MARCH 29, 2016

SUBTASK 4.1 REPORT

EVALUATION OF PIMS MODELING OF MACROECONOMIC VARIABLES

One of Three Six-Month Reports

IN-DEPTH TECHNICAL REVIEW OF PENSION BENEFIT GUARANTY CORPORATION'S MULTIEMPLOYER AND SINGLE-EMPLOYER PENSION MODELS

Prepared for:

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Contents

Introduction

In July 2015, the Social Security Administration (SSA) engaged the FTI Consulting team (FTI) to conduct an 18-month, in-depth technical review of the Pension Benefit Guaranty Corporation's (PBGC) single-employer (SE) and multiemployer (ME) Pension Insurance Modeling System (PIMS). Task 4 of the Statement of Work (SOW) consists of 10 subtasks required for this in-depth review - nine specific areas of review and a final report.[1] Three of the subtask reports are due at the end of each of the six-, 12- and 18-month periods. This report for Subtask 4.1, along with those for Subtasks 4.5 and 4.9, are due at the six-month period. As a part of our comprehensive review of PIMS, this report documents our evaluation of its macroeconomic variables (see Subtask 4.1: Evaluate Modeling of Macroeconomic Variables). It also addresses the following key questions raised in Subtask 4.1:

a. Is the estimation and application of these processes adequate?
b. Is the modeling of wages and salary increases at the firm level consistent with the inflation simulation?
c. Is a fixed real return appropriate?
d. Is using nominal rates from 1972-2007 to estimate the interest rate process appropriate?
e. Are the rate-of-return specifications appropriate to the models' intended use?
f. Are major variables lacking (e.g., unionization, unemployment) which are important to add, and if so how?

It should be noted that certain influences on PBGC's financial condition are not addressed here, but rather in subsequent reports. These include trends in mortality rates, changes in PBGC premium rates and their possible impact on plan sponsor behavior, and changes in applicable law, such as the Multiemployer Pension Reform Act of 2014.

Altogether, the SOW prescribed that FTI would produce three reports for each of the three six-month periods during the contract. Our team recognized that, due to the tasks necessary for the project start-up, the time to complete the reports during the first six months would be compressed. The start-up tasks included the initial kick-off meeting with the PBGC and SSA, creating the final workplan, installing the servers at the FTI Consulting Data Center, reviewing initial documentation and gaining an understanding of the system. Due to the tighter window to complete reports, we chose the three subtasks that were not solely dependent on the system being fully operational. Subtasks 4.1 and 4.9 (Evaluate the Presentation of Model Output) were identified by our team as ones for which a significant amount of work could be completed without access to PIMS software. We expected Subtask 4.5 (Evaluate PIMS Documentation) would be challenging to complete in the first six months, but also considered that a review of the documentation would be necessary in order to help our team understand the system. Although our team has produced comprehensive reports for this first six-month period, we also recognize that during the next 12 months there will be significant added insight gained that will enhance our understanding of PIMS and could potentially change some of our views. Additional information and findings will be included in the future as either an addendum to this report or in the Subtask 4.10 final report, or both.

[1] Social Security Administration, Evaluation of the Pension Benefit Guaranty Corporation's Pension Models, Description/Specification/Work Statement, p. 14.

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Initial Findings

Based on our analysis, we recommend that PBGC consider making the following changes in or additions to its SE-PIMS and ME-PIMS modeling:

- To forecast ***wages and salaries,*** consider using the long-term trend in the Social Security Administration's Average Wage Index (AWI), as this index is both readily available and used not just by the SSA but also widely by pension practitioners.

- Incorporate a ***unionization-trend variable*** in PIMS modeling, perhaps through modification of the weights assigned to alternative future outcomes, or modification of current benefit plan sampling methods.

- ***Increase investment, in relative terms, in economic research and analysis*** aimed at pinpointing, and assessing the impacts of, major competitive shifts and structural changes in domestic industry arising from economic trends both domestic and global, and related changes in technology, regulation, and the conditions of international trade.

- To forecast ***plan stock returns***, consider using a model that incorporates: (a) the time-varying nature of return distribution parameters (expected stock returns, volatility, and correlation with other asset classes, particularly bonds); (b) fat tails; and (c) different economic regimes. The last refers to different phases of the business cycle, periods in government regulation or policy, and other secular changes materially affecting the economic environment. In addition, consider mean-reversion in an economic contraction regime, if PBGC were to introduce regime-switching in its modeling of stock returns.

- To forecast ***plan bond returns***, consider modeling the term structure of both real and nominal interest rates. With respect to both, consider using a mean-reverting model with a deterministic time trend. Further, given the high persistence in both real and nominal interest rates documented in academic research and PBGC's projection horizon, also consider a random walk model for real interest rates similar to the one PBGC implemented in 2014 for nominal interest rates. Ultimately, the choice of any model is an empirical question, dependent on testing.

- Consider modeling ***both plan stock returns and bond yields*** using monthly or quarterly data, so that the models can be reliably estimated based on a recent history incorporating a regulatory structure, policy regime, and economic data more representative of the period PIMS is simulating.

- In addition to employing the ***discount rate*** currently used to present-value plan obligations, consider employing a rate based on the term structure of Treasury bonds or Government Agency Security interest rates.

Forecasting Wages and Salaries

Current Practice

According to the PIMS System Description of September 22, 2010,[2] plan participants' wages and salaries, a key determinant of plan obligations, are forecast to grow in such a manner as to reflect both productivity increases and increases in the cost of living (inflation).[3] More specifically, assumptions with respect to future values of both of those variables are taken from OASDI Trustees Reports.[4]

Implications of Recent Research

Recent research and related economic trends suggest that, considered in isolation, the above approach may lead to overstated wage and salary forecasts, as it fails to fully account for such factors as technological change causing the substitution of capital for low-skilled labor and the integration of labor markets worldwide attendant to globalization.[5]

As shown in Exhibit L-1, after adjusting for changes in the CPI-U, average hourly earnings[6] in the United States are no higher than they were 45 years ago, a result inconsistent with the assumption that they grow sufficiently to compensate workers for both increases in labor productivity (which more than doubled over the period – see Exhibit L-2) and a six-fold increase in the cost of living.[7] Indeed, the long-term stagnation, if not decline, in average real wages in this country has been the subject of extensive study, with no startling reversal in the future generally foreseen.[8]

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[2] Confirmed by PBGC staff as still applicable at the time of this writing.

[3] Pension Insurance Modeling System, *PIMS System Description for PIMS SOA "Core" (vFY09.1), Version 1.0* Revised 9/22/2010, pages 2-16 and 2-17.

[4] See, for example, Office of the Chief Actuary, Social Security Administration, "The Long-Range Economic Assumptions for the 2015 Trustees Report," July 22, 2015, page 1.

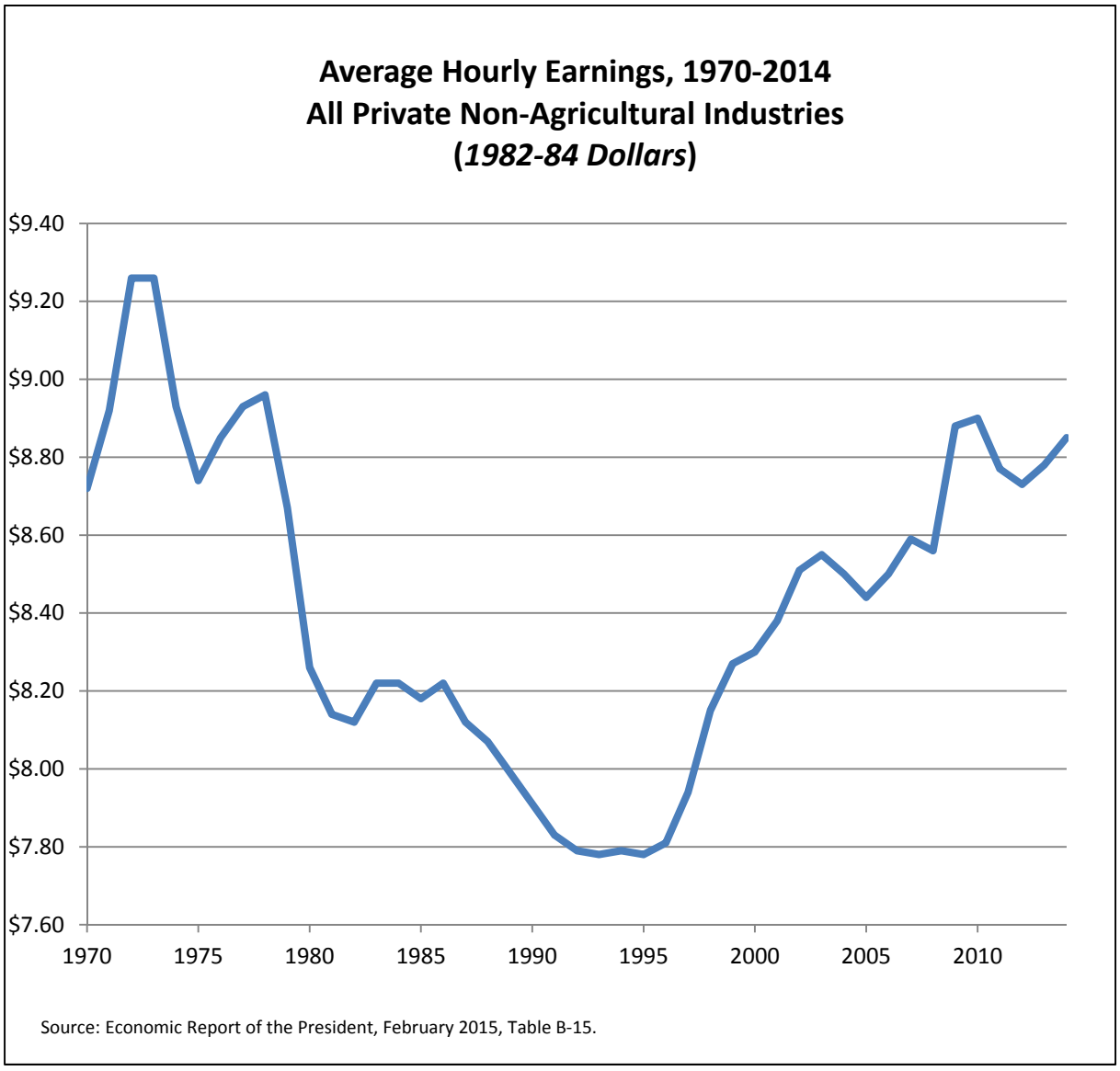
[5] This suppresses rightward shifts in the domestic demand curve for labor in the aforesaid category, as both the domestic and worldwide economies grow.

[6] As derived by Bureau of Labor Statistics under its Current Employment Statistics (CES) program. As the Bureau notes, "The CES hours and earnings series are derived from reports of payrolls and the corresponding paid hours for all employees… The payroll is reported before deductions of any kind, such as those for old-age unemployment insurance, group insurance, withholding tax, bonds, or union dues; also included is pay for overtime, holidays and vacation… Employee benefits (such as health and other types of insurance, contributions to retirement, and so forth, paid by the employer)… are excluded." U.S. Department of Labor, Bureau of Labor Statistics, *BLS Handbook of Methods*, Chapter 2, pages 2-3.

[7] Between 1970 and December 2014, the CPI-U increased by 490%. See U.S. Department of Labor, Bureau of Labor Statistics, *CPI Detailed Report,* Data for September 2015, page 70.

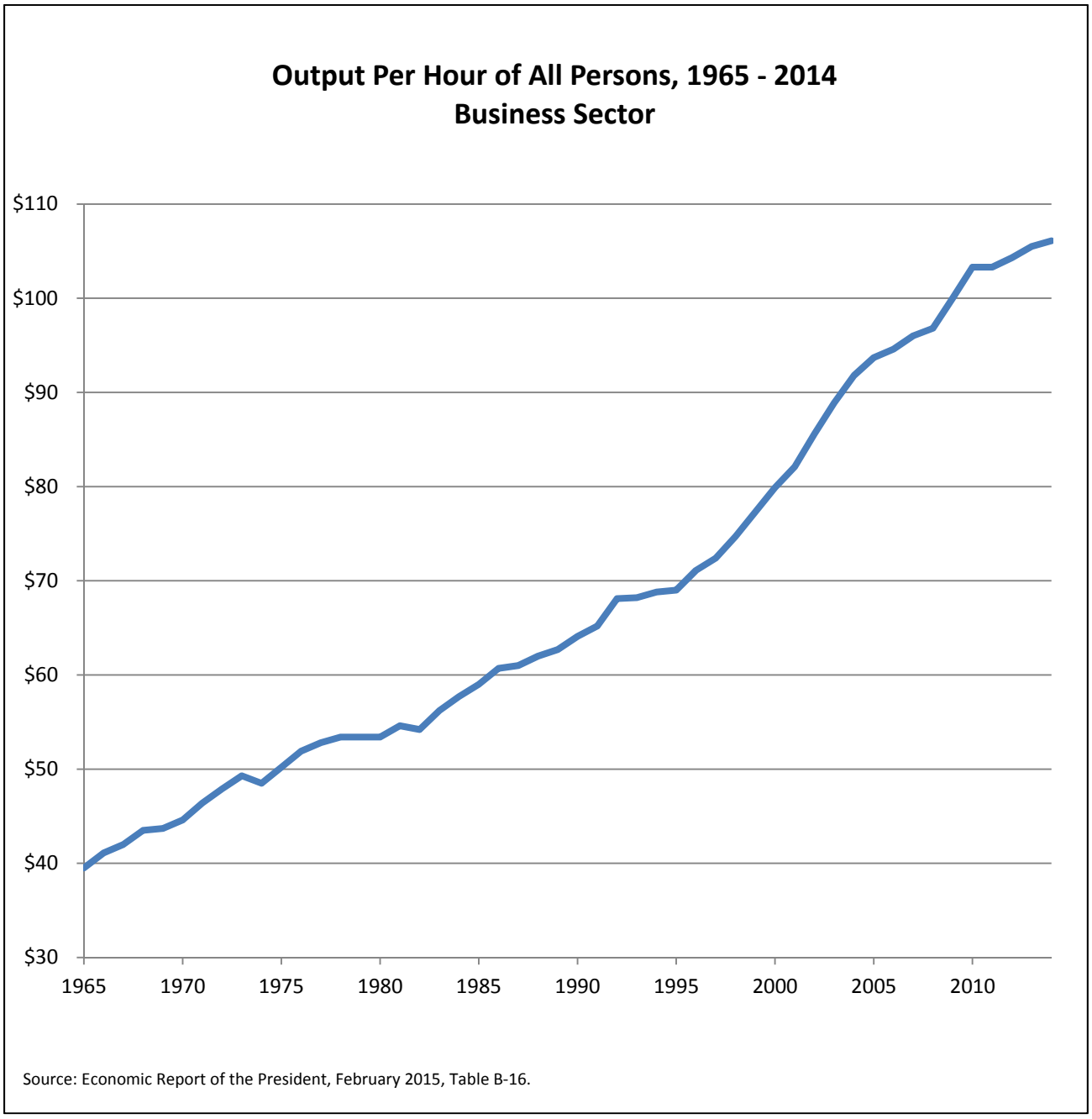
[8] See, for example, Jonathan Haskel, Robert Lawrence, Edward Leamer, and Matthew Slaughter, "Globalization and U.S. Wages: Modifying Classic Theory to Explain Recent Facts," *Journal of Economic Perspectives*, Spring 2012 ("With regard to the sobering falls in real income for the large majority of Americans, our [analytical] framework does add some new insights. We agree with Autor (2010a) that explaining falling real income remains a daunting empirical challenge. Much research to date has focused on income inequality, not income levels. We argue that this focus should change, because the post-2000 real income declines are pervasive, new and troubling. Our enriched trade framework offers some possible explanations for how globalization and/or innovation can boost superstar [highly skilled, highly compensated worker] real earnings yet reduce real earnings of so many others." 136-7), Robert Feenstra and Gordon Hansen, "Globalization, Outsourcing, and Wage Inequality," National Bureau of Economic Research, Working Paper 5424, 1996 (concluding that 31-51% of the increase in the relative demand for skilled labor in U.S. manufacturing in the 1980's was due to outsourcing to foreign firms), and David Autor,

Exhibit L-1



Lawrence Katz, and Melissa Kearney, "Trends in U.S. Wage Inequality: Revising the Revisionists," *Review of Economics and Statistics*, May 2008, pages 300-323 ("…skill demand shifts have played a central role in reshaping the wage structure… International trade and outsourcing factors [also] appear likely to become increasingly important, because of both rapid economic development in Asia and improvements in computer and communications technology that have dramatically reduced the costs of large-scale international trade in goods and services." (320))

Exhibit L-2



Source: Economic Report of the President, February 2015, Table B-16.

Alternative Approaches, Including
Other Compensation-Related Variables

As shown in Exhibit L-3, average hourly earnings in current (non-inflation-adjusted) dollars exhibit relatively steady (if disappointing) long-term growth, enabling one to make a 10-year forecast at the 90% confidence level by means of a quite simple time-series regression.[9] By eliminating the need to separately forecast productivity growth and inflation (difficult) – and, more importantly, by reflecting the suppressive effects on wage growth of the economic trends cited above – use of this variable and forecasting method might prove both more accurate and more economical than the approach in use today.

However, a similar approach based on a related but somewhat different variable – the *Average Wage Index* (AWI) employed by the Social Security Administration for determining cost-of-living adjustments[10] – might prove a better method still. Like average hourly earnings, the AWI is derived from Form W-2 payment amounts,[11] but because undivided by number of hours worked, reflects workers' full annual earnings. Exhibit L-4 illustrates the long-term trend in this index – which is, as one would expect, roughly as stable as that for average hourly earnings and (due to the cyclical sensitivity of hours worked) somewhat more impacted by the business cycle. That second consideration notwithstanding, this variable can be forecast with an even tighter confidence interval, by means of the same simple method.

The extent of the difference in wage and salary forecasts as between a productivity-plus-inflation method, on the one hand, and a simpler AWI-based method, on the other, can be seen through this example: *Escalating the 1973 value of the AWI ($7580) by (a) the increase in the CPI-U between that year and 2014 (439%) and, in addition, (b) the increase in labor productivity over the same period (115%), yields an expected AWI of $87,928 in 2014, as contrasted the actual $46,482*. Furthermore, even if the method were conceptually sound, separately forecasting the assumed components of a future wage increase would tend to compound the errors inherent in each constituent forecast.

More generally, the forecasting method now employed leads to wage projections for the post-2014 period greatly in excess of those derived by time-series analysis (Exhibit L-5).

In addition to average hourly earnings and the AWI, the Bureau of Labor Statistics' National Compensation Survey (NCS)[12] and related Employment Cost Index (ECI)[13] offer detailed information not

[9] Moving averages of first differences – of several alternatives, determined to have the best fit.

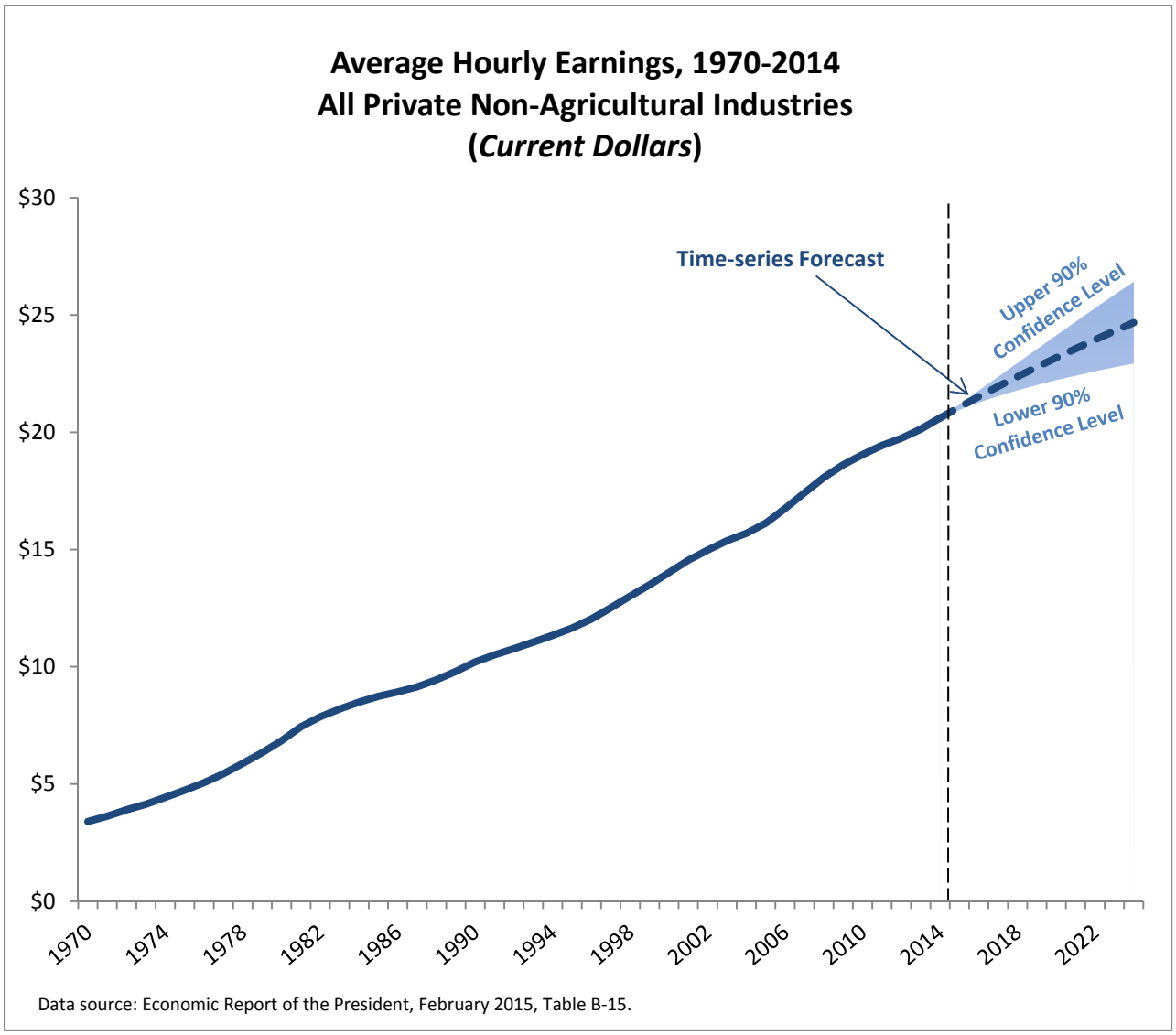
[10] See https://www.ssa.gov/OACT/COLA/awidevelop.html.

[11] See https://www.ssa.gov/OACT/COLA/netcomp.html.

[12] "The NCS is an establishment-based survey that provides comprehensive measures of (1) employer costs for employee compensation, (2) compensation trends, and (3) the incidence of employer-provided benefits among workers. The NCS also collects data on the provisions of selected employer-provided benefit plans." U.S. Department of Labor, Bureau of Labor Statistics, *BLS Handbook of Methods*, Chapter 8, page 1. Note that the NCS also generates data on retirement plan access, participation, and take-up rates, which, if tracked over time, might also be useful in forecasting PBGC liabilities. See, for example, U.S. Department of Labor, Bureau of Labor Statistics, "Employee Benefits in the United States," March 2015, USDL-15-1432, pages 5-6.

At the same time, it should be recognized that the NCS is a voluntary survey rather than an administrative data set like the Form 5500, raising the possibility of significant sampling and response bias. Further, both defined benefit (DB) plans insured by PBGC and those not are included, and the NCS data may also have some imprecision when a

Exhibit L-3



DB plan is frozen. Nevertheless, given our limited ability to assess it in the context of this engagement, we are reluctant to rule out its potential usefulness, even if only marginal.

[13] "The ECI is a measure of the change in the cost of labor, independent of the influence of employment shifts among occupations and industry categories. The total compensation series includes changes in wages and salaries and in employer costs for employee benefits…. Employer costs for employee benefits are collected for paid leave… premium pay for work done in addition to that performed during the regular work schedule… and for shift differentials, and non-production bonuses; insurance benefits… retirement and savings benefits – defined benefit and defined contribution plans; and legally required benefits – Social Security, Medicare, federal and state unemployment insurance, and workers compensation… As mentioned earlier, the ECI is a Principle Federal Economic Indicator." U.S. Department of Labor, Bureau of Labor Statistics, *BLS Handbook of Methods*, Chapter 8, pages 9-10.

