September 2002. pp. 385-401. (with Bruce Western)
- “The Government As Litigant: Further Tests of the Case Selection Model,” *American Law and Economics Review*, 2003. (with Theodore Eisenberg)
- “Can Increased Organizing Reverse the Decline of Unions in the U.S.? Lessons from the Last Quarter Century,” in *Changing Role of Unions: New Forms of Representation*. P. Wunnava, ed. M.E. Sharpe, 2004. pp. 323-361. (with Bruce Western)
- “Job Loss in the United States, 1981-2001,” *Research in Labor Economics* 23 (2004), pp. 69-117.
- “Is Tomorrow Another Day? The Labor Supply of New York City Cab Drivers,” *Journal of Political Economy* 113 (February 2005), pp. 46-82.
- “Nonunion Wage Rates and the Threat of Unionization,” *Industrial and Labor Relations Review* 58 (April 2005), pp. 335-352.
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- “Job Loss and the Decline in Job Security in the United States,” in Katharine G. Abraham, James R. Spletzer, and Michael Harper, eds. *Labor in the New Economy*. U. of Chicago Press, 2010.
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- “Job Loss: Historical Perspective from the Displaced Workers Survey.” in *Unexpected Lifecycle Events and Economic Security: the Roles of Job Loss, Disability, and Changing Family Structure*, Kenneth A. Couch, Mary C. Daly, and Julie Zissimopoulos, eds., Stanford University Press, 2013, pp. 11-33.

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- "An Analysis and Evaluation of Final Offer Arbitration," Working Paper No. 242, Department of Economics, M.I.T., May 1979.
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- “The Determination of Negotiated Wage Changes: A Reference Wage Approach,” Sep 1981.
- “The Demand for Union Representation,” Working Paper No. 295, Department of Economics, M.I.T., February 1982.
- “The Union Status of Jobs: Some Preliminary Results,” December 1982. Presented at Conference on Labor Economics, Hoover Institution, January 1983.
- “The Political Economy of Labor Unions,” October 1983.
- “Product Market Competition, Union Organizing Activity, and Employer Resistance,” Working Paper No. 551, Department of Economics, MIT, April 1990. (With John Abowd)
- “Evaluating Competing Theories of Worker Mobility,” Final Report submitted to U.S. Department of Labor, Bureau of Labor Statistics, March 1992.
- “The Relationship Between Quality of Care and Liability in Medical Malpractice,” mimeo, June 1992. (with Michelle J. White)
- “The Role of the Panel Study of Income Dynamics in the Analysis of Labor Force Dynamics,” mimeo, October 1994. (prepared at the request of the Board of Overseers of the Panel Study of Income Dynamics)
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- “Job Loss in the United States, 1981-1999,” Working Paper No. 453, Industrial Relations Section, Princeton University, June 2001.
- “What’s a Dropout to Do? Coping with the Deterioration of the Low-Skilled Labor Market,” Working Paper No. 467, Industrial Relations Section, Princeton University, July 2002. (with Leah Platt)
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- “Increasing Voter Turnout: Is Democracy Day the Answer?” Working Paper No. 546, Industrial Relations Section, Princeton University, February 2009.
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“Do Extended Unemployment Benefits Lengthen Unemployment Spells? Evidence from Recent Cycles in the U.S. Labor Market,” Working Paper No. 573, Industrial Relations Section, Princeton University, April 2013.

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**Sworn Testimony  
In the Past Five Years  
01/28/2014  
Henry S. Farber**

1. Deposition testimony, Patrick Brady, et al., vs. Air Line Pilots Association, International, USDC New Jersey, 02-2917 (JEI), January 2013.
2. Hearing testimony, before the National Labor Relations Board in the matter of New York University, employer, and GSOC/UAW, petitioner. Case 2-RC-23481, January 2011.
3. Deposition testimony, Chen Oster et al., v. Goldman, Sachs & Co. and The Goldman Sachs Group, Inc., November 19, 2013.

**APPENDIX B**

**Documents Considered in Preparing the  
Rebuttal Report of Henry S. Farber**

**A. Deposition Transcripts**

Deposition of Stephanie Blinder, April 30, 2013

Deposition of Lisa Donovan, July 1-2, 2013

Deposition of Caroline Heller Sberloti, July 10-11, 2013

Deposition of Jessica Kung, July 31, 2013 - August 1, 2013

Deposition of David Landman, October 10, 2013

Deposition of Bruce Larson, June 12, 2013

Deposition of Henry S. Farber, November 19, 2013

Deposition of Michael P. Ward, January 6, 2014

**B. Bates Numbered Documents**

GS0003383

GS0004777

GS0004968

GS0004990

GS0098006

GS0098769

GS0109388

GS0109402

GS0113195

GS0113548

GS0113858

GS0119395

GS0120158

GS0120172

GS0120195

GS0120580

GS0120594

GS0120828

GS0121383

GS0122578

GS0153476

GS0209411

GS0164972

GS0242506

**C. Electronic Documents**

*PeopleSoft:*

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

*Compensation Recommendation System (CRS):*

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]



*Firmwide Review System (FRS):*

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

*Division Specific Data*

[REDACTED]

*Backup materials for Dr. Ward's Expert Report of December 13, 2013*

**D. Other Documents**

Expert Report of Michael P. Ward, Ph.D. in the Matter of Chen-Oster et al. vs. Goldman Sachs & Co. and The Goldman Sachs Group, Inc.

First Amended Class Action Complaint, H. Christina Chen-Oster, Lisa Parisi and Shanna Orlich v. Goldman Sachs & Co. and The Goldman Sachs Group, Inc., September 19, 2011

Correspondence from Rebecca Farber, March 19, 2013

<http://www.goldmansachs.com/careers/why-goldman-sachs/our-divisions>

Greene William, H., *Econometric Analysis*, 5<sup>th</sup> edition, Prentice Hall, 2003, pp. 486-488

Eliason Scott, R., *Maximum Likelihood Estimation: Logic and Practice*, Sage Publications, 1993, p. 8 and p. 83 (Notes: 2)

Electronic Code of Federal Regulations, <http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=3b71cb5b215c393fe910604d33c9fed1&rgn=div5&view=text&node=41:1.2.3.1.2&idno=41#41:1.2.3.1.2.2.1.3>.