Exhibit L-4

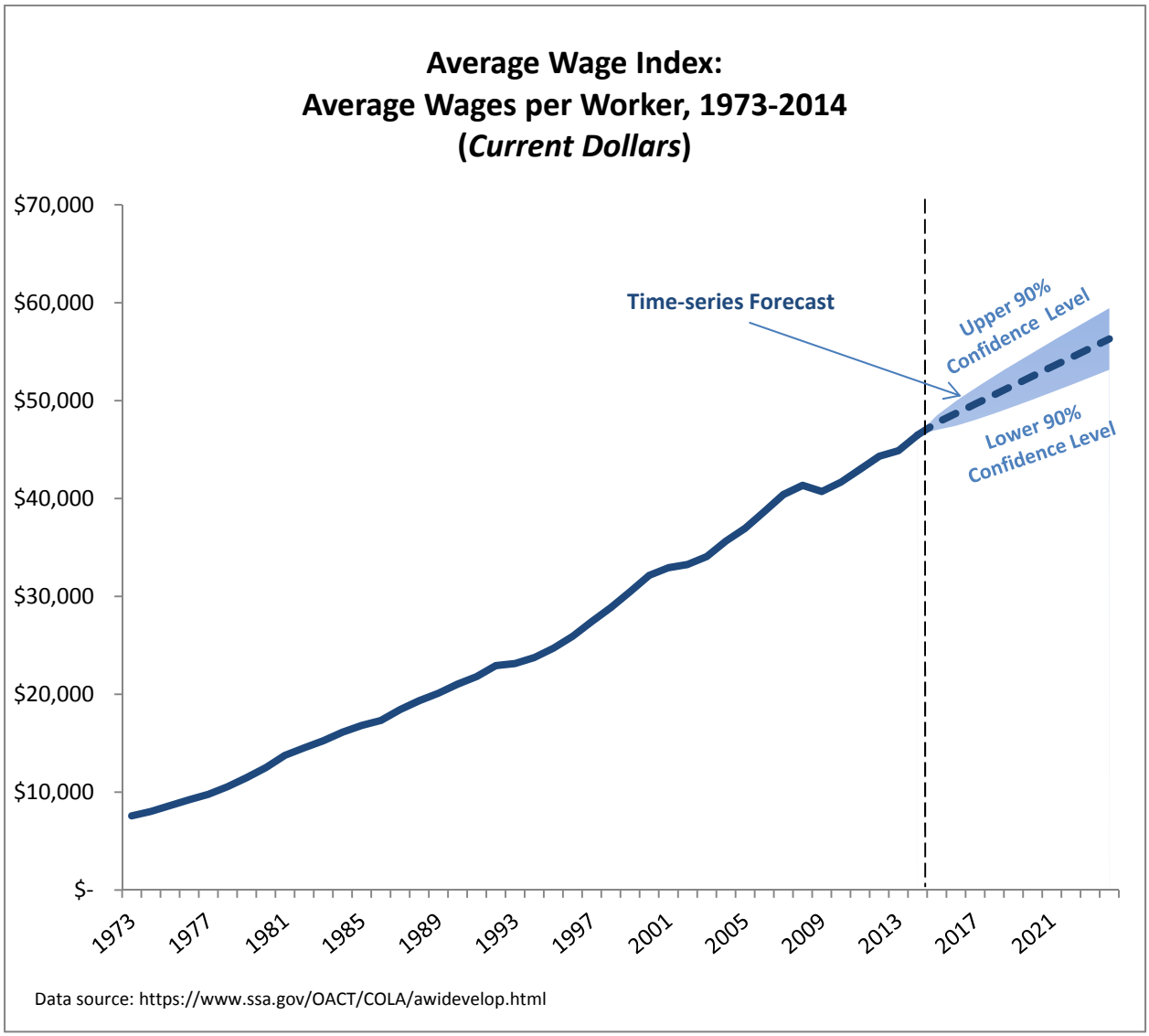
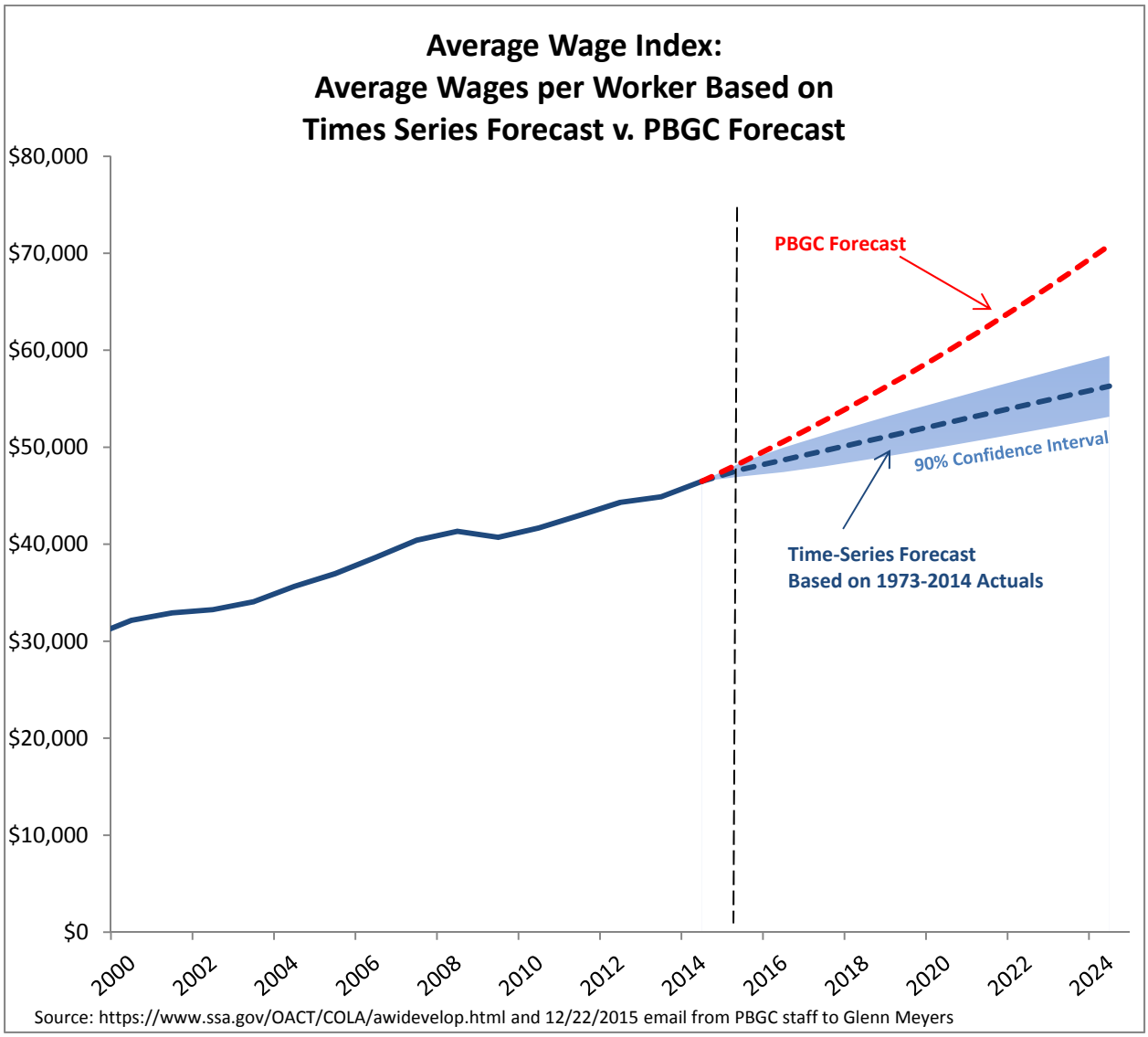

Average Wage Index:
Average Wages per Worker, 1973-2014
(*Current Dollars*)
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$-
1973
1977
1981
1985
1989
1993
1997
2001
2005
2009
2013
2017
2021
Time-series Forecast
Upper 90% Confidence Level
Lower 90% Confidence Level
Data source: https://www.ssa.gov/OACT/COLA/awidevelop.html

Exhibit L-5



Source: https://www.ssa.gov/OACT/COLA/awidevelop.html and 12/22/2015 email from PBGC staff to Glenn Meyers

just on wages and salaries, but all components of compensation – including employer costs for both defined-contribution and defined-benefit pension plans, per employee hour worked. (Costs are averaged across all employees, including those not covered by the plans in question.)

The post-2004[14] trend for the former, in the manufacturing sector, is shown in Exhibit L-6; for the latter, also in manufacturing, in Exhibit L-7. (Exhibit 1 in Appendix 2 presents the same data as Exhibit L-7, but in constant rather than current dollars.) Differences, including the very pronounced cyclicality of employer expenditure on defined benefit plans, are predictable based on the differing legal character and histories of the two types of plans, as well as economic events over the past 10 years. What may perhaps be surprising – and in some way useful in forecasting PBGC liabilities – is the tendency of defined benefit plan contributions to fluctuate around a level apparently "normal," at least for this period of history. Further, past reductions in employer costs at times of economic distress may provide some insight into plan sponsors' ability to absorb future shocks, apart from whatever support is provided by PBGC. Such cost reductions may include those stemming from negotiated wage reductions for current and/or new employees,[15] reducing future benefits commensurately, and/or changes in the character of retirement plans themselves (i.e., a switch from defined benefit to defined contribution plans[16]), as well as savings achieved through employee acceptance of lump-sum payments in lieu of a future income stream,[17] and the transfer of pension obligations to private insurers.[18] Of course, other factors can be presumed to influence employer costs for defined benefits plans, such as financial market fluctuations and legislated funding relief.

Recommendations for PIMS Modeling

Based on our research, we recommend that the PBGC consider forecasting wages and salaries based on the long-term historical trend in the AWI, in addition to the method currently employed.

Usefulness of Industry Trends in Union Representation in Forecasting PBGC Liabilities

Current Practice

It is our understanding that, at present, PIMS modeling does not systematically address industry-level trends in union representation, potentially indicative of significant changes in both industry- and firm-specific competitive advantage and financial soundness. Over the last several decades, such changes have arisen from, among other things, economic advancements worldwide, liberalized conditions of international trade, technological innovation, and the deregulation of key industries in the United States. All these factors (and more) have exposed industry incumbents to intensified competition, and to often sharply-varying degrees.

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[14] Data not available prior to that year.

[15] See, for example, Efraim Benmelech, Nittai Bergman, and Ricardo Enriquez, "Negotiating with Labor under Financial Duress," *Review of Corporate Finance Studies*, February 2012.

[16] See, for example, Leora Friedberg and Michael Owyang, "Not Your Father's Pension Plan: The Rise of the 401(k) and Other Defined Contribution Plans," The Federal Reserve Bank of St. Louis, 2002.

[17] See, for example, "GM Announces U.S. Salaried Pension Plan Actions," General Motors Corp. press release, June 1, 2012.

[18] Ibid.

Exhibit L-6

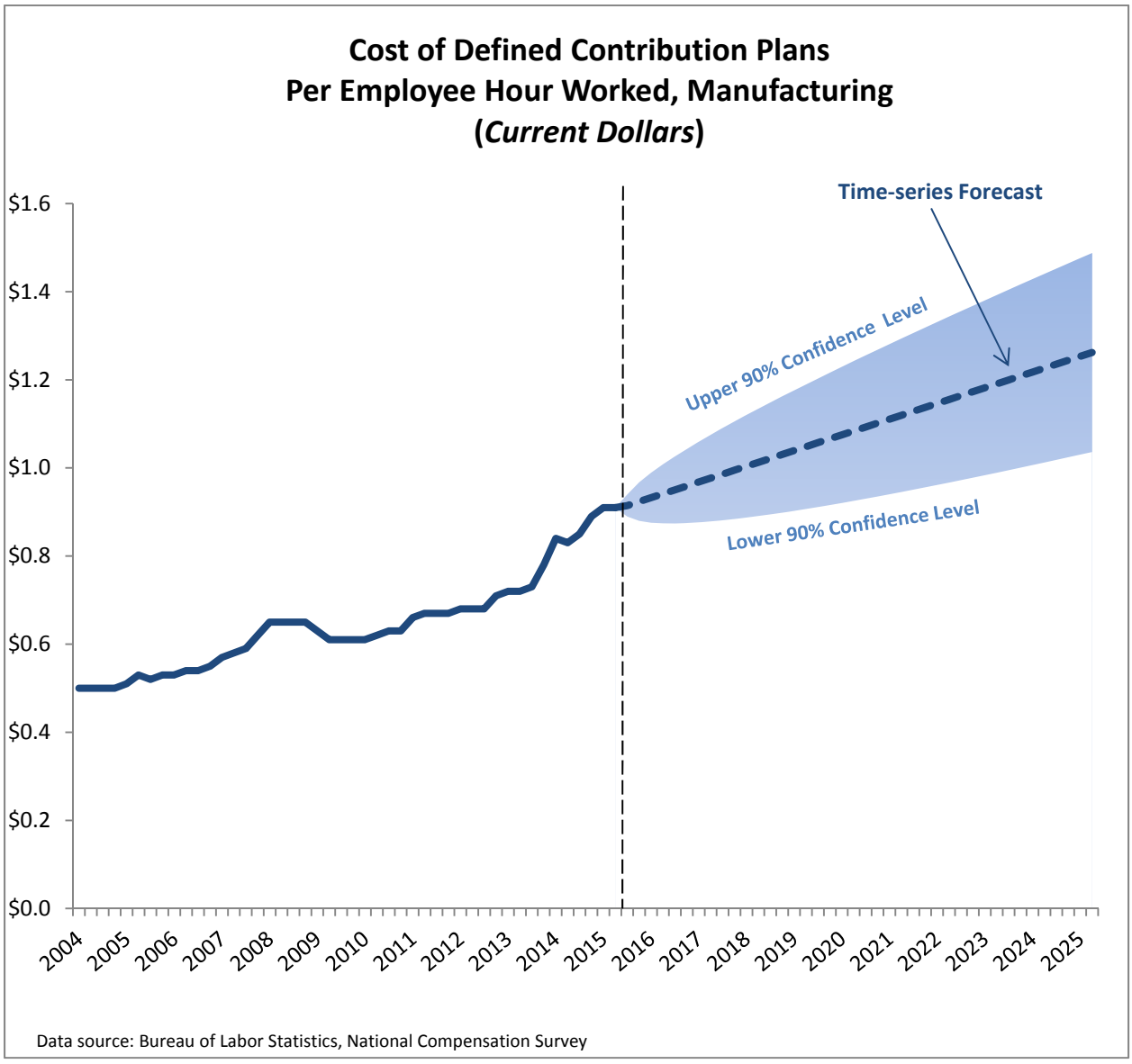
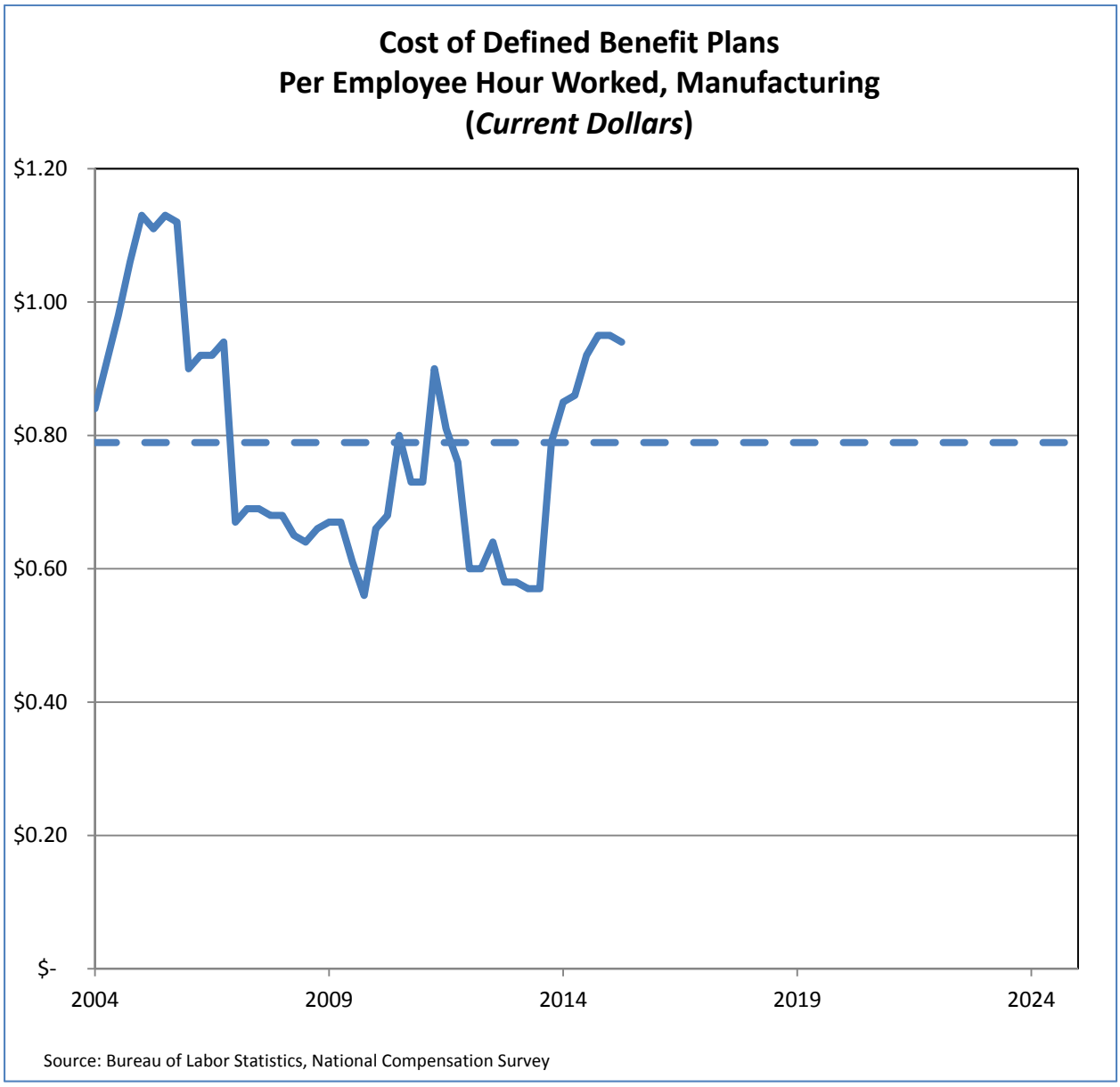

Cost of Defined Contribution Plans
Per Employee Hour Worked, Manufacturing
(Current Dollars)
Time-series Forecast
Upper 90% Confidence Level
Lower 90% Confidence Level
$1.6
$1.4
$1.2
$1.0
$0.8
$0.6
$0.4
$0.2
$0.0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Data source: Bureau of Labor Statistics, National Compensation Survey

Exhibit L-7


Cost of Defined Benefit Plans
Per Employee Hour Worked, Manufacturing
(*Current Dollars*)
$1.20
$1.00
$0.80
$0.60
$0.40
$0.20
$-
2004
2009
2014
2019
2024
Source: Bureau of Labor Statistics, National Compensation Survey

Implications of Recent Research

To assess the potential usefulness of industry trends in union representation in forecasting PBGC liabilities, we utilize a database constructed in 2003, and since updated annually, by Barry Hirsch (Georgia State University) and David Macpherson (Trinity University).[19] The database includes employment and number of employees represented by unions ("union coverage") for 259 private sector industries,[20] compiled from the monthly household Current Population Survey (CPS)[21] using Bureau of Labor Statistics methods.

Most basically, an effort was made to determine:

(a) Whether a relatively small subset of industries characterized by significant long-term declines in union representation account for a disproportionately large share of PBGC's single-employer or multiemployer program liabilities, either current or anticipated – and, if so, how large a share.

(b) Because declines in union representation are apt to be correlated with declines in industry employment, and the latter, we understand, is already treated as a "red flag" in PIMS modeling, whether consideration of the former variable might add significant liability "forecasting power" over and above that achievable by considering employment trends alone;[22] and, relatedly,

(c) The extent to which the industries responsible for most current and anticipated liabilities might have been pinpointed in 2001, based on trends in union representation and/or industry employment over the prior 18 years (1983-2000).

Confined to industries with employment of 50,000 or more as of either 2000 or 2014 (as appropriate to the analysis – see below) so as to screen out those with relatively limited potential to burden PBGC,[23] our analyses yield affirmative answers to both (a) and (b), above, and an answer of "substantially" to (c).

Long-term trends in unionization ratios from 1983 to 2014 for the seven industries showing the most pronounced declines in that ratio – over 20 percentage points relative to peak – are shown in Exhibit L-8. Notable features of the data include: (a) the relatively consistent decline in representation for all seven industries, suggesting a basis for extrapolation some distance into the future, in regard to plan liabilities; (b) the fact that four of the seven industries[24] include companies with pension plans figuring prominently in PBGC's current single-employer program; and (c) the fact that all three of those that do

[19] See Barry T. Hirsch and David A. Macpherson, "Union Membership and Coverage Database from the Current Population Survey," *Industrial and Labor Relations Review*, January 2003, and http://www.unionstats.com/ for full documentation.

[20] Because industry classifications have changed over the years (chiefly in 2003), for the full 1983-2014 period examined, FTI was obliged to create its own modified classification system, matching industries on the bases of industry name, industry hierarchy, and historical employment figures. Only a small number of imperfect matches, however, appear to have resulted. (Also see notes to exhibits.)

[21] Joint program of the Census Bureau and the Bureau of Labor Statistics.

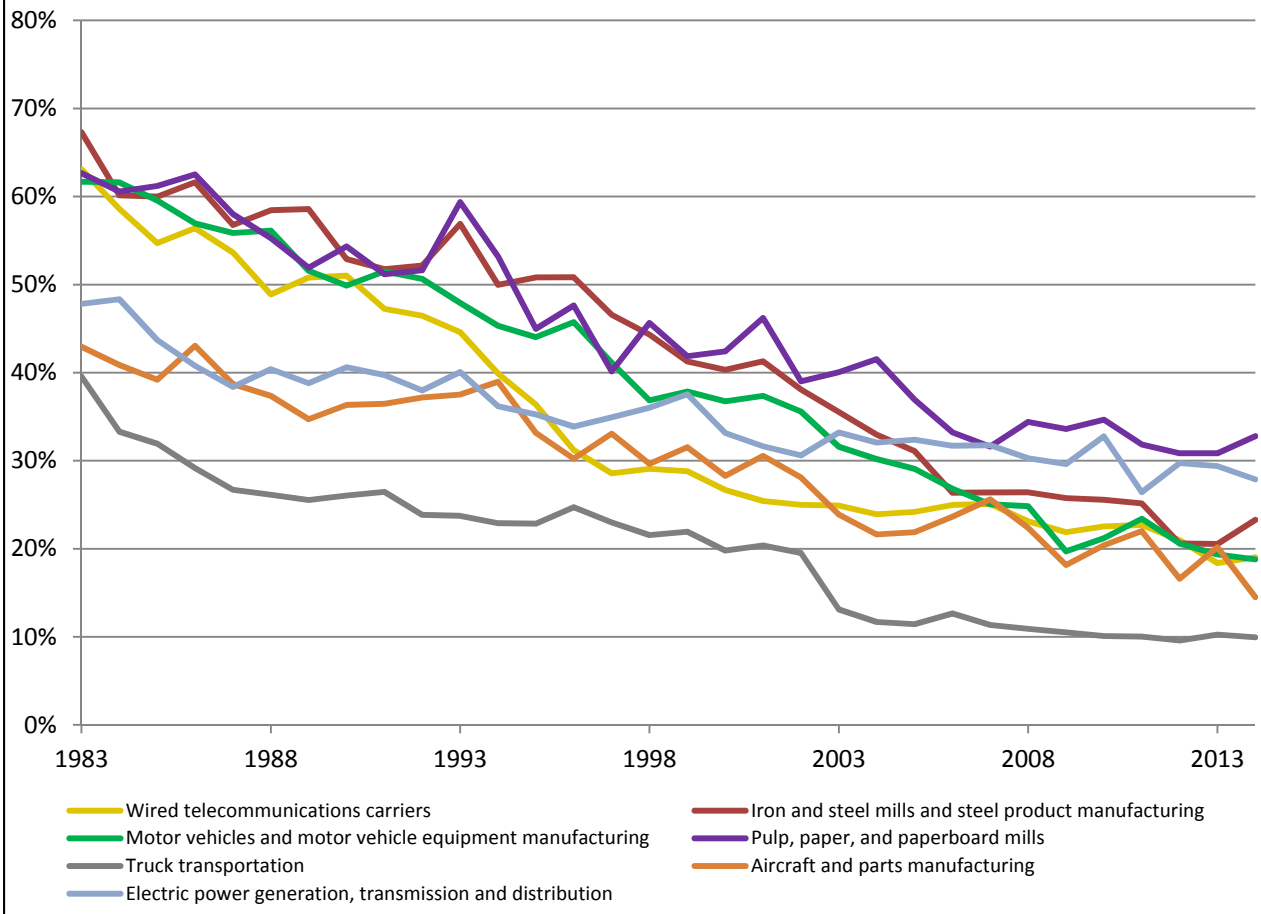
[22] In addition, of course, to the many other, non-labor-specific factors considered by PIMS.

[23] Thresholds that could of course be changed.

[24] Iron and steel mills and steel product manufacturing; truck transportation; motor vehicles and motor vehicle equipment manufacturing; and aircraft and parts manufacturing.

Exhibit L-8

Industries with Declines in Union Representation Ratios In Excess of 20 Percentage Points Relative to Peak[1] and 50,000+ Covered Employees in 2014[2]



Source: unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

Footnotes

(1) Where union representation (# of employees covered/employment) declined by 20% or more from its maximum over the period (1983-2014).

(2) Industries depicted correspond to only 2.7% of 259 industries analyzed.

not[25] consist largely of rate-regulated utilities, assured of the recovery of all costs considered prudently incurred, and thus unlikely candidates either for bankruptcy or multiemployer program support.

In Exhibit L-9, our requirement as to loss of union coverage is loosened to include all industries showing a loss of coverage of 10% or more, relative to peak. Caught in this more porous net is another major "culprit" – air transportation (see below) – along with two other industries which, like utilities, are largely insulated from foreign competition, (i.e., construction and railroads).

An Ex Ante Test

Exhibits L-10 and L-11 reflect the same data as Exhibits L-8 and L-9, but with a Year 2000 cut-off date and lines distinguished only on the basis of whether the industry in question includes a company or companies with a PBGC-trusteed plan with benefits valued at $100 million or more as of the date of distress termination. As indicated (and further illustrated below), hypothetically "standing" in 2001 with these data available, even an inquiry limited to the industries shown would have identified those accounting for a very large share of PBGC's current single-employer program liabilities, especially after industries relatively immune to foreign competition[26] were weeded out.

The possible efficiency of a forecasting process that gives significant weight to trends in union representation among finely delineated industries is made even more evident in Exhibits L-12 and L-13.

Represented in the former are all 203 private sector industries for which data is available back to 1983, many technology-based industries having been added, or at any rate incorporated into the classification system, since. As shown (and expected), the preponderance of industries registered declines in number of covered workers employed, with industries featuring trusteed plans of $100 million or more heavily concentrated among those showing the greatest declines. The three such industries showing substantial gains in union membership are construction, air transportation, and health services "not elsewhere specified" – largely, home healthcare services – all of these, again, relatively insulated from foreign competition, and for that and other reasons characterized by a persistently high degree of union bargaining power.

In showing only those industries with declining union membership, Exhibit L-13 makes the number with trusteed plans of $100 million or more – and again, their concentration at the top of the spectrum, in terms of union membership losses – somewhat easier to see, the industries themselves also being specified in Note (2) of the Exhibit. (Note that this exhibit purposefully relates union coverage data though the year 2000 only to large *post*-2000 trusteed plans, the intent being to demonstrate the usefulness of information available in 2000 in estimating future PBGC liabilities.)

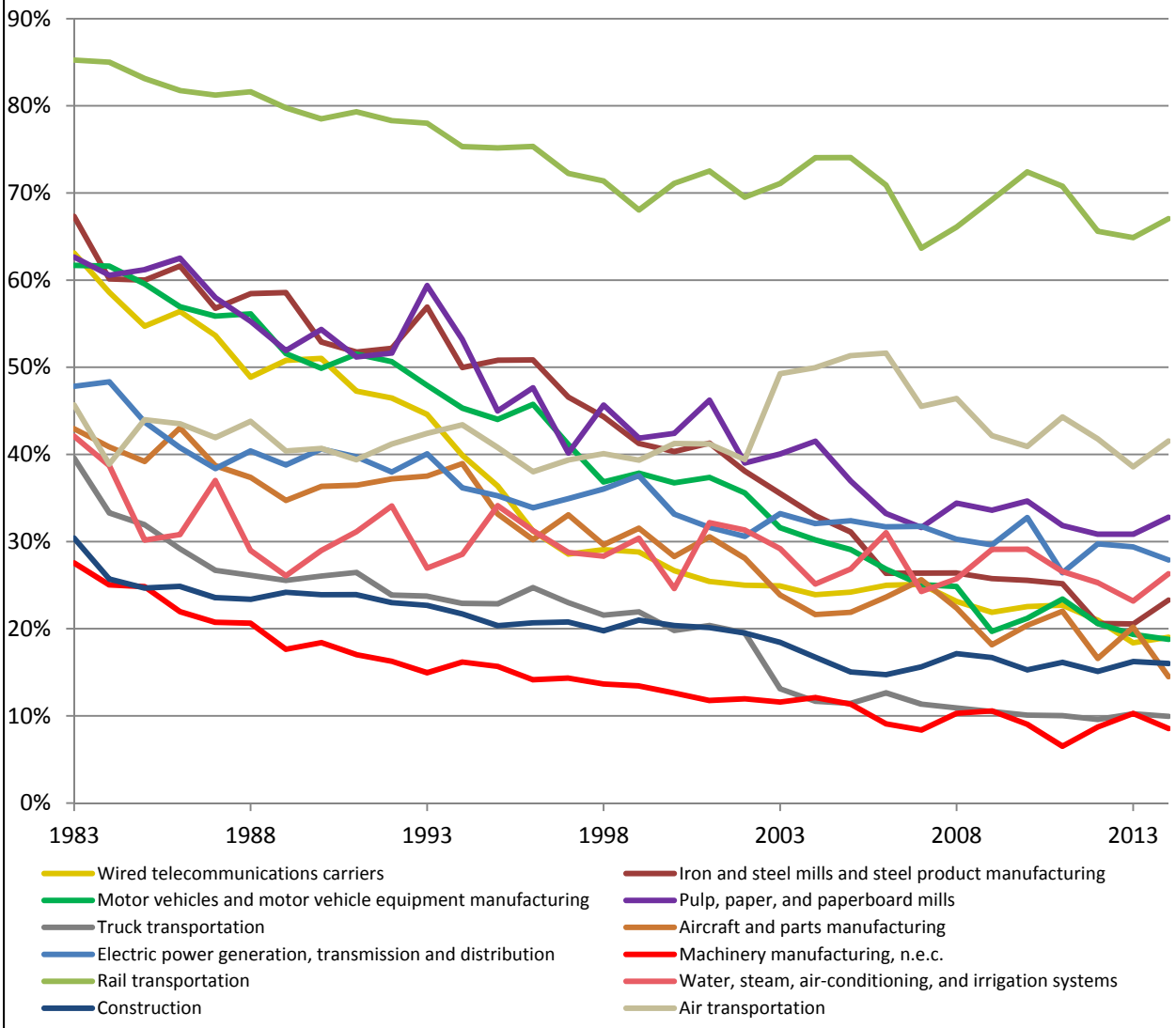
Finally, in focusing solely on those industries with trusteed plans of $100 million or more and indicating the number of such plans relating to each, Exhibit L-14 provides another, somewhat clearer view of the linkage between union membership trends and the sources of current PBGC liabilities.

[25] Wired telecommunications carriers; electric power generation, transmission and distribution companies; and water, steam, air-conditioning and irrigation systems.

[26] I.e., Utilities, rail transportation, construction, mining, bakeries, and animal slaughtering and processing.

Exhibit L-9

Industries with Declines in Union Representation Ratios In Excess of 10 Percentage Points Relative to Peak[1] and 50,000+ Covered Employees in 2014[2]



Source: unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

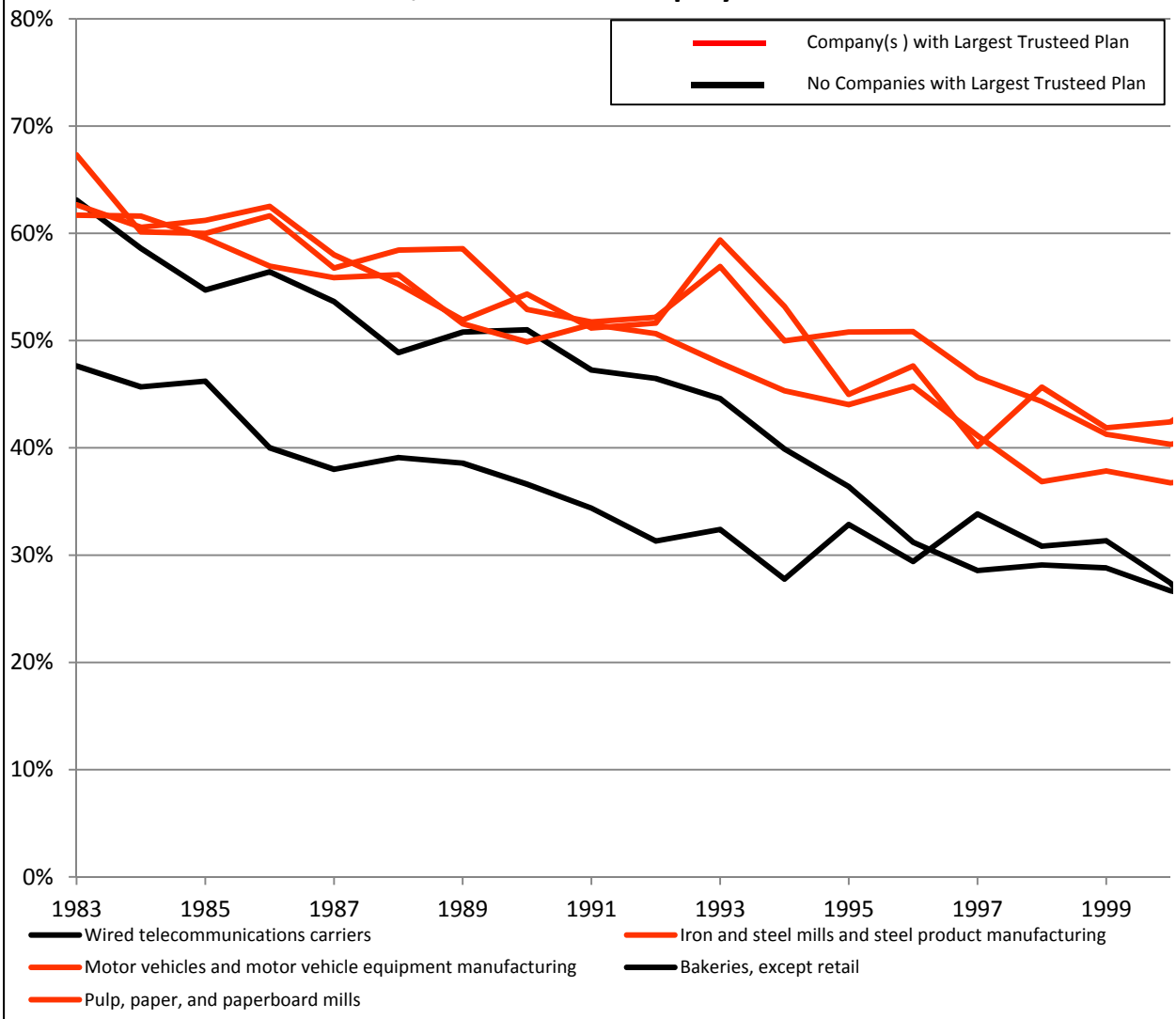
Footnotes

(1) Where union representation (# of employees covered/employment) declined by 10% or more from its maximum over the period (1983-2014).

(2) Industries depicted correspond to only 4.6% of 259 industries analyzed.

Exhibit L-10

Industries with Declines in Union Representation In Excess of 20 Percentage Points Relative to Peak[1] and 50,000+ Covered Employees in 2000[2]



Source: unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014)*. Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

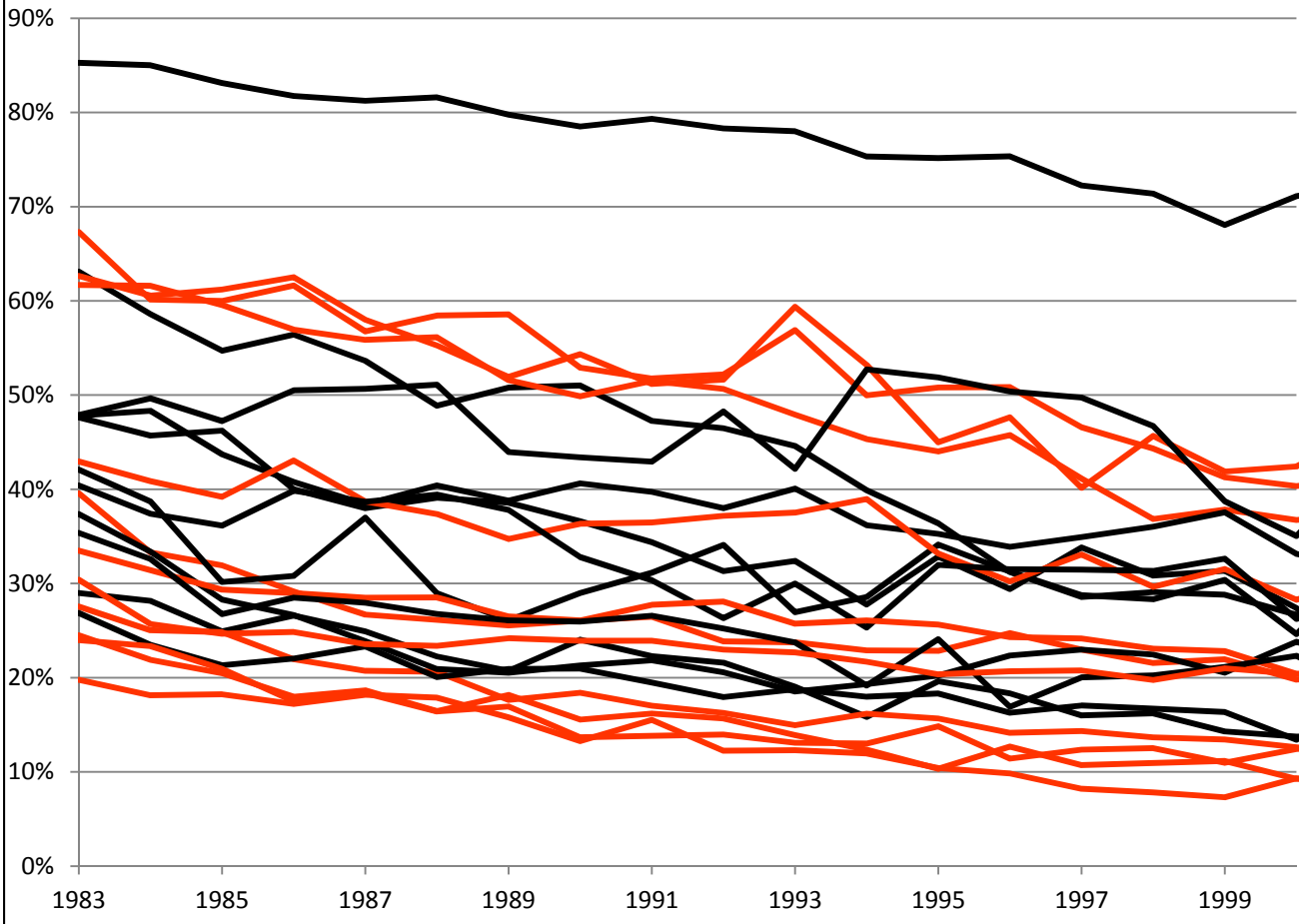
Footnotes

(1) Where union representation (# of employees covered/employment) declined by 20% or more from its maximum over the period (1983-2000).

(2) Industries depicted correspond to only 2.5% of 204 industries analyzed.

Exhibit L-11

Industries with Declines in Union Representation Ratios In Excess of 10 Percentage Points Relative to Peak[1] and 50,000+ Covered Employees in 2000[2]



At least one company with a PBGC-trusteed plan post-2000 in excess of $100M. Industries included: Iron and steel mills and steel product manufacturing; Motor vehicles and motor vehicle equipment manufacturing; Pulp, paper, and paperboard mills; Truck transportation; Electrical machinery, equipment, and supplies, n.e.c.; Machinery manufacturing, n.e.c.; Aircraft and parts manufacturing; Grocery stores; Plastics, synthetics, and resins; Furniture and related product manufacturing; Construction

No companies with a PBGC-trusteed plan post-2000 in excess of $100M. Industries included: Wired telecommunications carriers; Bakeries, except retail; Electric and gas, and other combinations; Water, steam, air-conditioning, and irrigation systems; Structural metals, and tank and shipping container manufacturing; Electric power generation, transmission and distribution; Fruit and vegetable preserving and specialty food manufacturing; Rail transportation; Animal slaughtering and processing; Industrial and miscellaneous chemicals; Construction, mining and oil field machinery manufacturing

Source: unionstats.com, Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

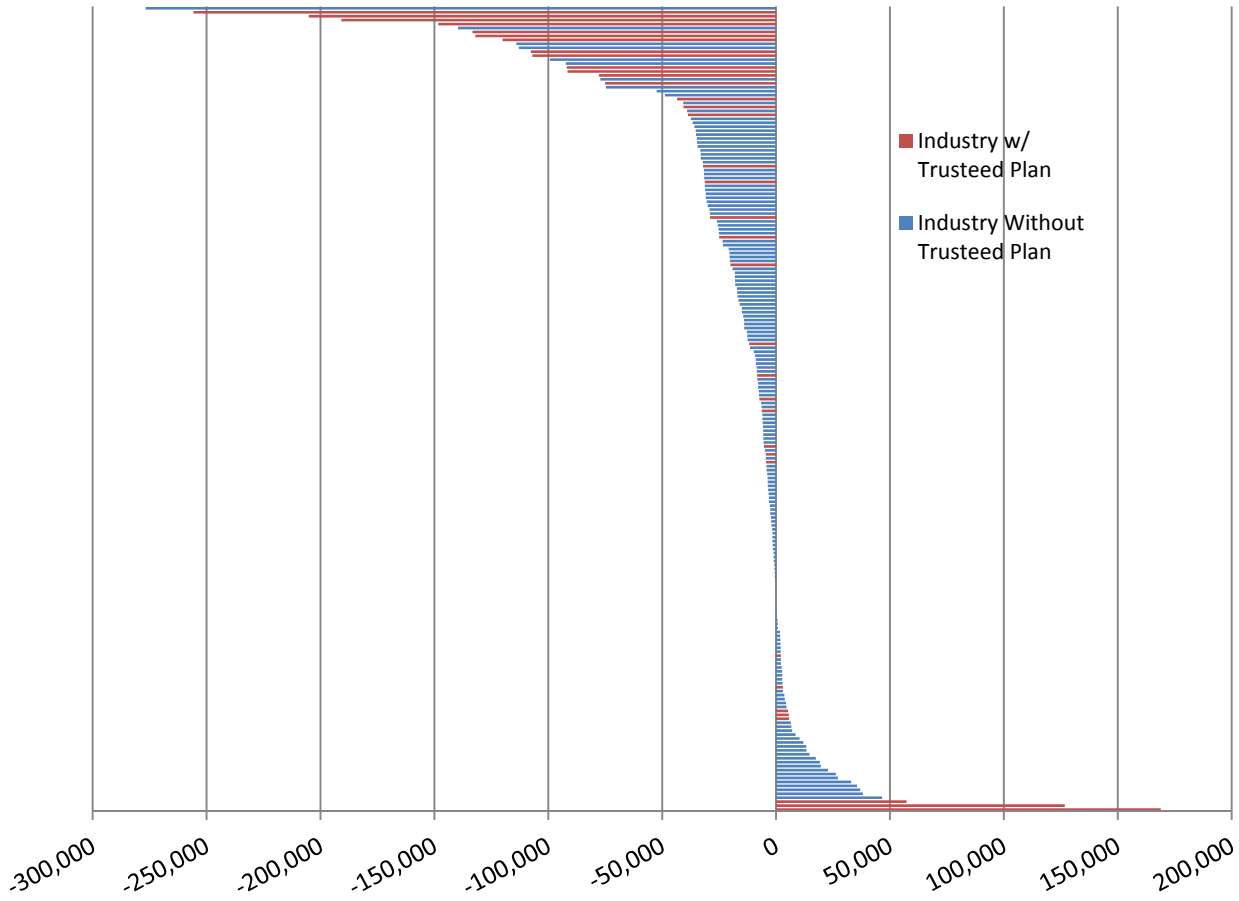
Footnotes

(1) Where union representation (# of employees covered/employment) declined by 10% or more from its maximum over the period (1983-2000).

(2) Industries depicted correspond to only 10.8% of 204 industries analyzed.

Exhibit L-12

Change in Number of Covered Employees by Industry 1983 - 2000[1]

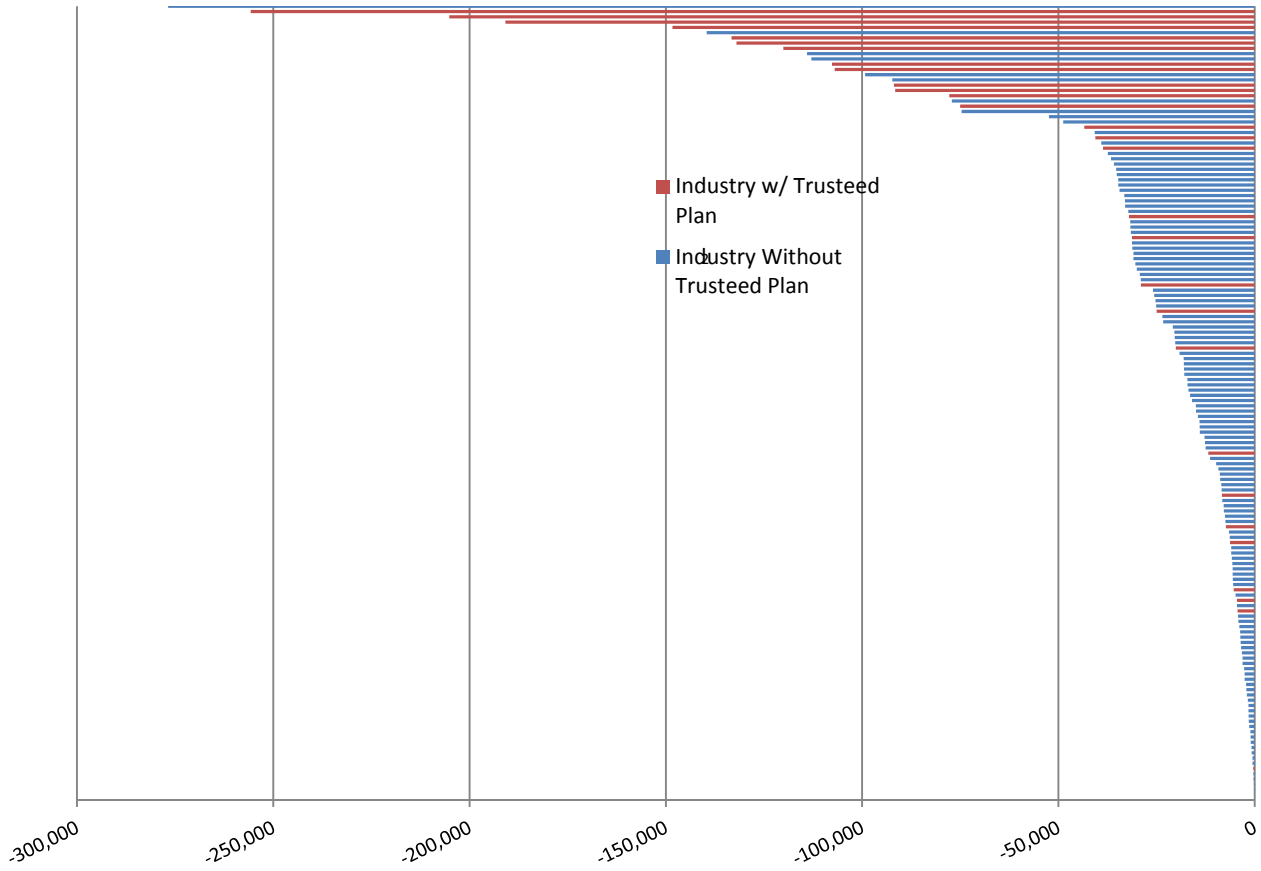


Source: unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

(1) All industries with union data available from 1983-2000 (204 of 259 industries); excludes all public sector industries (FTI Industry Categories beginning with PAS, as well as, Postal Service; Elementary and secondary schools; Libraries and archives)

Exhibit L-13

Decline in Number of Covered Employees 1983-2000[1]



Source: unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

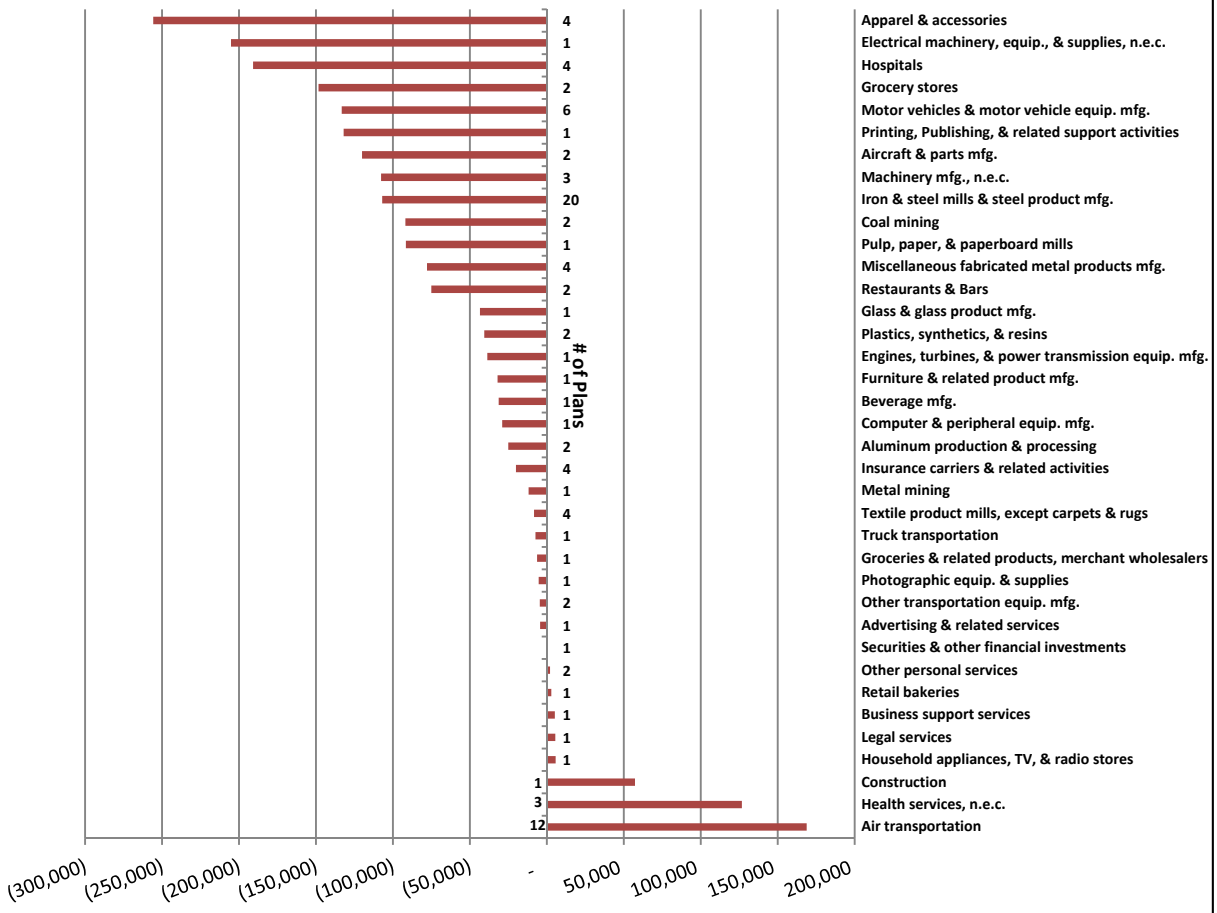
(1) All Private industries with union data available from 1983-2000 and a decline in members (152 of 259).

(2) At least one company with a PBGC-trusteed plan post-2000 in excess of $100M. 77 of the 103 trusteed plans were in an industry with a declining number of union members. These industries include (# Trusted Plans): Securities and other financial investments (1); Advertising and related services (1); Other transportation equipment mfg (2); Photographic equipment and supplies (1); Groceries and related products, merchant wholesalers (1); Truck transportation (1); Textile product mills, exc. rugs (4); Metal mining (1); Insurance carriers and related (4); Aluminum production and processing (2); Computer and peripheral equipment mfg (1); Beverage mfg (1); Furniture and related product mfg (1); Engines, turbines, and power transmission equipment mfg (1); Plastics, synthetics, and resins (2); Glass and glass product mfg (1); Restaurants and Bars (2); Durable Goods mfg (4); Nondurable Goods mfg (1); Mining, quarrying, and oil and gas extraction (2); Iron and steel mills and steel product mfg (20); Machinery mfg, n.e.c. (3); Aircraft and parts mfg (2); Printing, Publishing, and related support activities (1); Motor vehicles and motor vehicle equipment mfg (6); Grocery stores (2); Hospitals (4); Electrical machinery, equipment, and supplies, n.e.c. (1); Apparel and accessories (4).

Exhibit L-14

Change in Number of Covered Employees (1983 - 2000):

Industries with PBGC Trusteed Plans in Excess of $100M[1]



Source: unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

(1) PBGC-trusteed plan with over $100M of liabilities at the date of plan termination that was terminated after January 1, 2000 with union data available from 1983-2000. The following industries containing a PBGC-trusteed Plan were excluded due to lack of union data: Sewing, needlework, and piece goods stores; Management, scientific, and technical consulting services; Gift, novelty, and souvenir shops; and Software publishing.

Addition of an Employment-Trend Factor

Exhibit L-15 lists all single-employer PBGC-trusteed plans as of September 2014 with a present value of fixed benefits of $100 million or more at the time of plan termination. For each plan, the employer's industry is shown, as well as "x"s indicating whether that industry meets high-risk criteria regarding declines in union representation (at least 20% off maximum over the 1983-2000 period, as of 2000) and declines in employment (at least 20% off maximum over the 1983-2000 period, as of 2000). As shown, the preponderance of these large plans arises in industries meeting at least one of these criteria, and usually both, a correlation one would expect.[27] However, 14 would only have been flagged (in the context of this limited analysis) by the union-related criterion. Further, with 25 states now having right-to-work laws in place, and three having enacted them just in the last five years (Michigan, Wisconsin and Indiana),[28] the predictive value of industry-specific trends in union representation may increase, as those trends in some cases become more pronounced.

Nor can continuing competitive pressures from abroad be disregarded in this context, particularly given likely further trade liberalization in the near future. For example, in a 2012 paper, Pierce and Schott find, "…a link between the sharp drop in U.S. manufacturing employment after 2001 and the elimination of trade policy uncertainty resulting from the U.S. granting of permanent normal trade status to China in late 2000," further concluding that, "…[U.S.] industries where the threat of tariff hikes declines the most experience greater employment loss due to suppressed job creation, exaggerated job destruction and a substitution away from low-skilled workers."[29] More generally, a very substantial body of information on the impact of imports on especially vulnerable domestic industries is available at the U.S. International Trade Commission, in the form of both staff reports and industry filings not treated as confidential.[30] And while the determination of its effects on trade is analytically challenging, the use of currency undervaluation to promote exports to the U.S. (and other countries) may well be a factor significantly contributing to the underperformance of certain U.S. industries.[31]

Exhibits L-16 and L-17 present the information in L-15 in graphical form. Significantly, application of a joint standard – *either* the specified decline in union representation *or* the specified decline in employment – captures over half the trusteed plans under consideration here, both in terms of number and in terms of value, whereas application of the employment-decline criterion alone captures only 38%

[27] A notable exception being those associated with airline bankruptcies, ascribable primarily to new competition from low-cost carriers pursuant to industry deregulation in 1978, and secondarily to events such as the post-9/11 travel scare and coincident recession. See, for example, United States Government Accountability Office, "Commercial Aviation: Bankruptcy and Pension Problems Are Symptoms of Underlying Structural Issues," Report to Congressional Committees, September 2005.

[28] http://www.ncsl.org/research/labor-and-employment/right-to-work-laws-and-bills.aspx#chart.

[29] Justin Pierce and Peter Schott, "The Surprisingly Swift Decline of U.S. Manufacturing Employment," National Bureau of Economic Research Working Paper 18655, December 2012, page 1.

[30] https://edis.usitc.gov/edis3-external/app.

[31] See, for example, Willem Thorbecke and Hanjiang Zhang, "The Effect of Exchange Rate Changes on China's Labor-Intensive Manufacturing Exports," Research Institute of the Economy, Trade and Industry (Japan) Discussion Paper 08-E-038, September 2008. Exports of all three of the Chinese industries evaluated – apparel , furniture, and footwear – were found to be exchange-rate sensitive, and the U.S. counterparts to the first two of those industries are among those listed in Exhibits L-15 and L-19 (below).

Exhibit L-15

Industries Including Companies with PBGC-Trusteed Plans Over $100M Meeting Either Employment - Or Union - Trend Criteria

(a) Decline in Industry Employment of at least 20% from the maximum during the 1983-2000 period

(b) Decline in Union Representation of at least 20% from the maximum during the 1983-2000 period

PBGC Plan Name	FTI Industry	(a)	(b)	(a) OR (b)	(a) AND (b)
Alabama Aircraft Industries, Inc.	Aircraft and parts Mfg.	x		x	
Aloha Airlines Inc. Pension Pl	Air transportation				
Amcast Industrial Corp. Merged	Motor vehicles and motor vehicle equipment Mfg.		x	x	
Anchor Glass Pension Plan	Glass and glass product Mfg.		x	x	
Baptist Hospital System, Inc.	Hospitals				
Bethlehem Steel	Iron and steel mills and steel product Mfg.	x	x	x	x
Christ Hospital Employees Plan	Hospitals				
Circut City Stores,Inc.	Household appliances, TV, and radio stores				
Collins & Aikman Pension Plan	Motor vehicles and motor vehicle equipment Mfg.		x	x	
Consolidated Freightways Corp	Truck transportation		x	x	
Consolidated Retirement Plan F	Groceries and related products, merchant wholesalers				
Constar, Inc.	Plastics, synthetics, and resins				
Cpi Corp.	Other personal services				
Crucible Syracuse Usw	Miscellaneous fabricated metal products Mfg.		x	x	
Delphi Corp. Hourly	Motor vehicles and motor vehicle equipment Mfg.		x	x	
Delphi Corp. Salaried	Motor vehicles and motor vehicle equipment Mfg.		x	x	
Delta Pilots Retirement Plan	Air transportation				
Dewey & Lebeouf Pension Plan	Legal services				
Fairchild Corp.	Apparel and accessories	x	x	x	x
Foamax Lp	Plastics, synthetics, and resins				
Forum Health	Health services, n.e.c.				
Fraser Papers	Pulp, paper, and paperboard mills	x	x	x	x
Friendly Ice Cream Corp.	Restaurants and Bars				
Furniture Brands International Inc.	Furniture and related product Mfg.				
Grand Union Company Associates	Grocery stores				
Granite City Chemical Workers	Iron and steel mills and steel product Mfg.	x	x	x	x
Granite City Steelworkers Pen	Iron and steel mills and steel product Mfg.	x	x	x	x
Grede Foundries, Inc.	Iron and steel mills and steel product Mfg.	x	x	x	x
Greenwood Mills	Textile product mills, except carpets and rugs	x	x	x	x
Hartmarx Retirement Income	Apparel and accessories	x	x	x	x
Harvard Retirement Plan	Motor vehicles and motor vehicle equipment Mfg.		x	x	
Hawker Beechcraft Salaried	Aircraft and parts Mfg.	x		x	
Hayes Lemmerz	Other transportation equipment Mfg.		x	x	
Horizon Nr, Llc Employee Pens	Coal mining	x	x	x	x
Huffy Corporation Retirement P	Other transportation equipment Mfg.		x	x	
Ibc Defined Benefit (Hostess)	Retail bakeries				
Inco Alloys International, Inc	Iron and steel mills and steel product Mfg.	x	x	x	x
Interfaith Medical Center Nurses	Hospitals				
James River Coal Co.	Coal mining	x	x	x	x
Journal Register Co.	Printing, Publishing, and related support activities				
Kaiser Aluminum Pension Plan	Aluminum production and processing				
Kaiser Aluminum Salaried Emplo	Aluminum production and processing				
Kemper Retirement Plan	Insurance carriers and related activities				
Kidspeace Corp.	Health services, n.e.c.				
Laclede Hourly Employees Pensi	Iron and steel mills and steel product Mfg.	x	x	x	x
Landamerica Cb Plan	Insurance carriers and related activities				
Lehman Brothers Holdings	Securities and other financial investments				
Lenox, Incorporated Retirement	Gift, novelty, and souvenir shops				
Ltv Steel Hourly Pension Plan	Iron and steel mills and steel product Mfg.	x	x	x	x
Ltv Steel Mining Co. Pension P	Iron and steel mills and steel product Mfg.	x	x	x	x
Ltv Steel Salary Pension Plan	Iron and steel mills and steel product Mfg.	x	x	x	x
Metaldyne Corp.	Motor vehicles and motor vehicle equipment Mfg.		x	x	
Milacron Retirement Plan	Machinery Mfg., n.e.c.				
Murray Inc. Employees'' Retire	Machinery Mfg., n.e.c.				
Murray Inc. Pension Plan For H	Machinery Mfg., n.e.c.				
National Steel Corp Hourly Pen	Iron and steel mills and steel product Mfg.	x	x	x	x
National Steel Corp Retirement	Iron and steel mills and steel product Mfg.	x	x	x	x

Exhibit L-15 (continued)

Industries Including Companies with PBGC-Trusteed Plans Over $100M Meeting Either Employment - Or Union - Trend Criteria

(a) Decline in Industry Employment of at least 20% from the maximum during the 1983-2000 period

(b) Decline in Union Representation of at least 20% from the maximum during the 1983-2000 period

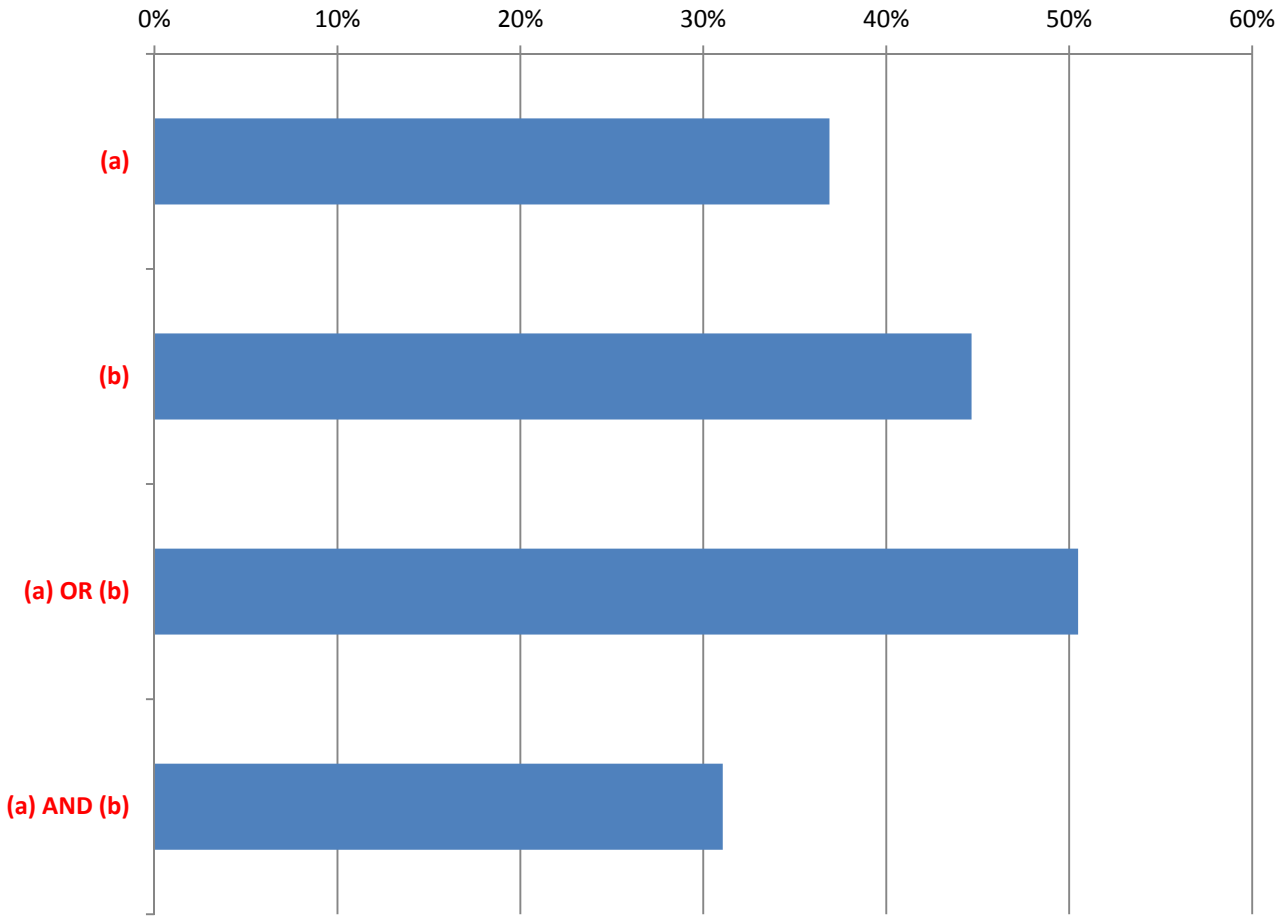
PBGC Plan Name	FTI Industry	(a)	(b)	(a) OR (b)	(a) AND (b)
Nortel Networks	Computer and peripheral equipment Mfg.	x		x	
Northwestern Steel & Wire Co.	Iron and steel mills and steel product Mfg.	x	x	x	x
Olan Mills, Inc.	Other personal services				
Ormet Pension Plan	Miscellaneous fabricated metal products Mfg.		x	x	
Outboard Marine Corporation Em	Engines, turbines, and power transmission equipment Mfg.	x	x	x	x
Pascack Valley Hospital Pensio	Hospitals				
Pension Plan For Acme Salaried	Iron and steel mills and steel product Mfg.	x	x	x	x
Pension Plan Of J. A. Jones In	Construction				
Piccadilly Cafeterias Inc Pen	Restaurants and Bars				
Pillowtex Corporation Retireme	Textile product mills, except carpets and rugs	x	x	x	x
Pillowtex Corporation Rp For H	Textile product mills, except carpets and rugs	x	x	x	x
Polaroid Pension Plan	Photographic equipment and supplies	x		x	
Pp For Hrly Standard Steel-Bur	Iron and steel mills and steel product Mfg.	x	x	x	x
Pp Of Cone Mills Corp.	Textile product mills, except carpets and rugs	x	x	x	x
Reichhold Inc.	Plastics, synthetics, and resins				
Reliance Insurance Co Retireme	Insurance carriers and related activities				
Republic Technologies Internat	Iron and steel mills and steel product Mfg.	x	x	x	x
Republic Technologies Internat	Iron and steel mills and steel product Mfg.	x	x	x	x
Ret. Income Plan For Pilots Of	Air transportation				
Retirement Plan For Certain Em	Air transportation				
Retirement Plan For Flight Att	Air transportation				
Rouge Steel Co. Uaw	Iron and steel mills and steel product Mfg.	x	x	x	x
Sbc Holdings, Inc.	Beverage Mfg.				
Sencorp Reirement Plan	Business support services				
Special Metals Corporation Sal	Iron and steel mills and steel product Mfg.	x	x	x	x
St. Vincent Catholic Medical Centers	Health services, n.e.c.				
Techneglas, Inc. Hourly Retire	Electrical machinery, equipment, and supplies, n.e.c.				
The Austin Company Retirement	Management, scientific, and technical consulting services				
The Penn Traffic Co Cash Balan	Grocery stores				
The Relizon Co.	Software publishing				
The Retirement Program Of Liam	Miscellaneous fabricated metal products Mfg.		x	x	
The Singer Company	Sewing, needlework, and piece goods stores	x		x	
Thunderbird Mining Co. Pension	Metal mining	x		x	
Trans World Airlines Inc Rp Fo	Air transportation				
Trans World Airlines, Inc. Rp	Air transportation				
United Air Lines Inc. Pilots F	Air transportation				
United Air Lines, Inc. Flight	Air transportation				
United Airlines Ground Employe	Air transportation				
United Airlines Management, Ad	Air transportation				
Us Airways Pension Plan For I	Air transportation				
Vertis Consolidated Pension Plan	Advertising and related services				
Weirton Retirement Program	Iron and steel mills and steel product Mfg.	x	x	x	x
Weirton Steel Corp. Ret. Plan	Iron and steel mills and steel product Mfg.	x	x	x	x
Westpoint Stevens Inc. Hourly	Apparel and accessories	x	x	x	x
Westpoint Stevens Inc. Retirem	Apparel and accessories	x	x	x	x
Wolverine Tube, Inc.	Miscellaneous fabricated metal products Mfg.		x	x	

Source: File titled "FOD20130930.xls" provided by the PBGC and unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014)* . Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

Exhibit L-16

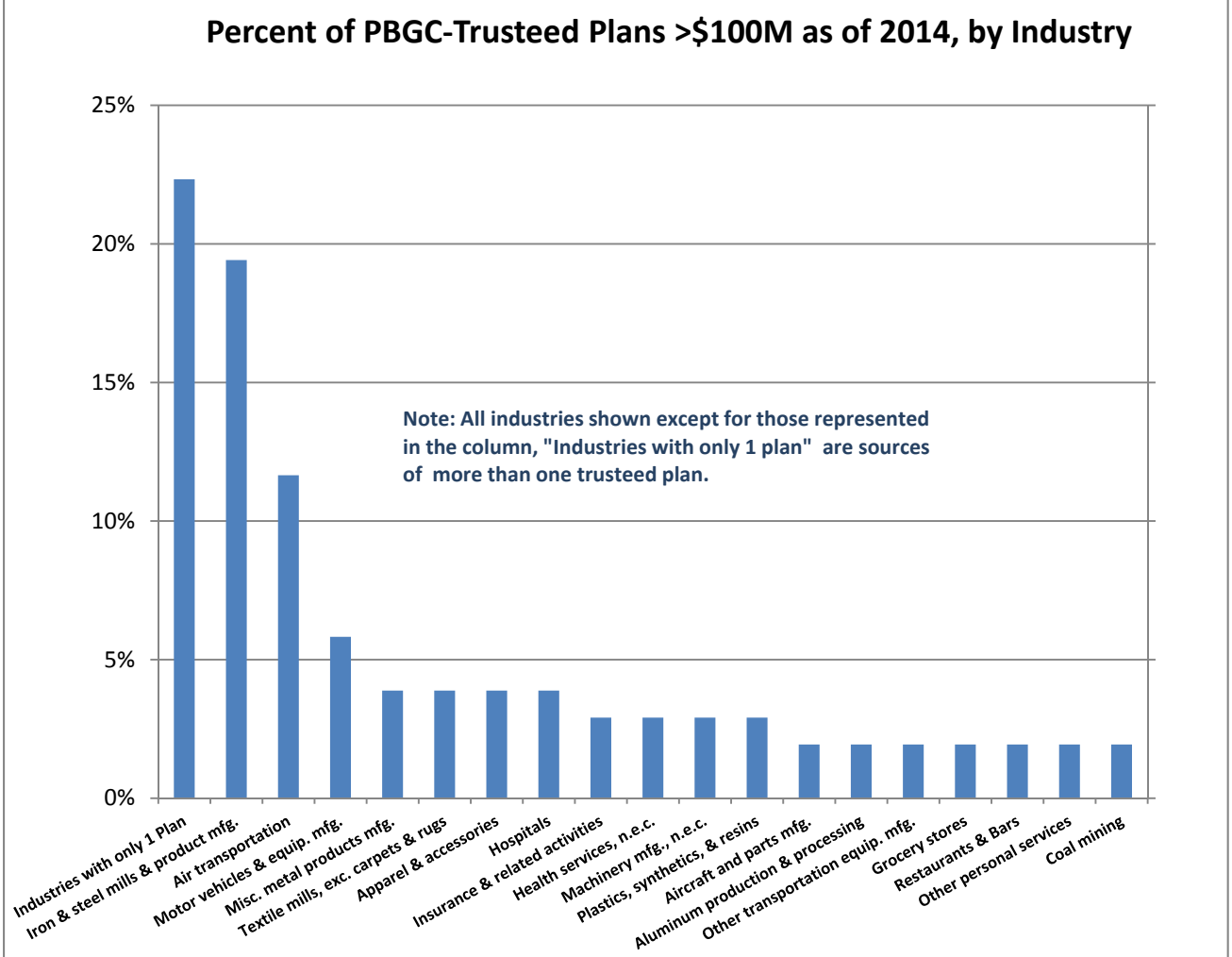
Percentage of PBGC-Trusteed Plans with 2014 Liabilities >$100M

(a) - Decline in Industry Employment of at least 20% from the maximum during the 1983-2000 period
(b) - Decline in Union Representation Ratio of At Least 20 percentage points from the 1983-2000 maximum



Source: FOD20130930.xls and unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

Exhibit L-17



Source: FOD20130930.xls and unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014*). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

in terms of number, and 31% in terms of value (Exhibit L-16). Further, Exhibit L-17 makes the point that well over a third of these large plans pertain to just three industries; Exhibit L-18, that while representing only 11% of all 259 industries considered, those meeting our union-related criterion account for 45% of all trusteed plans in excess of $100 million, as of September 2014.

Multiemployer Plan Liabilities Looming on the Horizon

Rather than assuming the role of plan trustee, as does the PBGC in the case of single-employer plans, in the case of multiemployer plans, the PBGC's role is confined to the provision of financial assistance to the trusts that continue to administer such plans.

But for those in the printing and publishing and retail grocery industries, nearly all the large (over $100 million) multiemployer plans considered by the PBGC to represent probable future liabilities, as well as the preponderance of those liabilities themselves, pertain to industries already identified as "high risk" based on trends in employment and unionization level as of the Year 2000, the term "usual suspects" thus clearly applying (Exhibit L-19). Moreover, 75% of all such plans are accounted for by just four industries (Exhibit L-20).

Proposed Industry Screening Criteria: Further Analysis

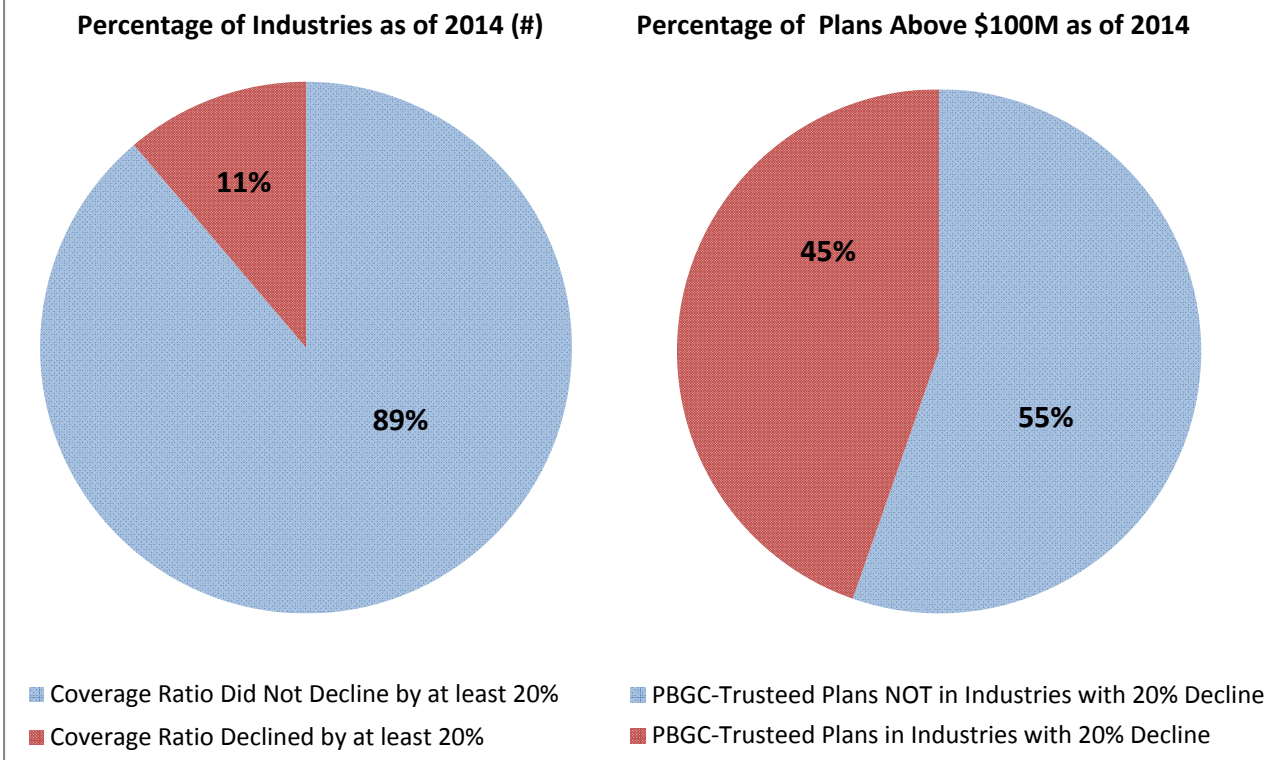
Based on the foregoing as well as other considerations, one might expect a given industry's contribution to PBGC's liabilities to be correlated both with its size and the extent of its unionization, as distinct from the trend in same. Insofar as that is true, it raises a question as to whether the screening criteria tested here might contribute no more to the efficiency of the modeling process than the two factors just cited.

To the extent that it was feasible to test that hypothesis here, we did so by correlating the 41 private sector industries in our database with 2014 employment of 500,000 or more, as well as the number of covered (union-represented) employees in each, to the industries listed in Exhibit L-19. As shown in Exhibit L-21, most of these relatively large industries do not appear in Exhibit L-19; nor do those with the greatest number of covered employees, with any degree of consistency. In our view, this suggests that rejection of the selection criteria proposed here in favor of arguably simpler alternatives would be premature. Further supporting that conclusion is the varying degree of union bargaining power across industries, such that those that remain more heavily unionized tend to be correspondingly insulated from competition, whether due to a franchised monopoly position, the impracticality of remote, centralized production, particularly high economic and/or social costs of work stoppages or slowdowns, or other such factors.

Another question meriting further consideration is whether the screening criteria suggested here would flag so many more industries than have actually proven problematic for PBGC, that their application would be counter-productive in terms of the efficiency of PIMS modeling. A partial answer to that question resides in the fact that of 259 industries analyzed, 147, or 57%, would not be flagged, by virtue of failing to employ at least 50,000, and/or failing to exhibit the required decline in employment, and/or the required decline in union coverage. It should also be noted that the thresholds for acceptance or rejection here applied might not be the optimal in terms of this consideration, as could be determined through further testing.

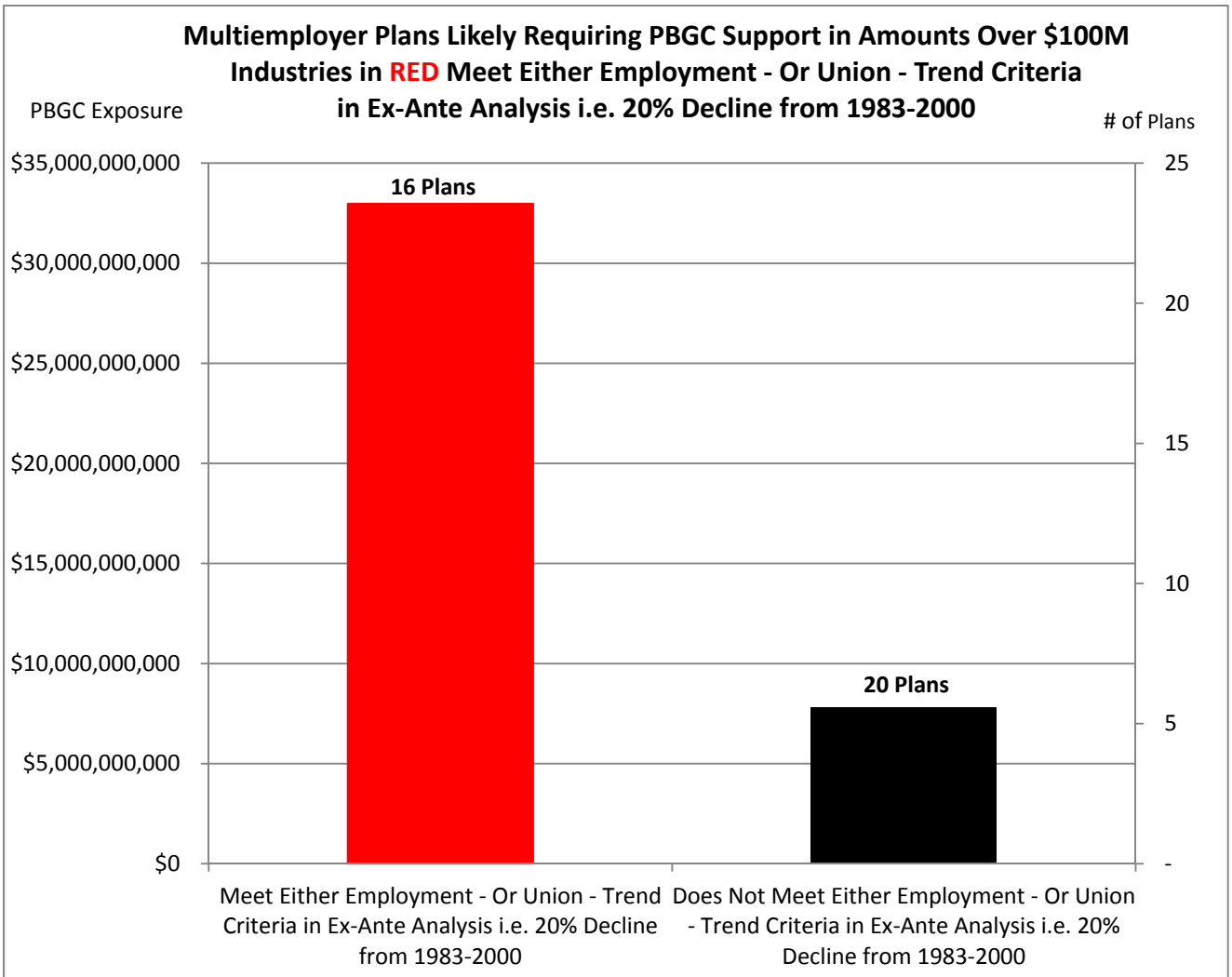
Exhibit L-18

Percentage of Industries and Large PBGC-Trusteed Plans Accounted for by Industries with Declines in Union Representation Ratio ≥ 20 Percentage Points



Source: FOD20130930.xls and unionstats.com, *Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014)*. Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

Exhibit L-19



Source: File titled "ME PROBSwReserves 9 30 14.xls" provided by the PBGC which included plans that the PBGC believed were probable to become liabilities in the future. unionstats.com, Union Membership, Coverage, Density, and Employment by Industry, by year (1983-2014). Although the data was extracted from U.S. Census Bureau's Current Population Survey ("CPS"), its industry categories have been changed three times since 1983; two minor changes in 1992 and 2009, and a significant change in 2003. FTI created a consistent categorization system adjusting for those disparities. Unionstats.com provided a conversion file to unify pre-1992 and post-1992 classifications. For the post-2002 industry conversions, FTI matched the industries using the industry name, industry hierarchy, and historical employment figures.

Exhibit L-20

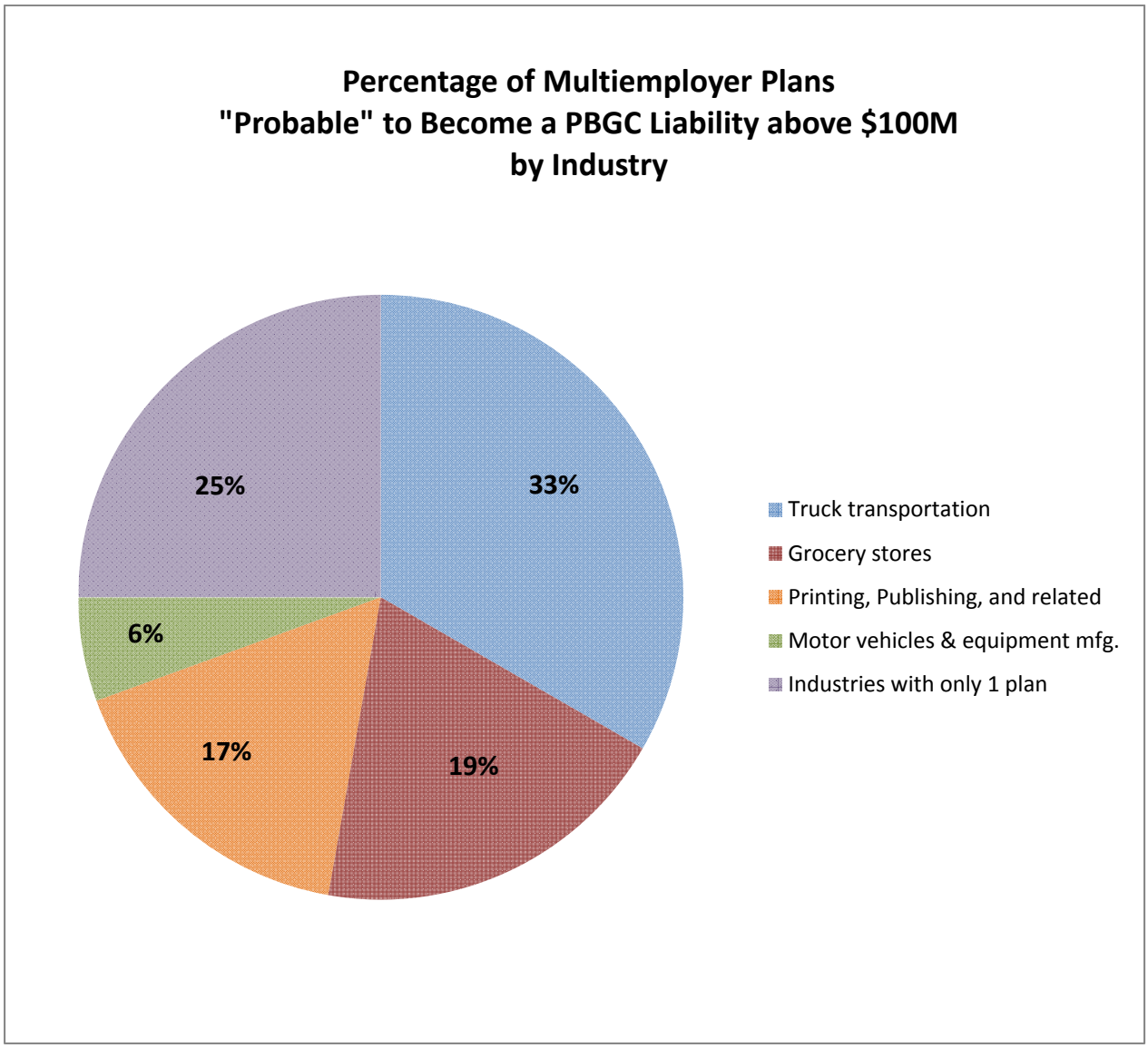
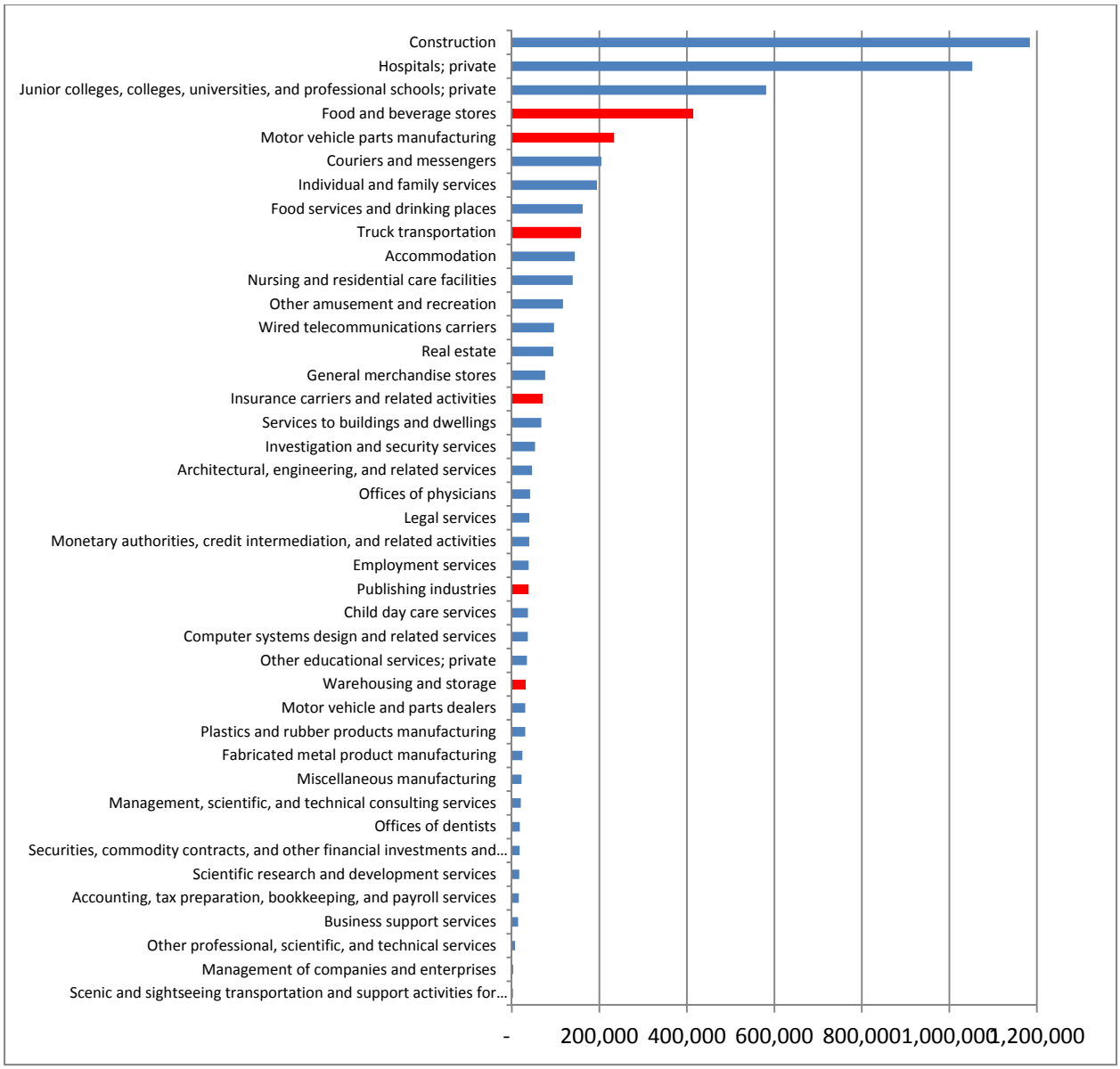

Percentage of Multiemployer Plans
"Probable" to Become a PBGC Liability above $100M
by Industry
33%
19%
17%
6%
25%
Truck transportation
Grocery stores
Printing, Publishing, and related
Motor vehicles & equipment mfg.
Industries with only 1 plan

Exhibit L-21

Industries with 500,000 Employees in 2014 per BLS
Union Members Covered



Source; unionstats.com.

Nor is the test proposed here intended to replace those already employed by PBGC in determining which pension plans on which to focus, or which otherwise might make sense. For example, industries especially hard-hit by technological change, such as publishing, would certainly justify a closer look; and, as is the case now, multiemployer plans could continue to be assessed based on the five ratios used by PBGC to identify those meriting a full solvency valuation.[32]

Recommendations for Both SE- and ME-PIMS Modeling

The foregoing suggests that PBGC's liability forecasting process might benefit from: (a) incorporation of a unionization-trend variable in the PIMS modeling, perhaps through modification of the weights assigned to alternative future outcomes, or modification of current benefit plan sampling methods; and (b) greater investment, in relative terms, in economic research and analysis aimed at pinpointing, and assessing the impacts of, major competitive shifts and structural changes in domestic industry.

The latter might be justified, in part, on the basis of the fact that those most-problematic industries not identifiable by the methods described above (i.e., airlines, printing and publishing, grocery stores, electrical machinery and equipment) even, for that matter, trucking – have all been undergoing radical transformation for many years, e.g., in the case of trucking as well as airlines, deregulation, beginning in the 1970's[33]; in the case of printing and publishing, competition from the internet and mobile devices[34]; in the case of groceries, industry consolidation over many decades, accelerating since the 1990's[35]; in the case of electrical machinery and equipment, increasing competition from abroad, again for several decades.[36]

Forecasting Stock Returns

In this section, we assess the processes used by PIMS to forecast stock returns, as described in the Statistical Analysis System ("SAS") program underlying PBGC's FY2014 Projection Report – "Economy_sim_fy14_v1.sas" [henceforth "PIMS 2014 SAS Program"].[37]

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[32] Assets to cash flow; active to inactive participants; fund inflow to outflow; assets to total liabilities; and assets to retired liabilities. Source: "Multiemployer PIMS, System-Validation Documentation, Key Differences between SE-PIMS and ME-PIMS," February 7, 2011, page 42.

[33] https://www.ftc.gov/sites/default/files/attachments/us-submissions-oecd-and-other-international-competition-fora/ibero-trucking.pdf.

[34] http://www.pewresearch.org/fact-tank/2015/05/22/the-declining-value-of-u-s-newspapers/.

[35] http://www.ers.usda.gov/topics/food-markets-prices/retailing-wholesaling/retail-trends.aspx. The rise of big-box retail chains has been a key influence over the past 20 years.

[36] See, for example, Thomas Lum and Dick Nanto, "China's Trade with the United States and the World," Congressional Research Service, CRS Report for Congress, Updated January 4, 2007, page 28 and related.

[37] Our initial review was based on the stock return forecasting model as described in Pension Insurance Modeling System, *PIMS System Description for PIMS SOA "Core" (vFY09.1), Version 1.0* Revised 9/22/2010 [henceforth "PIMS 2010 Guide"]. However, PBGC informed us that the description of stock return forecasting model as described in PIMS 2010 Guide is no longer valid. From the documentation provided to us, we cannot infer the reason for this modelling change and whether the change has led to improvement in stock return forecast.

Current Model

According to PIMS 2010 Guide, PIMS forecasted annual real stock returns using a "mean reverting" process.[38] This is no longer true; as of 2014, PIMS forecasts nominal stock returns with a random walk model, meaning that the return in a given year is independent of the return in the prior year, being a random realization from an overall return distribution.[39] Specifically in 2014, PIMS modelled natural logarithm of the excess of stock return[40] over the 30-year Treasury yield ("Log Equity Premium) as a random walk.[41] In technical jargon, in 2014, PIMS used a "martingale model" to forecast the equity risk premium.[42] Based on this model, PBGC derives forecasted stock returns in multiple scenarios, each of which "…consists of one time path of up to 20 years."[43]

Analysis

Note that, "PIMS is a simulation model designed to quantify the uncertainty that surrounds pension insurance."[44] In other words, PIMS does not aim to forecast a particular future outcome. Instead, it simulates a range of outcomes, including the extremely adverse. As such, it should capture the important properties of stock returns across simulated scenarios.

Based on a review of the relevant literature, we conclude that PBGC should consider using a forecasting model that incorporates: (a) the time-varying nature of return distribution parameters (expected stock returns, volatility, and correlation with other asset classes, particularly bonds); (b) fat tails; and (c) different economic regimes. As to the last, Ang and Timmerman observe, "When applied to financial series, regimes identified by econometric methods often correspond to different periods in regulation, policy, and other secular changes...,"[45] to which we would add, "either on a national or a global basis (as in the case of trade agreements). Further, as herein defined, an economic regime may reflect such

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[38] This is equivalent to assuming that returns tend to move around a stable long-term average.

[39] "Stock returns are modeled as independent from one period to the next. To determine a simulated sequence of stock returns, the model randomly draws returns from a distribution that reflects historical experience going back to 1926." [PBGC FY2014 Projections Report, page 46].

[40] Returns can be measured either in arithmetic or logarithmic terms. The arithmetic return on a stock equals the gain/loss in stock value for every dollar invested. The investment horizon determines the frequency of return. For example, if investment gains/losses are measured over a month, the return is referred to as the "monthly return."

[41] Specifically for FY2014, PBGC used the following equation to model stock returns: $\ln(1+r_t - yld_0) = \alpha_s + \varepsilon_{s,t}$
The random shock $\varepsilon_{s,t}$ is assumed to be correlated with the random shock to the 30-year Treasury yield and is drawn from a bivariate normal distribution. For Projections Report 2014, yld-0 was set equal to the 30-year Treasury yield measured as of September 30, 2014. [PIMS 2014 SAS Program]. In the program, α_s is set equal to 0.0390 and the random shock is derived from a bivariate normal distribution. The program does not explain the source of the "0.0390" value. The program notes that the distribution parameters are "…updated yearly so that sample mean & standard deviation of stock returns and its correlation to bond returns … hit the current targets."

[42] Stephen F. LeRoy, "Efficient Capital Markets and Martingales," *Journal of Economic Literature* 27 (4), Dec., 1989, pages 1583-1621.

[43] Each PIMS simulation comprises a user-specified number of scenarios, and, "Each scenario in a simulation starts with initial conditions for the economy, firm, plan, and PBGC condition that correspond to the baseline year of the simulation (PIMS year 0)." PIMS 2010 Guide, page 7-6.

[44] PIMS 2010 Guide, page 2-1.

[45] Andrew Ang and Allan Timmerman, "Regime Changes and Financial Markets," Network for Studies on Pensions, Aging and Retirement and National Bureau of Economic Research, June 2011, page 1.

specific secular changes as major advances in technology and changes in the global distribution of human capital that may confer additional competitive advantages to countries with low-cost labor.

There are several good models that incorporate the foregoing properties.[46] Relatedly, PBGC should consider modeling both stock returns and bond yields using monthly or quarterly data, so that its models can be reliably estimated based on a recent history incorporating a regulatory structure, policy regime *etc*. more representative of the period PIMS is simulating.[47]

In this report, we address certain properties of stock returns considered important in the academic literature:

a. Mean reversion and momentum in returns;

b. The time-varying nature of return distribution parameters - expected stock returns, volatility and correlation of stock returns with other asset classes (*e.g.*, bond yields);

c. Fat tails – the tendency of stock returns to exhibit extreme values, particularly negative ones;

d. Predictability of returns – the ability of certain other variables, such as the dividend-to-price ratio ("dividend yield") to forecast returns.

The extent to which stock returns exhibit these properties depends upon the time horizon, economic conditions, and whether an individual security or the market as a whole is being analyzed.

Autocorrelation in Returns – Mean Reversion and Momentum

Autocorrelation refers to the relationship between current period and prior period stock returns, and can be positive or negative. Negative autocorrelation leads to mean reversion, whereas positive autocorrelation implies momentum. While PIMS till recently modeled stock returns as mean-reverting, it now models them across various years as independent, setting the expected value of autocorrelation of returns at zero[48]

As discussed below, there is only weak evidence of long-term mean reversion for stock returns overall, a phenomenon seemingly limited to economic downturns. Given that PIMS currently does not model regime changes, use of a zero autocorrelation factor as of 2014 is consistent with findings in the academic literature. However, should an allowance for changes in regime be incorporated in PIMS, we believe that consideration should be given to a mean-reversion specification for economic contractions.

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[46] For example, see John M. Maheua and McCurdy, Thomas H., "Identifying Bull and Bear Markets in Stock Returns," *Journal of Business & Economic Statistics* 18 (1), 200, pages 100-112; Hardy, Mary R., "A Regime-Switching Model of Long-Term Stock Returns," North American Actuarial Journal 5 (2), April 2001, pages 41-53; M Guidolin, A Timmermann, "An Econometric Model of Nonlinear Dynamics In the Joint Distribution of Stock and Bond Returns," *Journal of Applied Econometrics* 21(1), 2006, pages 1-22; and Ang and Timmerman, op. cit.

[47] Should PBGC need a longer history for model testing, monthly stock return data since 1825 is now available. [Goetzmann, William N. and Ibbotson, Roger G. and Peng, Liang, A New Historical Database For The NYSE 1815 To 1925: Performance and Predictability," Yale ICF Working Paper No. 00-13, July 14, 2000. Available at SSRN: http://ssrn.com/abstract=236982.]

[48] PIMS 2010 Guide, Table 5-1, footnote 1, page 5-13.

So far as momentum is concerned, this property is evidenced primarily in the case of individual stocks, as opposed to the overall market modeled by PIMS; therefore, there is no need for PIMS to consider momentum in its modeling.

Mean Reversion

PBGC staff is aware that the evidence on mean reversion for overall returns is mixed. Citing Cochrane (1997), the PIMS 2010 Guide notes merely that "…[t]here is some evidence in the literature suggesting a mild mean reversion process over long periods."[49] Our reading of the literature comes to the same conclusion. Among other things, the strength of the evidence supporting mean reversion appears dependent upon the state of the economy during the analyzed history.[50]

While initial work in this area reported evidence of mean reversion,[51] subsequent research indicated that this finding was likely due to small-sample bias.[52] Kim, Nelson, and Startz (1991) reexamine "…the evidence of mean reversion in stock market prices," finding such reversion to be primarily a pre-World War II phenomenon.[53] However, while there doesn't appear to be strong evidence for mean reversion in returns overall, researchers report some following market declines.[54] Summarizing the literature, Bali, Demirtas, and Levy (2008) observe that while the empirical evidence for mean reversion in the aggregate is weak, "… when the market declines substantially mean reversion tends to cause it to have a significantly positive drift so that the market is pulled back to some long run average level over time."[55]

Hence, our recommendation that, should an allowance for changes in regime be incorporated in PIMS, consideration be given to a mean-reversion specification for economic contractions.

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[49] PIMS 2010 Guide, page 5-5.

[50] "The interest rate and stock return equations are estimated with an intercept and autoregressive parameter, respectively. Their parameter estimates are set to zero according to the priori expectations shown in equations 5-4 and 5-5." PIMS 2010 Guide, Table 5-1, fn. 1, page 5-13. As such, the stock return is modelled as a mean reverting process with an autoregressive coefficient that equals the random draw from a distribution centered on zero.

[51] See Summers, L., 1986, "Do Stock Markets Reflect Fundamentals?" *Journal of Finance*, XLI (July), 591-601; Poterba, J. M., and Summers, L. H., 1988, "Mean Reversion in Stock Prices: Evidence and Implications," *Journal of Financial Economics*, 22, 27-59; Fama, E. F., and K. R. French, 1988, "Permanent and Temporary Components of Stock Prices," *Journal of Political Economy* 96 (2), 246-273; Andrew W. Lo, A. Craig MacKinlay, 1988, "Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test," *Review of Financial Studies* 1(1), 41-66.

[52] Matthew Richardson and Stock, James H., 1989, "Drawing Inferences from Statistics Based On Multiyear Asset Returns," *Journal of Financial Economics*, 25 (1989) 323-348. Using a different approach to assess statistical significance, the authors find that mean reversion evidence reported in Fama and French (1988) and Poterba and Summers becomes weak.

[53] Kim Myung-Jig *et a*l, "Mean Reversion in Stock Prices: A Re-Appraisal of the Empirical Evidence," *Journal of Accounting & Economics*, 58, 1991, 515-528. Also published in *The Review of Economic Studies*, Vol. 58, No. 3, Special Issue: "The Econometrics of Financial Markets," May, 1991, pages 515-528.

[54] For example, Phillipe Jorion, 2003, "Long-Term Risks of Global Stock Markets," *Financial Management* 32(4), 1-26: while "…[t]here is no statistically significant mean reversion… markets that suffered interruption display mean aversion. Thus, evidence of mean reversion must be evaluated considering the survival of the market."

[55] Turan Bali *et al*, "Nonlinear Mean-Reversion in Stock Prices," *Journal of Banking and Finance*, Vol. 32, No. 5, 2008, pages 767-782 (page 20 in manuscript).

Momentum

The Wharton papers reviewing PIMS in 2013 cite evidence of momentum in monthly stock returns. For example, Brown *et al* (2013) note that, "…there is some evidence of positive momentum at a monthly level (for example, Jegadeesh and Titman 1993)."[56]

In this connection, it is important to bear in mind that momentum *per se* is not directly relevant to the modeling of aggregate stock returns, as it refers to the tendency of some stocks predictably beating other stocks over time.[57,58] Moreover, even in the case of individual stocks, the evidence for momentum is mixed.[59] And in the current context, momentum is only relevant to the extent that it could be driven by positive autocorrelation,[60] which needs to be separately accounted for in any proper time series forecasting exercise. Thus, the consideration appears peripheral to the mission of PIMS.

The Time-Varying Nature of Return Distribution Parameters

It is now well established that expected stock returns, their volatility, and their correlations with other asset returns (particularly bonds) vary with the state of the economy.[61]

As shown in Exhibit S-1, realized equity risk premia[62] vary considerably over time:

[56] Jeffrey Brown et al, "A Review of the Pension Benefit Guaranty Corporation Pension Insurance Modeling System," The Wharton School, Pension Research Council Working Paper, September 2013, page 20.

[57] Technically, "…momentum [in stock returns] is a cross-sectional result (winners beat losers)," not a time series phenomenon. [Lewellen, Jonathan, "Momentum and Autocorrelation in Stock Returns," *Review of Financial Studies* 15 (2), 2002, pages 533-564.]

[58] N. Jegadeesh and S. Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," *The Journal of Finance*, 1993.

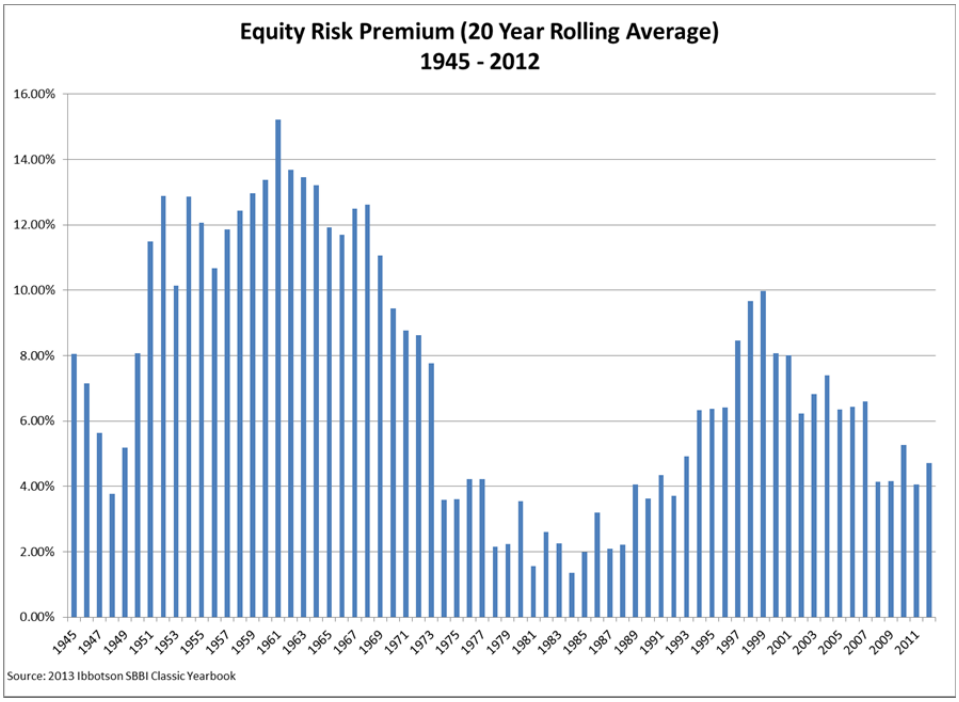
[59] D.A. Lesmond *et al*, "The Illusory Nature of Momentum Profits," *Journal of Financial Economics*, 2004.

[60] Lewellen (2002):"Intuitively a stock that outperformed other stocks in the past might continue to do so for three reasons: (1) the stock return is positively autocorrelated, so its own past return predicts high future returns; (2) the stock return is negatively correlated with the lagged returns on other stocks, so their poor performance predicts high future returns; and (3) the stock simply has a high unconditional mean relative to other stocks."

[61] "[E]xpected returns [on stocks and bonds] are lower when economic conditions are strong and higher when conditions are weak." [Fama, Eugene, and Kenneth French, "Business Conditions and Expected Returns on Stocks and Bonds," *Journal of Financial Economics* 25, 1989, pages 23-49.] Also see Fama, Eugene, and Kenneth French, "Dividend Yields and Expected Stock Returns," *Journal of Financial Economics*, XXII (1988), 3-27. Similarly, DeStefano, Michael, "Stock Returns and the Business Cycle," *Financial Review* 39 (4), November 2004 finds that, "As anticipated, stock returns decrease throughout economic expansions and become negative during the first half of recessions. Returns are largest during the second half of recessions, suggesting an important role for expected earnings. These results are consistent with the notion that expected stock returns vary inversely with economic conditions, yet suggest that realized returns are especially poor indicators of expected returns prior to turning points in the business cycle."

[62] The equity risk premium is defined as the excess of expected return over the risk-free rate.

Exhibit S-1



Further, research indicates that stock return volatility is higher during periods of economic crises/ recessions.[63] PIMS does not appear to model either of these properties.[64]

While PIMS does appear to update its equity risk premium every year,[65] it cannot model the regime-dependent nature of volatility, as it does not model regime switching.[66]

[63] See, *e.g.*, Schwert, G. William, "Business Cycles, Financial Crises, and Stock Volatility," NBER Working Paper No. 2957, May 1989 noting that, "…stock volatility increases during recessions and financial crises." Also see Campbell, John, and Ludger Hentschel, "No News Is Good News: An Asymmetric Model of Changing Volatility in Stock Returns," *Journal of Financial Economics* 31 (3), 1992, pages 281-318 ("One striking characteristic of the stock market is that the volatility of returns can be very different at different times."); Schwert, G. William, "Why Does Stock Market Volatility Change Over Time?," *The Journal of Finance,* 1989, 44, 1115-1153; and French, Kenneth R., *et al*, "Expected Stock Returns and Volatility," *Journal of Financial Economics* 19, 1987, pages 3-29.

[64] See, *e.g.*, Malcolm Baker, and Wurgler, Jeffrey, "Co-movement and Predictability Relationships Between Bonds and the Cross-section of Stocks," *Review of Asset Pricing Studies*, March 16, 2012, pages 1-13, noting that "Baele, Bekaert, and Inghelbrecht (2010) … find that the correlation between daily returns on stock and bond indices is on average modestly positive but has ranged anywhere from +0.60 to –0.60 over the past forty years and exhibits sharp changes of 0.20 or more from month to month."

[65] PIMS 2014 SAS Program.

[66] See, *e.g.*, Malcolm Baker, and Wurgler, Jeffrey, "Co-movement and Predictability Relationships Between Bonds and the Cross-section of Stocks," *Review of Asset Pricing Studies*, March 16, 2012, pages 1-13, noting that "Baele, Bekaert, and Inghelbrecht (2010) … find that the correlation between daily returns on stock and bond indices is on average modestly positive but has ranged anywhere from +0.60 to –0.60 over the past forty years and exhibits sharp changes of 0.20 or more from month to month."

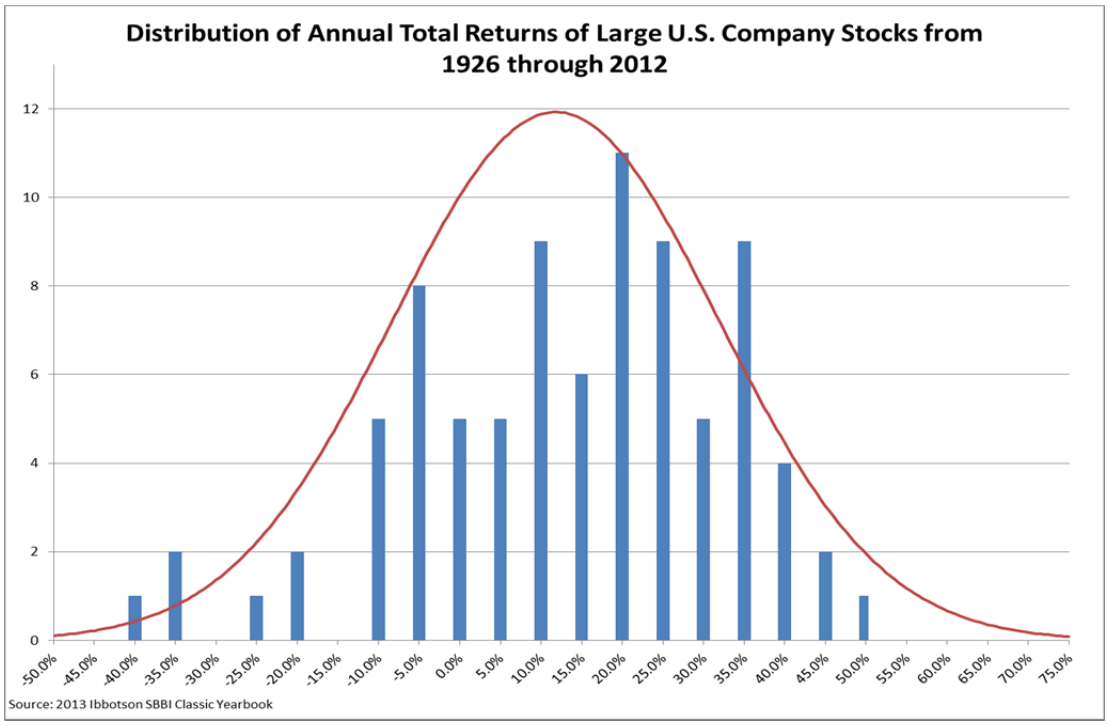
In normal times, stock returns and bond yields are positively correlated, given that when stocks are doing well, bond prices tend to fall. However, during stock market crashes, the stock and bond markets can become decoupled, with the correlation between stock returns and bond yields turning negative.[67]

In contrast, PIMS assumes a constant correlation between stock returns and bond yields. Thus, depending upon the realized correlation, it implicitly assumes either a crisis regime or a normal regime across all years in all simulated scenarios, with no switching across regimes.

Fat Tails

PIMS models stock returns as derived from a normal distribution. Given that PIMS models returns at an annual frequency, this is not an unreasonable assumption empirically. As Campbell *et al* (1997) points out, "In practice the evidence for non-normality is much weaker for long-horizon returns than for short horizon returns."[68] Exhibit S-2 provides a histogram of annual returns on the S&P 500 since 1926; as indicated, they do indeed appear consistent with a normality assumption, if only roughly.

Exhibit S-2



If the data are indeed from a normal distribution, 99.7% of the realized observations would fall within three standard deviations from the mean. However, the converse is not necessarily true; it could be the case that while 99.7% of the realized observations fall within three standard deviations, the data could actually be drawn from a fat-tailed distribution,[69] the realized history being too short to capture this

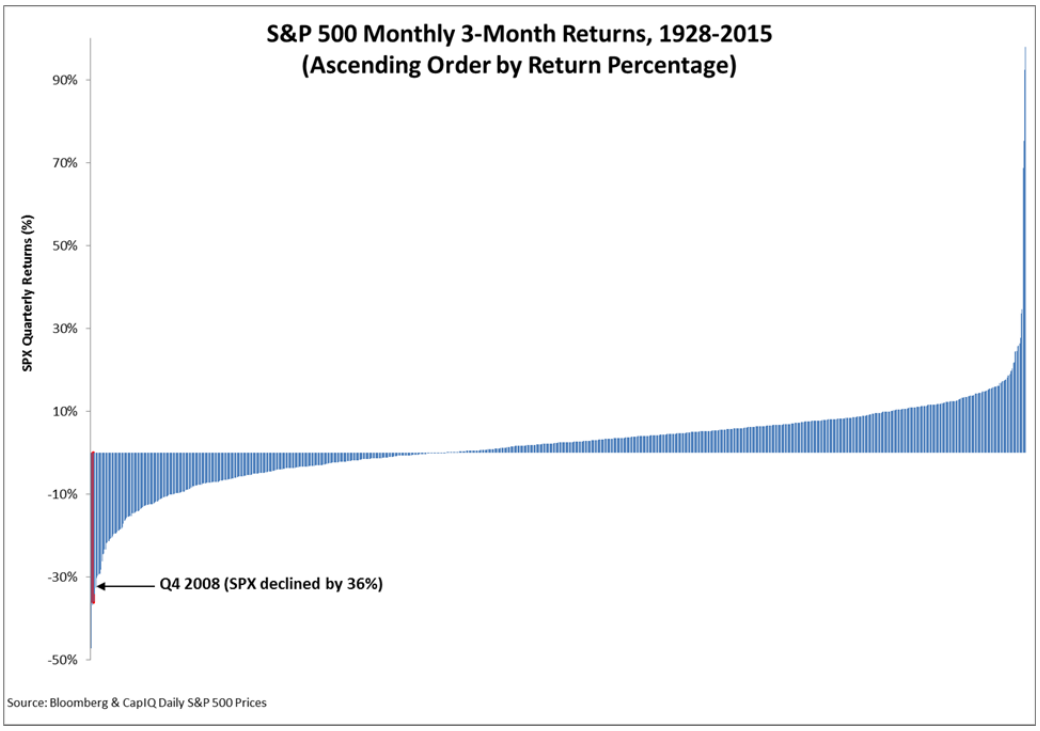
[67] Les Gulko, "Decoupling," *The Journal of Portfolio Management*, Spring 2002, 28 (3), pages 59-66.

[68] John Campbell, Andrew Lo and A. Craig MacKinlay, *The Econometrics of Financial Markets (*Princeton: Princeton University Press, 1997), page 19.

[69] A fat-tailed distribution is one under which the probability of extreme returns is larger than that of a normal distribution.

non-normality.[70] For example, as Exhibit S-3 shows, Q4 2008 (-36%) exhibited the worst quarterly decline in the SPX since the Great Depression.[71] However, when examined on an annual frequency, the extreme annual return of 37% during 2008 is within three standard deviations of realized annual returns since 1926.[72]

Exhibit S-3



Ensuring that PIMS adequately captures extreme returns, especially negative ones, is an important concern here: "Since PBGC insurance both conceptually and as modeled in PIMS is expected to pay at times when plans are underfunded and sponsors are in distress, having a more accurate representation of equity market extremes seems quite important."[73] Indeed, summarizing the findings of the Technical Review Panel on PIMS, Mitchell (2013) notes that, "But having experienced the recent global financial crisis, we now know that tail risk is far more of a concern than previously anticipated. [74]

[70] Brown *et al* (2013): "Campbell (2000) discusses some of the 'econometric pitfalls' that are relevant for evaluating this issue. A key one is that as the forecast horizon lengthens, the number of non-overlapping observations decreases rapidly."

[71] Quarterly returns on SPX are computed on a rolling basis. In other words, Exhibit S-3 shows quarterly returns for every month in the period from April 1928 to December, 2015.

[72] The standard deviation of annual returns for the period from 1926 to 2012 is 20.18%. [Source: see Exhibit S-2.]

[73] Geczy (2013), page 9.

[74] Olivia Mitchell, "Technical Review Panel for the Pension Insurance Modeling System (PIMS): An Overview," University of Michigan Retirement Research Center Working Paper, WP 2013-290(a), 2013, page 7. Also see Brown *et al*, page 16 ("Overall, it appears that the existing model underestimates the likelihood of extreme or 'tail' events.")

Evidence of a fat-tail distribution is easily seen when daily and monthly returns are modeled.[75] Exhibit S-4 reproduces Table 1 of Kimball (2000), showing that the number of extreme monthly returns over the period 1926 to 1997 is almost double of what one would expect given a normal distribution.[76]

Exhibit S-4

Extreme Losses on Large Stocks and L-T U.S. Treasuries, 1926 to 1997

	Mean Monthly Return (%)	Standard Deviation of Mean Monthly Return (%)	# of Expected Extreme Losses if Distribution Was Normal	Actual Number of Extreme Losses
Large Stocks	1.0291	5.7036	8.64	16
Long-Term U.S. Treasuries	0.4469	2.2194	8.64	15

Source: Ibbotson Associates, Stocks, Bonds, Bills and Inflation: 1998 Yearbook

Exhibit S-5 on the following page depicts results from Table 1 of Jansen *et al* (2000), who performed formal statistical tests on 67 years of monthly stock and bond return data, finding the distribution of those series to be non-normal with fat-tails.[77]

Campbell *et al* (1997) observe that, "Recent research tends … to model returns as drawn from a fat tailed distribution with finite higher moments, such as the t-distribution, or as drawn from a mixture of distributions."[78] As earlier noted, PIMS does not appear to model this property, but might well benefit from doing so, if cost-effective.

[75] For daily returns, see Chang *et al* (2013), and Fama, "The Behavior of Stock Prices," *Journal of Business* 47 (January 1965), pages 244-280. For monthly returns, see R. Officer, "The Distribution of Stock Returns," *Journal of the American Statistical Association* 67 (340), December1972, pages 807-812. The paper examines, "…the distribution of monthly returns of a random sample of 39 stocks, listed continuously from January 1926 to June 1968," finding it non-normal.

[76] Ralph Kimball, "Failures in Risk Management," *New England Economic Review,* January/ February 2000.

[77] Dennis Jansen *et al*, "Portfolio Selection with Limited Downside Risk," *Journal of Empirical Finance*, 7 (2000), pages 247–269. The authors examine, "…67 years of monthly data on a US bond index and a US stock index, 1926.01–1992.12… from the CRSP database." The paper notes that, "Table 1 also reports kurtosis calculations, which indicate that these three series have fat tails, and the Bera–Jarque test statistics, which decisively reject the normality of these returns. Our conclusion from the summary statistics is that there is little reason to think that either stock or bond returns are normally distributed."

The expected value of kurtosis under a normal distribution is 3. As Exhibit S-6 shows, the kurtosis for monthly returns of US corporate bonds, government bonds and stocks is much higher than 3, confirming the presence of fat tails in stock returns.

[78] "For example the return might be conditionally normal, conditional on a variance parameter which is itself random; then the unconditional distribution of returns is a mixture of normal distributions, some with small conditional variances that concentrate mass around the mean and others with large conditional variances that put mass in the tails of the distribution. The result is a fat-tailed unconditional distribution with a finite variance and finite higher moments." Campbell *et al*, *The Econometrics of Financial Markets*, page 19.

Exhibit S-5

Returns on monthly US Corporate Bonds, Government Bonds, and Stocks

	Corporate bonds	Government bonds	Stocks
Mean	0.004445	0.003938	0.007943
Standard deviation	0.019782	0.021674	0.055702
Range	+ 0.133, -0.093	+ 0.142. -0.088	+ 0.320. -0.340
Skewness	0.746	0.746	-0.488
Kurtosis	10.027	8.496	9.888
J-B normality test	1728.6	1086.6	1621.4
No, of observations	804	804	804
Correlation of returns			
Corporate bonds, government bonds: 0.838			
Corporate bonds, stocks: 0.231			
Government bonds, stocks: 0.1 S3			

Predictability of Stock Returns

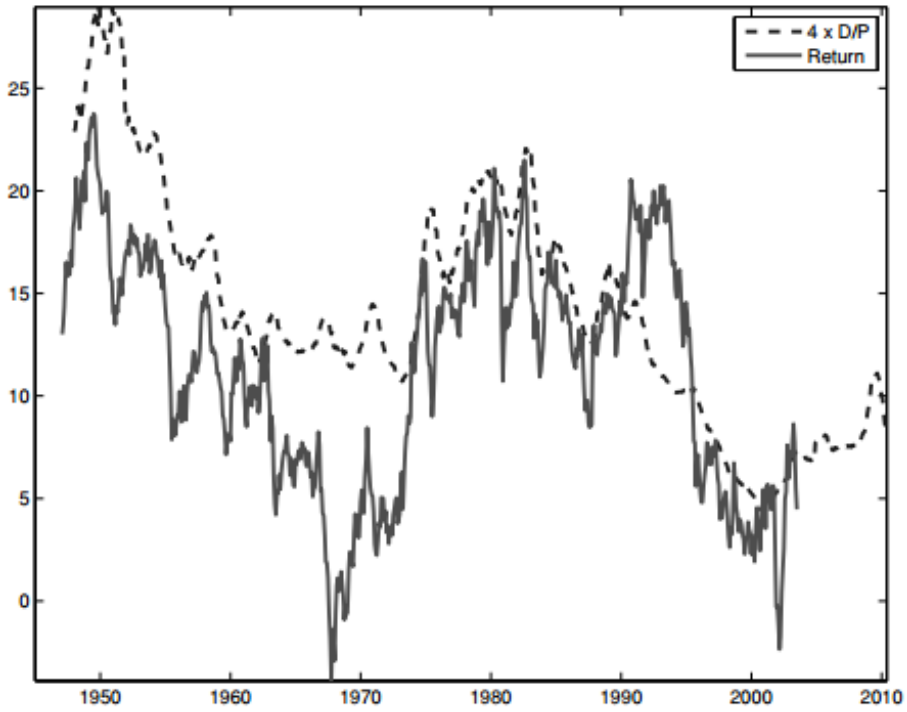
As also noted in our Subtask 4.9 report, the predictability of stock returns is an unsettled question. Initial research by Fama and others suggested that returns follow a martingale process, and are unpredictable in any useful sense. However, later research showed that, historically, poor (good) returns follow high (low) price-dividend ratios and other measures of market value relative to cash flows, such as the market value of equity as a percentage of GDP. [79] Exhibit S-6 reproduces Cochrane (2011), Figure 1, showing that current dividend yields forecast stock returns over the next seven years with some degree of reliability.[80] However, this predictability seems to be largely an in-sample phenomenon, and subsequent research finds even the in-sample predictability to be low.[81] Thus, it is not at all apparent that an effort to model return predictability in this sense would be beneficial or cost-effective for PIMS.

[79] See Lettau M. and Ludvigson S., "Consumption, Aggregate Wealth, and Expected Stock Returns," *The Journal of Finance* 56(3), pages 815-849 ("It is now widely accepted that excess returns are predictable by variables such as dividend-price ratios, earnings-price ratios, dividend-earnings ratios, and an assortment of other financial indicators."

[80] J.H. Cochrane, "Presidential Address: Discount Rates," *The Journal of Finance* 66(4), 2011, pages 1047-1108.

[81] See, *e.g.*, Handbook of Economic Forecasting, Vol 2A, Chapter 6, page 578: "Bossaerts and Hillion (1999), Goyal and Welch (2003, 2008), Brennan and Xia (2005), and Butler et al (2005) argue that the in-sample evidence of return predictability is not robust to out-of-sample validation. The study by Goyal and Welch (2008), which won the 2008 Michael Brennan Best Paper Award for the Review of Financial Studies, has been especially influential in this regard. Considering a variety of economic variables from the literature, Goyal and Welch (2008) show that out-of-sample equity premium forecasts based on the bivariate predictive regression, (1), fail to consistently outperform the simple historical average benchmark forecast in terms of MSFE." Also see, R. Bansal *et al*, "An empirical evaluation of the long run risks model for asset prices," NBER Working Paper No.15504, 2009 ("The evidence for return predictability in the data is very fragile. ... using the ... dividend-price ratio less the real risk-free rate, the level of return predictability declines from 31% to only about 9% at the five-year horizon").

Exhibit S-6



Source: Cochrane JH, "Presidential address: Discount Rates," *The Journal of Finance* 66(4), 2011, pg. 1049.

Forecasting Interest Rates

In this section, we assess PIMS's modeling of interest rates, as described PIMS 2014 SAS Program.[82]

Current Model

Apart from stock returns, PIMS currently employs four economy-level variables: (a) 30-year Treasury rates, both real and nominal; (b) the yield on corporate bonds; and (c) inflation. Of these, PIMS itself currently models only the nominal yield on 30-year Treasuries.[83] The real rate of interest is an externally-sourced input to PIMS, and the yield on corporate bonds is modeled as the forecast 30-year bond yield "…plus a fixed spread (*e.g.* 1%), multiplied by a proportional increase factor (*e.g.* 105%)."[84] The inflation rate is inferred from the 30-year nominal yield and the real interest rate input.[85]

[82] As noted earlier, our initial review was based on the description provided in PIMS 2010 Guide. However, PBGC has since informed us that the interest rate forecasting model described in PIMS 2010 Guide no longer applies. From the documentation provided to us, we cannot infer the reason for this modeling change, or whether the change has led to any improvement in forecasting.

[83] PIMS 2010 Guide, page 2-9.

[84] PIMS 2010 Guide, page 2-9.

[85] Specifically, "The inflation rate is derived from the nominal interest rate by adjusting for a real interest rate component, r, as follows: (2-18) $(1+\rho_t) = (1+i_t)/(1+r)$." The inflation rate is used to make "inflationary adjustments to pension benefits and other real-to-nominal conversions." PIMS 2010 Guide, page 2-9.

To forecast 30-year nominal yields on government bonds, PIMS models the natural logarithm of interest rates ("Log Rate") as a random walk.[86] This means that the 30-year nominal yield in a given year is independent of the yield realized in prior years, and determined as a random realization.[87]

Analysis

At the outset, we note that there are widely-traded financial instruments (*e.g.*, forward contracts), with prices that can be used to infer interest rate expectations. Also, there are professionals who forecast interest rates on a regular basis; for example, every month, the Blue Chip Economic Indicators survey[88] provides five- to nine-quarter forecasts of three-month Treasury bill rate and 10-year Treasury note yield. However, neither individual forecasters nor financial markets offer the 10-year forecasts PBGC requires.

In this connection, it is likewise important to note that the future liabilities related to pension insurance, and the assets held to fulfill those liabilities, are impacted by both short-term and long-term interest rates, whereas PIMS models only one nominal long-term (*i.e.*, 30-year) rate.[89]

Exhibit I-1 reproduces Brown *et al* (2013)'s Figure 2, which shows that as of January 2011 and 2013, the term structure of yields on both Treasury securities and Treasury Inflation-Protected Securities ("TIPS") was indeed upward sloping.[90] The exhibit also shows that the real interest rate at the short end was negative, as compared to positive long-term real rates.

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[86] In technical terms, PIMS forecasts the Log Rate using the equation: $\ln(i_t) = \alpha_i + \varepsilon_{i,t}$ [PIMS 2014 SAS Program]. In the SAS program, α_i is set equal to natural logarithm of 30-year Treasury yield of September 30, 2014 and the random shock is derived from a bivariate normal distribution. The program does not describe how the distribution parameters are determined.

[87] Previously, PIMS modeled the uncertainty in parameter values. However, PIMS 2014 SAS program no longer uses parameter uncertainty and thus, the parameter values no longer change from one scenario to another. We do not know the reason for this change, nor what improvement, if any, resulted from it.

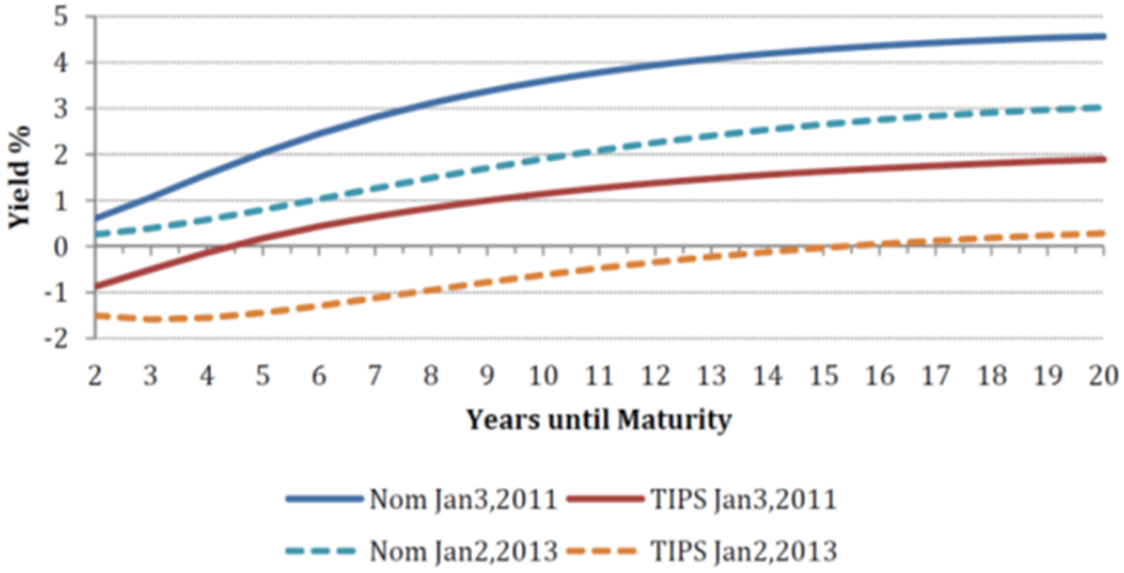
[88] About this survey, American Economic Association observes that. "[Blue Chip Economic Indicators] may be the best known organization for consensus macro forecasts. Their "Blue Chip Economic Indicators" surveys leading business economists and from the interviews, they distribute a 16 page monthly report. It offers forecasts for real GDP and 15 other macro variables." https://www.aeaweb.org/rfe/showRes.php?rfe_id=1922&cat_id=12.

[89] See, *e.g.*, Brown *et al* (2013), page 17: "…the PIMS model assumes a flat term structure for both real and nominal yields, that is, there is no distinction between short-term and long-term interest rates. Yet even a casual observation of yields… clearly indicates that real interest rates are not independent of a bond's maturity. … In periods of a steep yield curve, the PIMS model's assumption of a flat yield curve has the effect of under-stating the importance of nearer term liabilities relative to longer-term liabilities, for example." In this connection, PBGC staff notes that, "Since the 30-year rate that is used is a yield to maturity, not a zero-coupon rate, some portions of a pension payment stream will be undervalued discounting with the single rate and some will be overvalued. The total liability discounted with that rate will typically only be understated if it has a lower duration than that of a 30-year bond."

[90] Brown *et al* (2013), Figure 2, page 17.

Exhibit I-1

Yield Curves



Consequently, we recommend that PBGC consider modeling the term structure of both real and nominal interest rates.

The 30-Year Real Interest Rate

The real interest rate utilized in PIMS is the starting long-term Treasury bond yield less the average rate of inflation forecast in the current OASDI Trustees Report.[91]

As noted, PIMS models this rate as fixed. While this assumption is consistent with certain research,[92] real rates have in fact been declining over the long term. As observed by the Executive Office of the President in regard to the chart below, "A trend line fitted to the data in Figure 2 (Exhibit I-2) shows that the real 10-year [interest] rate [the blue line in Figure 2] has declined slightly under 2 basis points per year on average between 1876 and 2013, though the fit of the trend line is weak."[93] More significantly for our purposes, the downward trend has strengthened since mid-1980s.[94]

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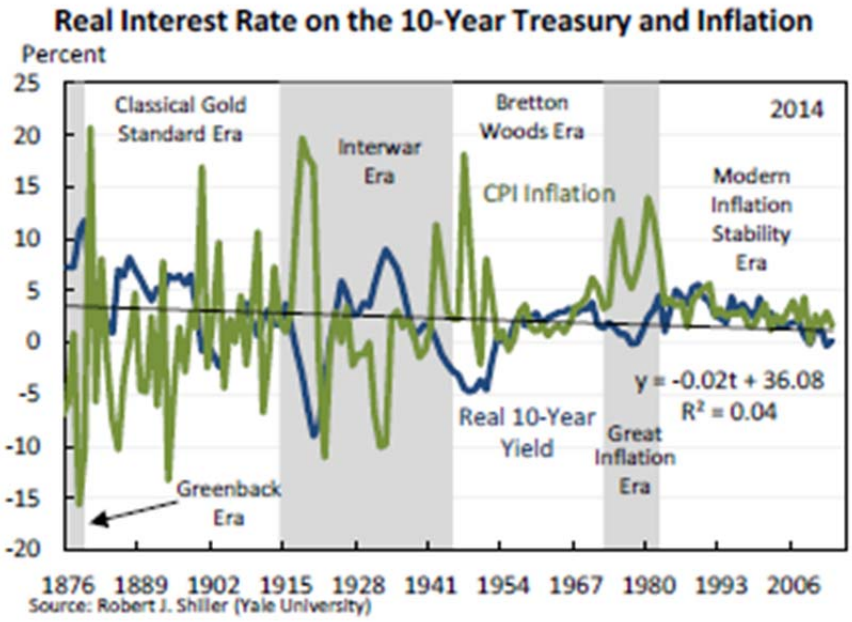
[91] Source: PBGC staff comment. The PIMS 2010 Guide does not describe how the models' forecast real interest rate is determined. According to staff, "…projected inflation is based on the assumptions in Table V.B1 of the current OASDI Trustees report."

[92] See, *e.g.*, Ang, A., Bekaert, G. And Wei, M. (2008), "The Term Structure of Real Rates and Expected Inflation," *The Journal of Finance* 63, pages 797–849: "…theoretical research often assumes that the real interest rate is constant..."

[93] "Long-Term Interest Rates – A Survey," Executive Office of The President of the United States, July 2015 [henceforth "White House LT Rate 2015 Survey"], page 8.

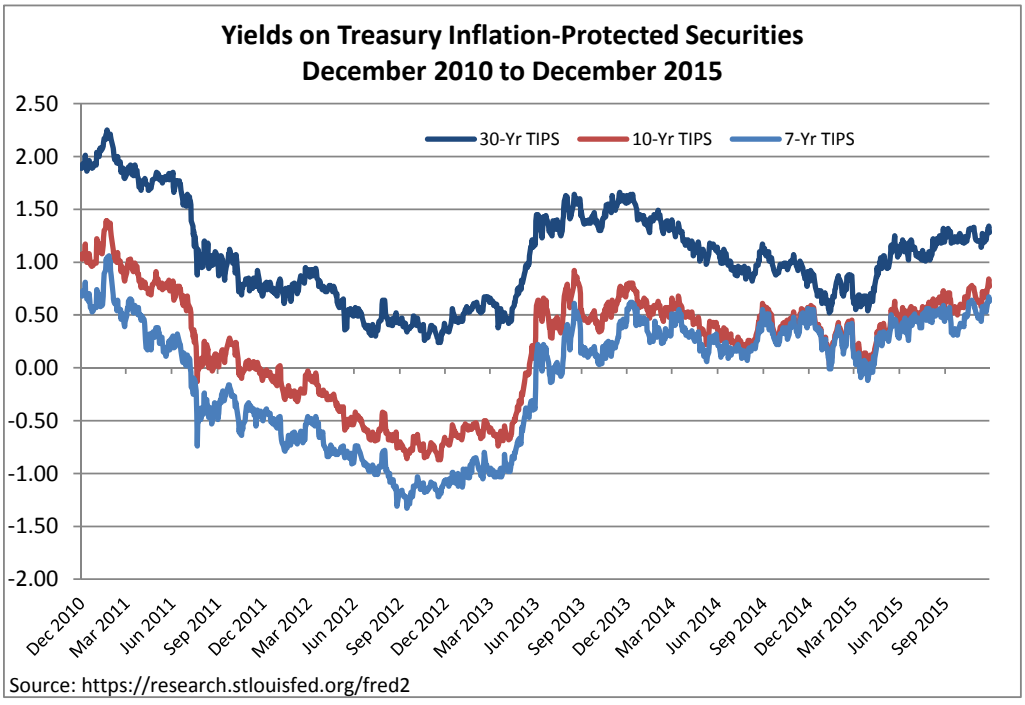
[94] White House LT Rate 2015 Survey, page 12: "Real and nominal interest rates in the United States have been on a steady decline since the mid-1980s."

Exhibit I-2



Further, real rates have also been highly volatile over the last five years. Exhibit I-3 shows the yield on TIPS of seven-, 10- and 30-year maturities since December 2010. Notably, yields on 10-year TIPS turned negative at the end of 2011, remaining so at the end 2012.

Exhibit I-3



The modeling of long-term real interest rates has evolved over the last 50 years. In the 1960s, for any given maturity, such rates were considered constant.[95] Now, they are believed to vary with time, a key question being whether they are mean-reverting.[96] Recent research indicates that "…real and nominal interest rates revert to their mean very slowly, with close to unit root (non-stationary) properties,"[97] while, "Economic theory strongly suggests that real interest rates are bounded, if not fully mean-reverting."[98]

These findings suggest that PBGC should consider modeling the long-term real rate. Based on our review of the literature, we suggest considering a mean reversion model in combination with a deterministic trend.[99,100] Also meriting consideration is a simpler random walk model, because, given the high persistence in real interest rates, the random walk may also suffice over the PBGC projection horizon. The final choice of a model is an empirical question.

Further, as suggested for stock returns, PBGC should consider modeling real rates at monthly or quarterly frequency if feasible, so that its models can be reliably estimated using a recent history incorporating a regulatory structure, policy regime, and economic data more representative of the period PIMS is simulating.[101]

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[95] Eugene Fama, "Short-term Interest Rates as Predictors of Inflation," *The American Economic Review* 65 (3), 1975, pages 269–82: "…expected real returns on bills seem to be constant during the period [1953-1971]."

[96] White House LT Rate 2015 Survey, page 11: "To the extent interest rates are mean-reverting, the historical average may contain the most useful information for projecting the long-run long-term interest rate. On the other hand, if changes in interest rates are permanent (or at least, highly persistent), recent data may contain more useful information about long-run interest rates than historical data."

[97] Ibid, citing the findings in Hamilton, James D., Ethan S. Harris, Jan Hatzius and Kenneth D. West, "The Equilibrium Real Funds Rate: Past, Present, and Future," Working Paper, 2015. Citing Neely and Rapach (2008), the survey further notes that, "…mean reversion with very high persistence is difficult [to detect] in a finite sample of data."

Also see Christopher Neely and David E. Rapach, "Real Interest Rate Persistence: Evidence and Implications," *Federal Reserve Bank of St. Louis Review*, 90(6), 2008, pages 609-641 ("A key stylized fact is that postwar real interest rates exhibit substantial persistence, shown by extended periods when the real interest rate is substantially above or below the sample mean.)"

[98] White House LT Rate 2015 Survey, page 11.

[99] White House LT Rate 2015 Survey, page 11, noting that, "…[e]ven when interest rates are mean-reverting, and therefore stationary in the statistical sense, they can be 'trend-stationary,' reverting to means that evolve deterministically over time rather than being constants."

[100] For specification of such a model, see Equation (5) in Yangru Wu and Hua Zhang, "Mean Reversion in Interest Rates: New Evidence from A Panel of OECD Countries," *Journal of Money, Credit and Banking*, 1996, pages 604-621.

[101] The history of directly-observed real interest rates is very limited, as TIPS started trading only in 1997. Further, the market for TIPS was not very liquid in the initial years. Therefore, for the initial history, observed yields represent the sum of real interest rates and the liquidity discount. The same observation holds for 2008, when, during the financial crisis, there was panic selling of TIPS. (Stefania D'Amico *et al*, "Tips from TIPS: The Informational Content of Treasury Inflation-Protected Security Prices," *Finance and Economics Discussion Series (FEDS) Working Paper*, 2014-24, 2014.

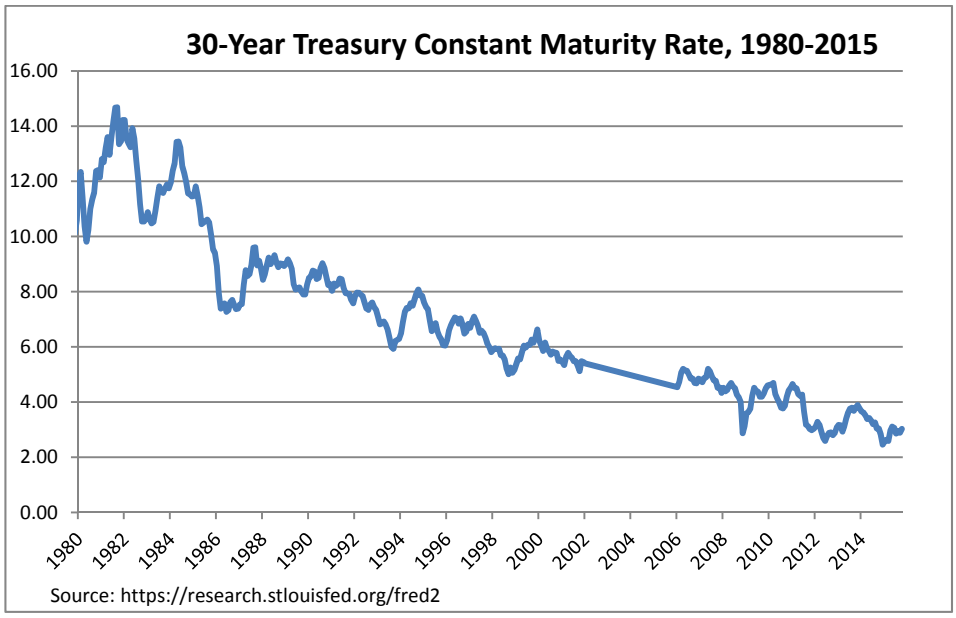
The 30-Year Nominal Rate

Currently, "PIMS uses a random walk model of interest rates."[102] However, as shown in Exhibit I-4 on the following page, nominal rates have been falling steadily since 1980.

In justification of its random-walk model, PBGC notes that parameters of a mean-reverting process estimated based on data for the 1972-1993 period, "…implies long-run mean reversion to an interest rate of 8.76 percent. However, the last time the year-end interest rate was above that level was 1988."[103] An equal concern, however, should be the likelihood that the rate will prove to be well *below* the value forecast.

Exhibit I-5 on the following page reproduces PIMS results from "…running 100 30-year stochastic simulations using the 1993 starting interest rate of 6.54 percent."[104] As indicated, the estimated mean-reversion process generates an upward trend in simulated interest rates, while, at the same time, PBGC concludes that modeling the interest rate as a random walk results in "…an approximately 60 basis point drop in the median interest rate from its starting value to its value in year thirty of the simulation."[105] (See Exhibit I-6.)

Exhibit I-4



[102] PIMS 2010 Guide, page 5-5.

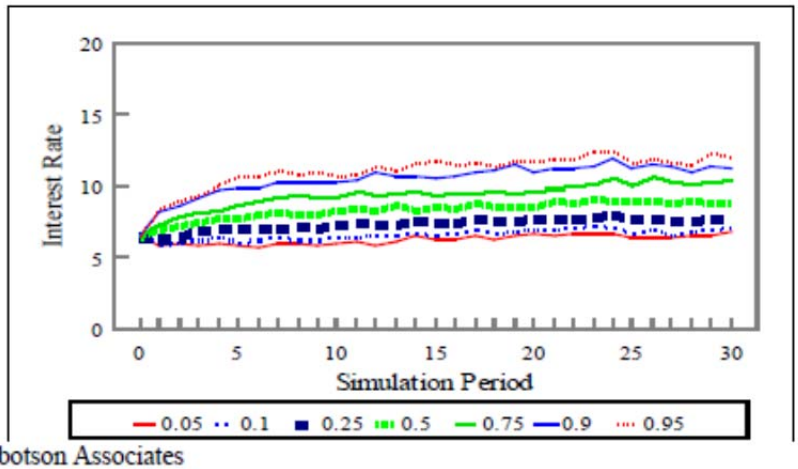
[103] PIMS 2010 Guide, page 5-3.

[104] PIMS 2010 Guide, page 5-3.

[105] PIMS 2010 Guide, page 5-4.

Exhibit I-5

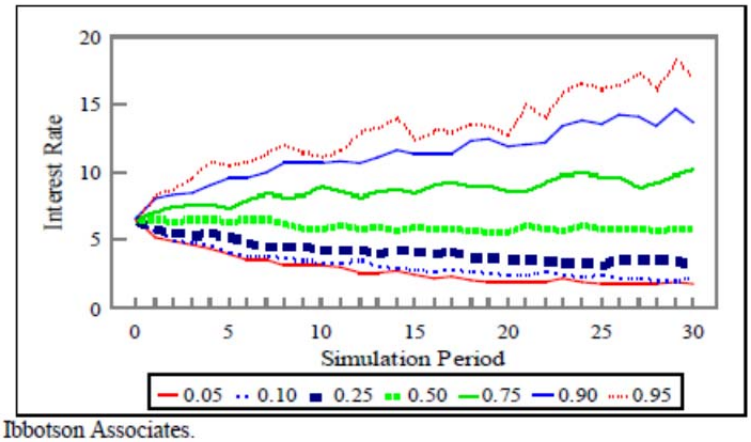
Figure 5-1: Interest Rate Modeled with Mean Reversion, 1972-1993 Data
(Period by Period Percentiles of the Interest Rate From 100 Simulated Scenarios)



Source: Ibbotson Associates

Exhibit I-6

Figure 5-2: Interest Rate Modeled with a Difference Equation, 1972-1993 Data
(Period by Period Percentiles of the Interest Rate From 100 Simulated Scenarios)



Source: Ibbotson Associates.

PIMS further justifies the use of a random walk on the grounds that:

> This characterization reflects the perspective that future interest-rate regimes are uncertain. In this model, long-term interest rates are not expected to be significantly different than the current interest rate. In comparison to a mean-reversion model, however, the random-walk model has more variance, and this variance increases over time,

> reflecting the increasing uncertainty about interest rates far in the future. [106]

We agree that, relative to a mean-reversion model, a random-walk model better captures assumed ***greater*** uncertainty over the long term; however, on December 16, 2015, for example,"…[t]he Federal Open Market Committee unanimously voted to set the new target range for the federal funds rate at 0.25 percent to 0.5 percent, up from zero to 0.25 percent. Policy makers separately forecast an appropriate rate of 1.375 percent at the end of 2016."[107] Overall, experience over the last decade shows that the Federal Reserve has assumed a more active role in influencing rates and managing inflation. Given its recent pronouncements, there is a clear expectation of a slow positive trend in nominal interest rates which the PIMS random-walk model is unlikely to capture.

This suggests that, here again, PBGC should consider use of a mean-reversion model in combination with a time trend, and/or based on more recent data. Such approaches would also be consistent with evidence that, "…nominal interest rates revert to their mean very slowly."[108] But again, the final choice of a model is an empirical question, dependent on testing, and – given the high persistence in interest rates – the current random walk model may prove adequate over PBGC projection horizon.

Further, as suggested for stock returns and real interest rates, PBGC should consider modeling nominal interest rates at monthly or quarterly frequency if feasible, so that its models can incorporate a regulatory structure, policy regime, and economic data more representative of the period PIMS is simulating.[109]

Corporate Bond Yields

PIMS determines a forecast corporate bond yield by adding a fixed spread to forecast Treasury bond yields,[110] assuming that that spread does not vary with economic conditions. However, as the 2008 financial crisis and Exhibit I-7 demonstrate, credit spreads do vary with the state of economy, tending to increase during recessions.[111] Further, credit spreads also vary with term structure.[112] Currently, PIMS does not appear to model either of these properties, and might consider incorporating them.

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[106] PIMS 2010 Guide, page 5-4.

[107] "Fed Ends Zero-Rate Era; Signals 4 Quarter-Point Increases in 2016," *Bloomberg News*, December 16, 2015.

[108] White House LT Rate 2015 Survey, page 11, citing findings in James Hamilton *et al*, "The Equilibrium Real Funds Rate: Past, Present, and Future," Working Paper, 2015.

[109] The history of directly-observed real interest rates is very limited, as TIPS started trading only in 1997. Further, the market for TIPS was not very liquid in its initial years. Therefore, for the initial history, observed yields represent the sum of real interest rates and the liquidity discount. The same observation holds for 2008, when there was panic selling of TIPS. (Stefania D'Amico *et al*, "Tips from TIPS: The Informational Content of Treasury Inflation-Protected Security Prices," *Finance and Economics Discussion Series (FEDS) Working Paper*, 2014-24, 2014.)

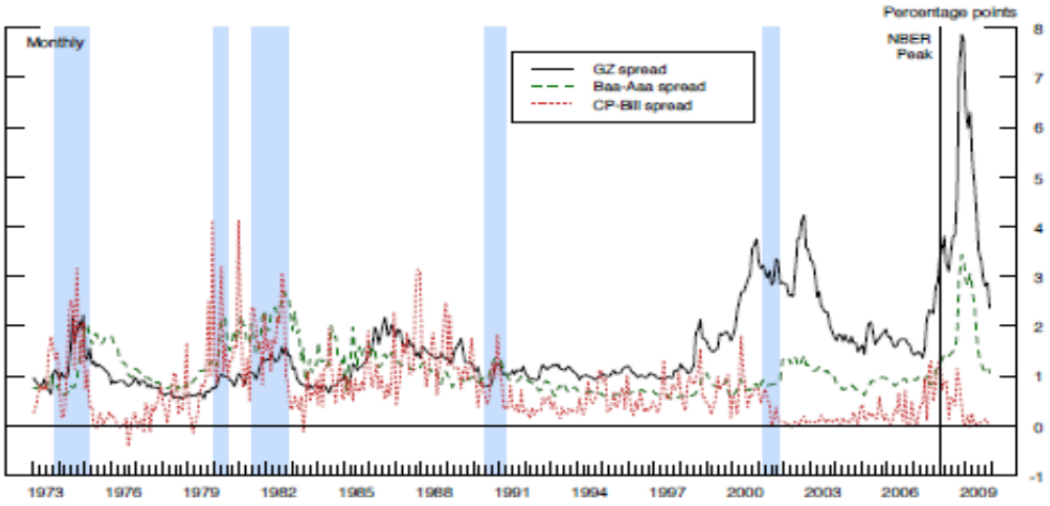
[110] PIMS 2010 Guide, page 2-9.

[111] Source: Simon Gilchrist and Egon Zakrajšek, "Credit Spreads and Business Cycle Fluctuations," National Bureau of Economic Research, 2011.

[112] See, *e.g.*, Table 1 in Duffee, G., "Treasury Yields and Corporate Bond Yields Spreads: An Empirical Analysis," Federal Reserve Board Working Paper, May, 1996.

Exhibit I-7

Figure 1: Selected Corporate Credit Spreads



NOTE: Sample period: Jan1973–Dec2009. The figure depicts the following default-risk indicators: GZ spread = average credit spread on senior unsecured bonds issued by nonfinancial firms in our sample (the solid line); Baa-Aaa = the spread between yields on Baa- and Aaa-rated long-term industrial corporate bonds (the dashed line); and CP-Bill = the spread between the yield on 1-month A1/P1 nonfinancial commercial paper and the 1-month Treasury yield (the dotted line). The shaded vertical bars represent the NBER-dated recessions.

Overall Plan Asset Returns

PIMS assumes that plan assets comprise of two asset classes, stocks and bonds. As such, under any scenario, the total return on plan assets is determined by forecast stock returns and bond yields. We have already commented upon PIMS methods for forecasting those variables, so here we only address the models' asset mix assumption, and how it relates asset returns to stock and bond returns.

Current Model

PIMS models returns on plan assets with a variant of Capital Asset Pricing Model,[113] assuming that excess returns[114] on plan assets are a linear function of excess returns on stocks and bonds. Specifically, PIMS models the portfolio excess return (ER) in the following form:[115]

$$ER_t = \alpha + \beta_S(s_t^* - i_t) + \beta_B(R_{Bt} - i_t) + \varepsilon_t,$$

[113] PIMS 2010 Guide, page 2-18.

[114] Excess return on a plan asset equals total return on the asset less 106% of corporate bond yield.

[115] PIMS 2010 Guide, page 5-7. "s* and "I" are the economy nominal stock return and 106% of the corporate bond yield, respectively. "R_B" is the plan's nominal bond return, which includes both interest and capital gain (CG)." PIMS 2010 Guide, page 2-18. The equation "…was estimated using historical Form 5500 information from a sample of defined benefit pension plans. In total, 148 equations of the [same] form… were estimated using OLS. Data was used from a longitudinal sample of single employer defined benefit plans covering the years 1980 – 1995. These estimated equations are selected randomly by PIMS for each pension plan and applied to the plan's experience as it is advanced through each simulated economic scenario." PIMS 2010 Guide, page 5-16.

Analysis

Modeling plan assets as made up only of stocks and bonds is inconsistent with the asset allocation of typical pension funds, which "…allocate funds across a much wider range of assets, including international stocks and bonds, real estate, commodities, agriculture, private equity and hedge funds, among others."[116] Geczy (2013) notes, "…pension plans insured by the PBGC have potentially drastically different allocations (implying vastly different effective capital market assumptions) than the PIMS system contemplates."[117]

The additional asset classes cited have very different risk-return profiles than stocks and bonds. Thus, there may be need to consider additional asset class benchmarks when modeling plan asset returns. Brown *et al* (2013) note that PBGC staff is "…currently working on a plan to use the detailed asset allocation data available in the Form 5500 data to do additional work in this area."[118]

The Liability Discount Rate

PIMS's Current Practice

According to PIMS and third party documentation, current practice is to discount the PBGC's future benefit payment obligations of the pension plans that the PBGC has taken over to a present value. The PBGC uses a survey provided by the American Council of Life Insurers to determine currently available annuity rates,[119] calculating the effective discount rate embedded in those rates. For the year ended Sept. 30, 2015, this rate was 2.86%.[120]

Analysis

Both fundamental economic principles and market practice demand that the discounting of future cash flows take into account two components: (a) the time value of money (the risk-free component); and (b) the risk of not receiving full and timely payments (the credit risk component).[121, 122] While the latter

[116] Brown *et al* (2013), page 22.

[117] Geczy (2013), page 14.

[118] Brown *et al* (2013), page 22.

[119] See "PBGC Procedure for Setting Interest Factors Used to Value Liabilities For PBGC Financial Statements."

[120] PBGC *Annual Report* for FY 2015, page 34.

[121] This basic idea of what comprises discounting also appears in federal judicial decisions. For example, *Energy Capital Corp. v. United States, 302 F.3d 1314, 1333, (2002 U.S. App.)*: "When calculating the value of an anticipated cash flow stream …. the discount rate performs two functions: (i) it accounts for the time value of money; and (ii) it adjusts the value of the cash flow stream to account for risk." The Supreme Court also affirmed the basic principle that, "…the rate of interest [] must include a premium for risk." See *Till v. SCS Credit Corp., 124 S.Ct., 1951 (2004)*.

[122] This observation is consistent with the Financial Standards Accounting Board (FASB) Concepts Statement No. 7, "Using Cash Flow Information and Present Value in Accounting Measurement," ("Concept 7") provides guidance in the selection of the appropriate interest rate for discounting purposes. Under Concept 7, the selected discount rate should reflect the "appropriate risk premium." It is "the rate commensurate with the risk" of the assets or liabilities, the risk of which are being measured and require analysis. Indeed, "[t]he appropriate rate of interest for the cash flows being measured must be inferred from the observable rate of interest in some other asset or liability and, to draw that inference, the characteristics of the cash flows must be similar to those of the assets being measured." (See Concept 7, paragraph 44.)

factor may be an appropriate one to consider by a hypothetical purchaser of (for example) PBGC debt obligations (see below), in our view, it is inappropriate for PBGC itself to include a credit risk factor in the discount rate applied to its own best estimate (or estimates) of its future obligations. By doing so, it is, in a sense, disavowing some portion of those obligations, as well as presenting a picture of its financial condition that could be misleading to those unfamiliar with the details of its discount rate calculations and assumptions.[123] Thus, echoing a conclusion in our Subtask 4.9 draft report, we recommend that, in addition to its current reporting method, PBGC also reports its liabilities based on a discount rate corresponding to the risk-free rate of interest – more specifically, on the basis of the yield curves for U.S. Treasury securities, perhaps adjusted upward somewhat to allow for the uniquely high liquidity of such securities.[124]

Market Valuation of Hypothetical PBGC Obligations

As suggested above, should PBGC finance its obligations through a bond issue, the attendant risk of default would expose bondholders to credit risk, the cost of which PBGC would be obliged to bear. The marketplace provides a plethora of data that could be used to quantify that cost. Indeed, the necessary market information may be derived both directly via observable prices and spreads of traded securities, and indirectly via the structured product markets (e.g., default swaps premiums, asset swap spreads, credit-linked note levels). However, in the case of the PBGC, such an approach is complicated by at least two factors: (a) inherent uncertainty as to the willingness and ability of the U.S. government to assume PBGC's future obligations; and, somewhat relatedly, (b) the lack in the marketplace of tradeable instruments which could provide observable prices and spreads related to PBGC's creditworthiness.

The former issue harkens back to the positions and roles in the marketplace of certain government-sponsored enterprises (e.g., Fannie Mae, Freddie Mac). Indeed, the capital markets treated those enterprises as if the federal government, despite the lack of an explicit guarantee, was the ultimate guarantor of their obligations. And although such explicit guarantees were disavowed in the prospectuses issued by Fannie Mae and Freddie Mac, the existence of a guarantee was widely assumed in the marketplace, and ultimately proven accurate.

Therefore, the proper credit spread associated with hypothetical PBGC obligations ought to lie somewhere between zero (i.e., assuming an explicit guarantee by U.S. government) and a level reflecting PBGC's true, fundamental creditworthiness as a stand-alone entity.

In our view, given the largely political (and thus extremely difficult to quantify) nature of that uncertainty, the fundamental way to improve the transparency and accuracy of the discount rate assumptions associated with PBGC's future obligations would be through the issuance / presence in the marketplace of PBGC debt obligations of various maturities. In this regard, historical credit spreads of Fannie Mae and Freddie Mac may be somewhat instructive, albeit an admittedly imperfect proxy for PBGC's credit spreads going forward.[125]

---

[123] Further, as noted by the American Academy of Actuaries, "Future [PBGC] investment gains, should they occur, would immediately reduce future deficits as they are reflected in the market value of assets. But reducing liabilities by reflecting risk premiums before any higher returns actually occur understates the current value of PBGC obligations and would be inconsistent with the way most financial statements are prepared." American Academy of Actuaries Issue Brief, "Perspectives on the PBGC Single-Employer Deficit, August 2013, page 4.

[124] See, for example, Robert Novy-Marx, "Economic and Financial Approaches to Valuing Pension Liabilities," The Wharton School, Pension Research Council Working Paper, September 2013.

[125] See, for example, Novy-Marx, op. cit.

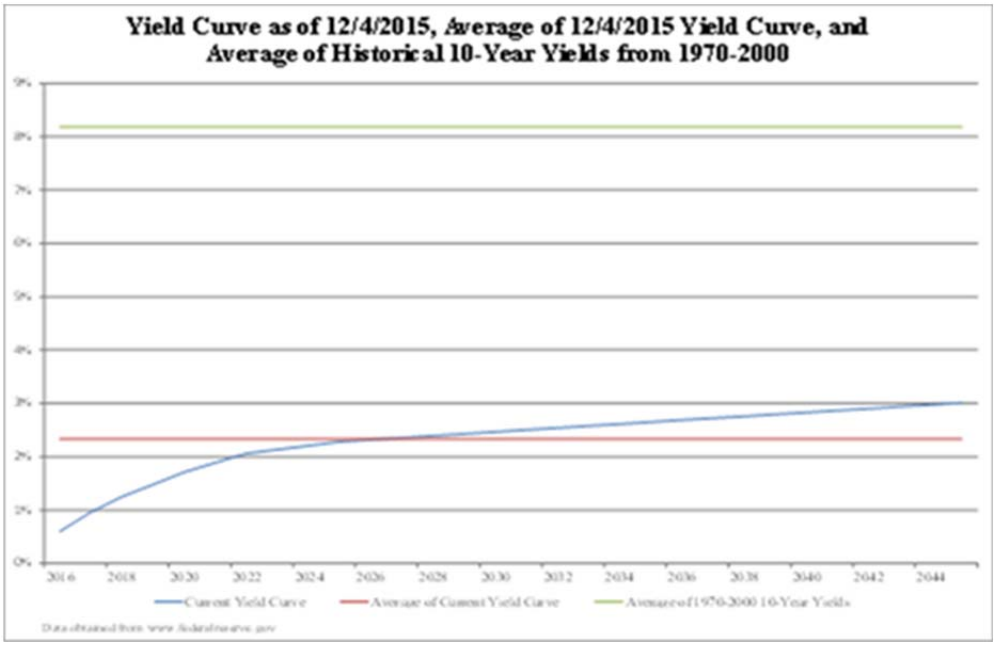
Further Considerations

We would like to underscore the importance of estimating appropriate risk-free rates and credit spreads based on: (a) contemporaneous, forward-looking data; and (b) data derived from financial instruments of maturities corresponding to the time frames of PBGC's various future obligations.

With regard to the former, reliance on historical data is bound to introduce significant, even substantial, errors, since such data reflect past economic, social, and political realities of limited relevance to future developments in the marketplace. For example, a calculation based on the historical average of the 10-year U.S. Treasury Note over the 1970-2000 period introduces an approximate 46.7% error in discounting an annual stream of cash flows over a 30-year time frame.

With respect to the choice of appropriate financial instruments, reliance on data (e.g., average yields or, worse yet, average historical yields) based on instruments of maturities that do not correspond to the time frames of the PBGC's future obligations is also bound to introduce significant, even substantial, error. That is because the U.S. Treasuries' yield curve is not flat, different time horizons being associated with different yields.[126] (See Exhibit D-1.)

Exhibit D-1



Application to PBGC's Current Practice

Given the foregoing, estimation of an appropriate discount rate for PBGC's obligation based on implied rates from a private-sector annuity market survey raises a number of concerns.[127] First, annuity rates are essentially individually negotiated rates, not market rates. Secondly, annuity providers are subject

[126] See, for example, Jeffrey Brown et al, "A Review of the Pension Benefit Guaranty Corporation Pension Insurance Modeling System," The Wharton School, Pension Research Council Working Paper, September 2013, page 17.

[127] See, for example, Frank J. Fabozzi, "Measuring and Explaining Pension System Risk," The Wharton School, Pension Research Council Working Paper, September 2013.

to default risk that may not be appropriate to consider when evaluating the risk attached to PBGC obligations. To reiterate, for those and other reasons, we recommend that, in addition to its current reporting method, PBGC also report its liabilities based on a discount rate corresponding to the risk-free rate of interest, with due consideration to term structure.

Discount Rates in Programs Abroad

Canada

An independent evaluation of the financial status of Ontario's Pension Benefit Guarantee Fund (PBGF) published in 2010, the "Eckler Report" (see Appendix 1), employed a discount rate of 6.0% to present-value the projections of going-concern liabilities. This was based on an assumed asset allocation of 40% bonds and 60% equities and expected annual rates of return of 4.25% for bonds and 7.5% for equities.[128] The resulting discount rate of 6.2% was then adjusted upward by 70 basis points to reflect the benefit of being an actively-managed portfolio, downward by 50 basis points to account for investment fees, and downward by 40 basis points to allow for adverse deviation,[129] resulting in the final of 6.0%.

To present-value projected solvency liabilities, Eckler used a stochastic model's outputs for yield curves, based on a discounting method prescribed by the Canadian Institute of Actuaries. Set forth below, that method affords a fund substantial latitude to set a discount rate above that advocated here, i.e.,

> For pension plans that are funded, in selecting the best estimate assumption for the discount rate, the actuary may either:
>
> *Take into account the expected investment return on the assets of the pension plan at the calculation date and the expected investment policy after that date*; or
>
> Reflect the yields on fixed income investments, considering the expected future benefit payments of the pension plan and the circumstances of the work.[130]

And indeed, Eckler appears to have used a rate equaling the expected rate of return of the assets held by the PBGF, to generate a present value of liabilities termed their "budget value."

The UK

The Long Term Risk Model (LTRM) employed by the UK's Pension Protection Fund (PPF), further discussed in Appendix 1, employs annual discount rates based on yield curves, therefore vary according to the term. The rates are modeled based on a portfolio consisting of "…cash, plus appropriate zero-coupon interest rate swap contracts, inflation swap contracts plus nominal gilt strips (or notional gilt strips)." To account for the fact that cash is unlikely to earn the six-month LIBOR rate, the zero-coupon

[128] The source of the 4.25% and 7.5% assumptions is not specified in the Eckler Study.

[129] Adverse deviation refers to the negative effect of any misestimates or unexpected deterioration in the expected outcome.

[130] "Determination of Best Estimate Discount Rates for Going Concern Funding Valuations," Committee on Pension Plan Financial Reporting, December 30, 2015, page 4 (emphasis added). Note that the Eckler Study was completed in March 2010, and therefore refers to an earlier version of this publication. Also see, for example, "Measuring Pension Obligations," American Academy of Actuaries Issue Brief, November 2013.

interest rate swap yields are adjusted downward by 15 basis points. For each term, the portfolio consists of the higher-yielding of the zero-coupon interest rate swaps less 15 basis points and gilt strips.

As of March 31, 2015, the discount rate ranged from 0.564% for a one-year term to 2.347% for a 50-year term.

Thus, the PPF appears to use a set of discount rates that are essentially modeled as the term structure of risk-free rates, a methodology comporting most closely with our recommendations.

Recommendation

We suggest that the PBGC consider presenting in its report a calculation in addition to those currently presented that includes information regarding the present value of its obligations as discounted by the term structure of Treasury bonds or interest rates on Government Agency Securities such as those Fannie Mae or Freddie Mac.

Appendix 1: Comparable Programs Abroad

The PBGC is one of the oldest agencies of its kind. Since its inception in 1974, many other countries have implemented roughly comparable programs, having learned from PBGC's experiences and made corresponding modifications to its basic model. Here we describe some representative programs in high-level terms, and compare macroeconomic variables used to forecast future liability. Subject to certain caveats (see below), further study of such programs and their recent performance may provide additional evidence bearing on the recommendations presented here.

United Kingdom's Pension Protection Fund

The UK's Pension Protection Fund ("PPF") began operating in April of 2005, in response to political pressures arising from benefit losses to 65,000 workers due to the bankruptcies of sponsoring companies.[131] In establishing the PPF, UK legislators examined the PBGC's experiences in an attempt to build a more flexible program, manifested chiefly in the PPF's "...ability to charge a levy [premium] consistent with the risks that the Fund faces and its skill in securing stakeholder acceptance of the process by which it does this."[132] Additionally, in extreme circumstances, the agency may reduce the compensation paid to covered workers, either independently or through the intervention of the British Secretary of State.[133]

In 2007, the PPF implemented its stochastic "Long Term Risk Model" (LTRM) to assist in "… [forming] a judgement on the level of liabilities that the Fund may have to meet in the future, and then [set] a levy consistent with financing those liabilities"[134] – or, as they put it, "pay the right people the right amount of money at the right time."[135] The model's basic structure is similar to that of PIMS, comprising an [Macro] Economic Scenario Generator whose output is inputted into an Insolvency Engine and an Exposure Engine (also receiving inputs separately from the Insolvency Engine), with the latter's output inputted into a Claims Engine, and the Claims Engine providing input into a Balance Sheet Model.[136] The Economic Scenario Generator is not the PPF's own, but rather proprietary to the consulting firm Barrie and Hibbert, Ltd., "…widely used by financial institutions carrying out stochastic analyses."[137]

Assessing Risk

To understand the PPF's approach to risk management, it is critical to understand their central financial objective (i.e., *to be self-sufficient at the funding horizon*).[138] The agency's board selected 2030 as the

[131] Fiona Stewart, "Benefit Security Pension Fund Guarantee Schemes," Organization for Economic Cooperation and Development, Working Paper on Insurance and Private Pensions No. 5, January 2007, page 20.

[132] Martin G. Clarke, "Modeling Risk-based Pension Insurance Premiums," Pension Research Council Working Paper, September 2013, page 1.

[133] Clarke, op. cit., page 4.

[134] Pension Protection Fund, "Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model," August 2007, page 6.

[135] Pension Protection Fund, "PPF Long Term Funding Strategy Update," July 2015, page.4.

[136] Pension Protection Fund, "Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model," August 2007, page 17.

[137] Pension Protection Fund, "Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model," August 2007, page 18.

[138] Pension Protection Fund, "PPF Long Term Funding Strategy Update," July 2015, page 5.

current horizon, a year by which "…future claims on the PPF were expected to be small relative to the size of the PPF itself."[139] The self-sufficiency target is "…set as a percentage margin over the liabilities, this being held to cover remaining risks after we reach the funding horizon," the current margin being 10%.[140] The agency's board periodically reviews this target, and has the ability to reset it to assure that it is realistic. The PPF then runs its LTRM model and uses the target to determine the program's probability of self-sufficiency by 2030, so as to help it justify premium increases. In contrast, PIMS employs a 10-year horizon without a comparable target, a practice for which it has been criticized.[141]

Also unlike the PBGC, the PPF uses its LTRM forecasts both to determine a funding requirement and to formulate investment strategy. And while the PPF acknowledges that PBGC's overall approach to modeling risk is similar to its own, it highlights certain other differences: (1) use of a third-party provider (Barrie & Hibbert) to generate 1,000 economic scenarios for every relevant asset class;[142] (2) consideration of smaller pensions in modeling risk; and (3) use of market-based information on credit ratings to model insolvency probability.[143]

Ontario's Pension Benefit Guarantee Fund

The only fund of its kind in Canada, the Pension Benefit Guarantee Fund ("PBGF") of Ontario began operating in 1980. Prior to 2012, it had not changed its premium/fee structure, which included a per-person fee and a risk-based fee levied on underfunded plans depending on the level of underfunding.[144] In 2008, Ontario's Ministry of Finance commissioned a study by Eckler Ltd. to evaluate PBGF's financial sustainability, quantify its risk exposure, and consider alternative program strategies ("Eckler Report"), some of the findings of which are referenced here.

Assessing Risk

Before discussing the economic modeling used to assess the PBGF's financial sustainability, it is important to note that the agency currently guarantees a maximum benefit of only $2,500 a month unadjusted for inflation, which eliminates inflation risk as to future liabilities.

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[139] Ibid. ("While there is no formal definition of 'small' in this context our modelling has shown that expected claims at the 90th percentile to decrease to less than 2 per cent of the PPF's liabilities from around the year 2025. The Board therefore chose 2030 to be a suitable funding horizon.")

[140] Ibid. ("When the risk margin was introduced, it was set at 10 per cent and was intended to cover two key risks which would remain after the funding horizon: the risk of unexpected longevity improvements and any future claims (beyond the funding horizon) in excess of PPF levies. The margin was calculated such that at the assumed funding horizon it would be sufficient in 90 per cent of modelled scenarios to cover these risks and thus provide compensation payments in full.")

[141] Clarke, op. cit., pages 21-22.

[142] Pension Protection Fund, "PPF Long Term Funding Strategy Update," July 2015, pages 24-25. ("The economic scenarios form a set of projected paths for asset prices, bond yields, inflation and risk-free rates.")

[143] Pension Protection Fund, "Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model," August 2007, page 13. ("The PBGC's requirements are rather different from the PPF's – in particular premiums are set by Congress so their model is primarily intended to illustrate risk rather than determine funding requirements. Their model differs from the PPF's in taking no account of smaller schemes – and in using an in-house model of insolvency probability – rather than market based information on credit ratings. It also requires information on schemes that is not currently collected on UK DB schemes. But overall the approach is similar.")

[144] Eckler Ltd.,"Looking Ahead: Projecting Ontario's Pension Benefit Guarantee Fund," June 2010, page 6.

Unlike the PBGC and the PPF, the PBGF does not regularly use stochastic modeling for risk assessment. However, Eckler (2010) used a stochastic model of its own to evaluate PBGF's risk exposure and develop recommendations on how make its program sustainable. For purposes of their analysis, sustainability was defined as conformity with these conditions: (1) future assessments must be sufficient to cover expected future claims plus expenses, with a high degree of probability based on the stochastically modeled result, on a present value basis; and (2) in all situations where an employer becomes insolvent and there is an underfunding in the pension plan on its wind-up, the PBGF must have sufficient funds on a projected cash flow basis to meet claims, within the prescribed limits, at any point in time.[145]

Like the PPF, Eckler used a third-party's (DFA Capital Management's) General Economy and Market Simulator ("GEMS") as a macroeconomic scenario generator.[146] GEMS modeled asset returns, interest rates, and Canadian GDP and unemployment; also considered in Eckler's modeling were wage inflation at the national level and GDP and unemployment in Ontario.[147] Additionally, Eckler projected future insolvency rates via a correlation between those rates and three economic variables – 6-Month T-bill (positively correlated), Ontario GDP growth (inversely correlated) and Ontario unemployment rates (positively correlated). To address differences in insolvency rates among industries, they applied industry multipliers based on Annual Business Insolvency Rates by NAICS sector.[148]

Among other things, Eckler concluded that, as of 2010:

- "In the absence of external funding, the PBGF funds will be depleted and unable to cover anticipated 2010 claims or any future claims…
- "In the absence of any future external funding, an increase in overall assessments in the order of 800% would be required to ensure the sustainability of the PBGF with a high degree of certainty…
- "Securing additional funding on all future claims above a pre-defined catastrophic threshold, in combination with an increase in assessments and/or a reduction in coverage, could achieve PBGF sustainability."[149]

Germany's Pensions-Sicherungs-Verein Versicherungsverein auf Gegenseitigkeit

Established in 1974, Germany's Pensions-Sicherungs-Verein Versicherungsverein auf Gegenseitigkeit (PSVaG) is an independent body by law, operating as a mutual insurance association, and designated by parliament as the sole carrier of mandatory pension termination insurance.[150] As noted in a 2006 study of its risk exposure and premium policy, while, "The Pension Benefit Guarantee [sic] Corporation (PBGC) in the USA charges a flat premium per insurant, to which a supplemental variable premium for

[145] Eckler Report, page 65.

[146] Eckler Report, page 43.

[147] Eckler Report, page 42.

[148] Eckler Report, page 57.

[149] Eckler Report, page 62.

[150] Stewart, op. cit., page 25.

underfunding was only added in 1987... PSVaG premiums are based on the annual cost of the pension insurance plan," and "…are independent of default probabilities."[151] Relatedly, Stewart observes,

> "A key difference between the PBGC in the USA and the PSVaG in Germany is that on the insolvency of a member the latter purchases annuities from a consortium of life insurance companies (this was made up of 58 companies in 2005 – Allianz being the largest). The PSVaG does not take over the assets of the pension fund, and consequently operates more like an intermediary, buying out benefits through private insurance companies. Benefits are secured up to a limit of 3x a reference monthly salary..." and
>
> "Each year's premium is based on estimated losses during the previous 12 months, with this estimate divided by the contribution basis (the insured pension liabilities) to give a contribution rate."[152]

Thus, as Gerke *et al* point out, "The PSVaG does not use any stochastic modeling techniques to capture counterparty risk."[153] Based on their research, those same authors recommend a new regime of risk-adjustment premiums, noting that these "…are one way to mitigate adverse selection effects and are consistent with a generally higher risk awareness among financial institutions."[154]

As is also true for Sweden (see below), book reserve pension plans are common in Germany, a fact which should be taken into consideration in applying these countries' experiences to PBGC.

Sweden's Pension Guarantee
Mutual Insurance Company

Founded in 1961 also as an independent mutual insurance association, Sweden's Pension Guarantee Mutual Insurance Company ("FPG") is overseen by a board consisting of representatives of roughly 1600 covered employers and two multiemployer trade unions representing about 200,000 employees; unlike the situation in the United States, it is those trade unions that require employer participation in the pension insurance scheme.[155] As one would expect given its private, mutual structure, "Policyholders have an obligation to help the FPG to meet claims should reserves be totally exhausted," with levies capped (at least in 2007) at 2% of a company's pension liability.[156]

Particularly salient features of the FPG are described by Stewart as follows:

> In the case of a company insolvency, the FPG buys out benefits with the insurance company Alecta – meeting the full cost for securing the

[151] Wolfgang Gerke, Ferdinand Mager, Timo Reinschmidt and Christian Schmeider, "Empirical Risk Analysis of Pension Insurance – the Case of Germany," Deutsch Bundesbank Discussion Paper Series 2: Banking and Financial Studies, No. 07/2006, 2006, page 1.

[152] Stewart, op. cit., page 26.

[153] Gerke *et al*, op. cit., page 2.

[154] Gerke *et al*, op. cit., page 21.

[155] Stewart, op. cit., page 28.

[156] Stewart, op. cit., page 29.

> benefits in the case that liabilities were book reserved, and the shortfall in cases where liabilities were partially funded. Since inception the scheme has tried to assess the risk of a corporation to insolvency and to cover its exposure accordingly. It does so by effectively running an in-house rating agency, analyzing corporate accounts, historical performance, profitability, industry factors, leverage and where applicable external ratings… Contracts can last up to 3 years and a key time for stepping in and demanding more collateral if the situation looks to be deteriorating is when the renewal is due.[157]

She concludes that, as of 2007, "…the Swedish model is [was] probably the most successful currently in existence. The issue is therefore whether it could be transferred to other countries wishing to introduce a pension benefit guarantee scheme. One of the major obstacles would be implementing such a rigorous screening procedure on a large scale, mainly due to cost."[158] That obstacle is, of course, especially germane in the case of the PBGC, although elsewhere in this report we suggest that some movement toward a more "micro" approach to assessing plan default probability might be in order, once one had narrowed-in on more problematic industry sectors. Also to be considered, of course, is whether Stewart's conclusion would still hold up in the post-financial crisis period in which we find ourselves today.

Summary Information for
The UK's PPF and Ontario's PBGF

The table on the next five pages addresses select features of the economic forecasting models of the UK's PPF and Ontario's PBGF (both of which, as noted earlier, are proprietary to outside consultants). The entries in the "Y/N" column indicate whether or not the model attribute in the first column applies (first two rows), and whether or not the variable listed is considered (next seven rows). In the last row, information is also provided on the basic nature of the insolvency/bankruptcy models employed.

[157] Stewart, op. cit., page 28.

[158] Stewart, op. cit., page 29.

	United Kingdom - Pension Protection Fund		
	Y/N	Description	Source
Internal Stochastic Modeling System	Y	Long Term Risk Model ("LTRM")	Description of Model - *Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model*, PPF, August 2007.
Internally Modeled Economic Scenarios	N	**Third Party - Barrie & Hibbert** "The projection process begins in the Economic Scenario Generator with the production of one thousand economic scenarios. Each scenario is a set of projected paths for asset prices, interest rates, bond yields and inflation rates. These are obtained from an Economic Scenario Generator (ESG) provided by an external provider, Barrie & Hibbert, and adapted for use by the PPF." "The ESG is an asset price based model –and is used by the PPF to project forward the returns on key asset classes and other variables, required for the other stages of the analysis (such as long term nominal and real bond yields) rather than modelling economic growth and inflation directly."	*PPF Long Term Funding Strategy Update*, Pension Protection Fund, July 2015, p.23 Description of Model - *Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model*, PPF, August 2007, p.18
Variables Modeled			
Asset Returns	Y	"Asset Returns are generated by the ESG and rolled forward."	*Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model*, pp. 38 & 68-72
Interest Rates	Y	"Interest rates are generated by the ESG. The interest rate projections are calibrated to bond yields observed in the market at the start of the projection. We use standard stochastic models of interest rates – the extended 2-Factor Black-Karasinski model for nominal interest rates, and the 2-Factor Vasicek model for real interest rates. Both of these models assume mean reversion."	*Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model*, pp. 38 & 68-72
Inflation	Y	"RPI (retail price index) is generated by the ESG. The PPF has its own internal model for projecting CPI. It is a regression model that forecasts the RPI-CPI inflation wedge as a function of projected RPI, house price inflation, and short term interest rates. Every year the CPI model is updated to reflect recent developments in the key drivers of the inflation wedge."	*PPF Long Term Funding Strategy Update*, p. 25

Discount Rates	Y	"A discount rate on liabilities based on swap rates (reflecting the expected actual cost of deferred liabilities)."	*Modelling Uncertainty: An Introduction to the PPF Long Term Risk Model*, p. 22
Industry/Sector Data	Y	"As the LTRM categorizes sponsoring employers into 15 industry sectors, this aspect is captured by specifying: • the correlations in industry-level insolvency risk between the 15 different industry sectors (inter-sector correlation); • the proportion of industry-level insolvency risk which explains total sponsoring employer insolvency risk (intra-sector correlation); and • the correlations of industry-level insolvency risk to UK Equity returns (which is used as a proxy for the health of the economy)."	*PPF Long Term Funding Strategy Update*, p. 11
Unemployment	N	N/A	
GDP	N	N/A	
Insolvency/Bankruptcy Model	Y	"Insolvencies are modelled in the Insolvency Engine by assigning a credit rating to each company and using transition probabilities to model credit ratings changing over time. We have five hundred scenarios for credit risk, with the transition rates varying in each. Each such scenario is mapped to each of the economic scenarios providing 500,000 scenarios in all." "For the large schemes we assess the initial creditworthiness of the sponsor(s) by looking up current actual or market-implied credit ratings. For the smaller schemes we use the failure scores provided for levy purposes and map these to a hypothetical credit rating. We model credit ratings as changing over time, the probabilities of transition being provided by Barrie & Hibbert and reviewed within the PPF." "The LTRM uses the insolvency scores from an insolvency risk service provider to estimate the likelihood of insolvency and project future levels of levy and claims. The failure scores provided have a significant impact on the LTRM because they are used to both determine the credit rating that each company is initially mapped to when projecting insolvency events, and are also used to determine the levy paid by each scheme, both now and throughout the projection period. From 2015/16, PPF levies will be based on Experian rather than D&B insolvency scores. Changes have been made to LTRM to allow for this new provider."	*PPF Long Term Funding Strategy Update*, pp. 25-27

	Ontario - Pension Benefit Guarantee Fund		
	Y/N	Description	Source
Internal Stochastic Modeling System	N	One time study done to model risk performed by Eckler, Ltd.	Eckler Report, "Looking Ahead: Projecting Ontario's Pension Benefit Guarantee Fund," June 2010.
Internally Modeled Economic Scenarios	N	**Third Party - DFA Capital Management Inc.** "The GEMS model, developed by DFA Capital Management Inc., was designed to stochastically simulate consistent real-world scenarios. At the request of the Ministry of Finance, we used the ESG to stochastically generate 500 random economic scenarios."	Eckler Report, p. 43
Variables Modeled			
Asset Returns	Y	"GEMS modeled the following variables S&P/TSX Composite (Canadian Equity), S&P 500 (U.S. Equity), MSCI EAFE (International Equity), DEX Universe Bond Index (Canadian Bonds), and Cash." "GEMS combines stochastic volatility with jump diffusion to model equities. This stochastic volatility with jumps, or SVJ, model is one of the most sophisticated models currently used to model equities and produces the following desired features: stochastic volatility, which produces heavy or fat tails, jump clustering (large changes, positive or negative, clustered together), volatility persistence (periods of increased volatility that tend to last longer), and leverage effect (where past returns are anti-correlated with future volatilities)."	Eckler Report, p. 42
Interest Rates	Y	"GEMS modelled the following interest rates: Short-term interest rates (6- and 12-month T-bills); Series V122542 – 7-Year Government of Canada Bond; Series V122544 – Long-Term Government of Canada Bond; Series V122553 – Long-Term Real Return Government of Canada Bond."	Eckler Report, p. 42
Inflation	Y	"In developing the CPI projections, we have assumed that the Bank of Canada will maintain the inflation control range of 1% to 3% with a target of 2%." "Future salary increases were assumed to include a merit and inflationary component, depending on the assumptions used for the matching valuation. The merit component, if specified, was assumed to continue at the same rate as in the matching valuation. The inflationary component was stochastically generated."	Eckler Report, pp. 45 & 46

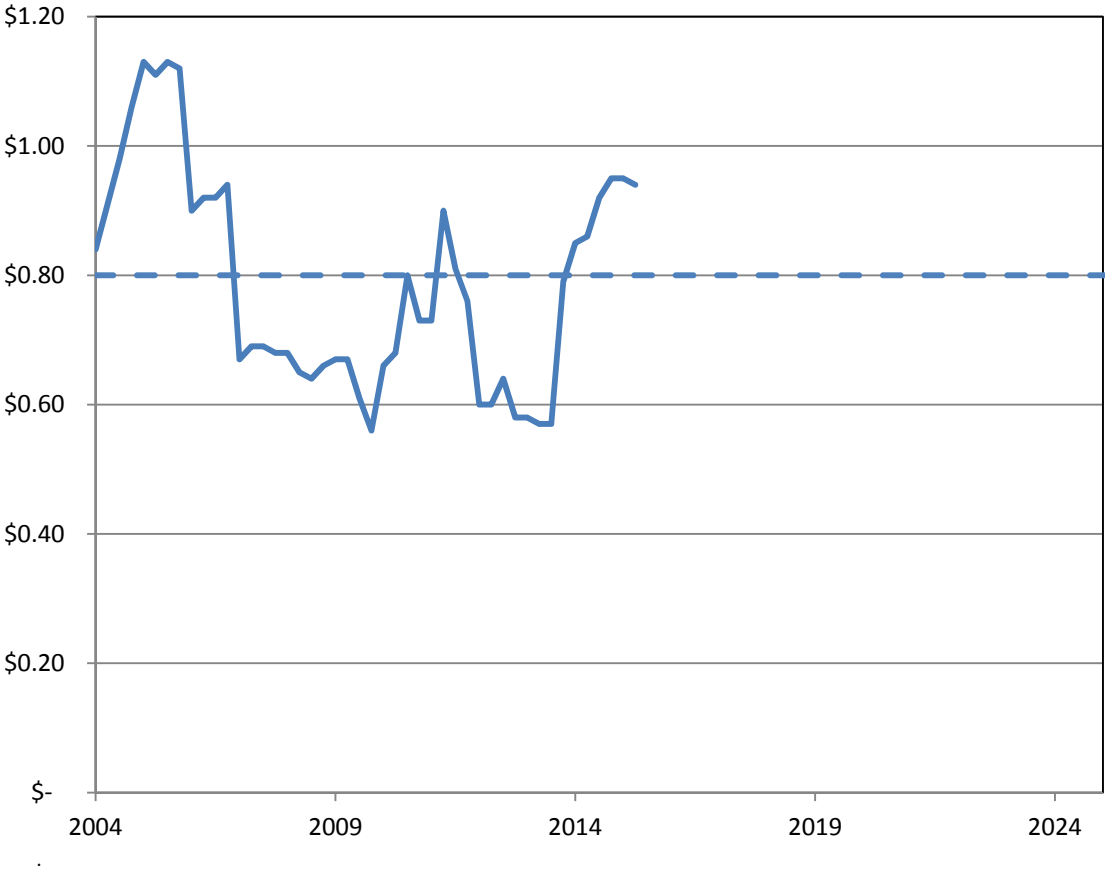
Discount Rates	Y	"Going-Concern Liability Projections - The discount rate used to value the going-concern liabilities for the projections was set at 6.0% per annum. This was based on an expected long-term rate of return of 4.25% per annum for bonds and 7.5% per annum for equities, assuming a continuation of the current average asset split of 40% bonds and 60% equities, based on the IIS data provided for the 52 main plans. We added an allowance of 0.7% for active management, subtracted 0.5% for investment fees and 0.4% for adverse deviation, to produce the rate of 6.0%." "Solvency Liability - The future discount rates used in the projection of the solvency liabilities were stochastically generated. For members whose benefits were assumed to be settled by commuted value, we modelled the yield curves from the bond series dictated by the Canadian Institute of Actuaries (CIA) to be used to generate the discount rates. We assumed that the current method outlined by the CIA to determine the initial rate would remain unchanged over the projection period. For simplicity's sake, we also assumed the thereafter rate would equal the initial rate. Similarly, for members whose benefits were assumed to be settled by annuity purchase, we modelled the yield curve from the bond series currently dictated by the Canadian Institute of Actuaries (CIA) to be used to generate the discount rate, and we assumed that the current method outlined by the CIA to determine the rate would remain unchanged over the projection period."	Eckler Report, p. 47
Industry/Sector Data	Y	"The Ministry of Finance provided NAICS codes for the 31 sponsors of the main plans for the purposes of the projection. Eckler matched up the remaining sponsors in the plan universe with an appropriate NAICS industry code. Eckler applied multipliers based on Annual Business Insolvency Rates by NAICS Economic Sectors."	Eckler Report, pp. 15 & 57
Unemployment	Y	"GEMS modelled unemployment in Canada and Ontario."	Eckler Report, p. 42
GDP	Y	"GEMS modelled GDP in Canada and Ontario."	Eckler Report, p. 42

Insolvency/Bankruptcy Model	Y	"Eckler projected the future expected insolvency rates by determining a correlation between insolvency rates and three economic variables – 6-Month T-bill (positively correlated), Ontario GDP growth (inversely correlated) and Ontario unemployment rates (positively correlated). Additionally, to address differences in insolvency rates between industries, Eckler applied industry multipliers based on Annual Business Insolvency Rates by NAICS Economic Sectors. IRt = (0.40 x (1.5 + 0.25 x 6-Mo.TBillt)) + (0.3 x (2.1 - 0.16 x GDPt)) + (0.30 x (-3.1 + 0.75 x URt))" "The way to address a lack of statistical credibility is to estimate the incidence of insolvency stochastically. For this purpose, we used a Monte Carlo simulation. For every one of the 500 economic paths, and for each of the projection years, we calculated the deterministic insolvency rate following the derived formula for IRt (see the regression formula following Chart 7.6). We roll 20 times for every one of the 500 paths, every year, so 10,000 times in total for each plan and each year. A 1,500-roll process is usually considered sufficient to provide reasonably accurate stochastic projections, although 5,000 is the preferred minimum target. With 10,000 rolls, we increase the statistical probability of covering virtually all possibilities."	Eckler Report, pp. 53 -58

Appendix 2: Supplementary Exhibit

Exhibit 1

Cost of Compensation per Hour Worked:
Defined Benefit Plans, Manufacturing
(*2009 Dollars*)



Sources: Bureau of Labor Statistics, National Compensation Survey, and the Federal Reserve Bank of St. Louis (https://research.stlouisfed.org/fred2/series/GDPDEF/downloaddata).

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