A Better Defined Benefit Contribution Policy: Contribute No Less than the Normal Cost

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Abstract:

A frustrating aspect of pension funding rules for U.S. plan sponsors is that contribution requirements are adversely correlated with business cycles. For example, not only did plan sponsors get hit with large contribution requirements in the perfect storm of the early 2000s, but many sponsors were prohibited from contributing in the late 1990s boom due to full funding limitations.

In this paper we propose that plan sponsors be allowed to contribute the normal cost as a deductible contribution each year. In hindsight, this would have allowed plan sponsors to pay for benefits as they accrued in the late 1990s and ultimately mitigated some of the crash of the early 2000s. This change could be layered on to existing regulations or be part of a new set of regulations.

We aim to demonstrate that a contribution policy allowing contributions to be at least equal to the normal cost will result in less volatility of contributions and improve the funded status over time. Clearly, with this outcome the proposed contribution policy would be better than the current system in the U.S. where the full funding limit can restrict contributions to zero.

For comparison, we also consider additional proposals listed below.

- Current Law – U.S. ERISA/Internal Revenue Code rules,
- Proposal 1 – Allow the normal cost to be a deductible contribution,
- Proposal 2 – Require the normal cost to be contributed each year plus supplemental contribution if needed,
- Proposal 3 – Eliminate the full funding limitation rules.

This paper explores the range of contribution policies allowable under the above sets of rules and determines optimal contribution strategies for different objectives.

We show that adopting Proposal 1 achieves several objectives of the Society Of Actuary's (SOA's) stated Funding System Constraints namely,

- Maximum flexibility to participants
- Minimal volatility of contributions for plan sponsors
- Maximum predictability of contributions for plan sponsors
- Minimal risk to shareholders
- Minimal risk to participants
- Minimal risk to guaranty agencies

The same constraints are examined for Proposals 2 and 3 with mixed outcomes. Additional funding system constraints as outlined by the SOA will not be addressed.

1. Introduction

1.1 Statement of the Problem

One of the most pressing issues facing private pension plan sponsors in the U.S. today is the burden of large contributions in a weakened economy. Looking back a few years, many plan sponsors were prohibited from contributing during the economic boom of the late 1990s by the full funding limit. Another way of saying this is that the current U.S. funding rules produce contribution requirements that are negatively correlated with the business cycle.

There are many factors that have gotten us to the current situation and much discussion about possible remedies. One key fact is that participants continue to accrue benefits during good and bad economic times. Having regulations such as the full funding limit that prohibit contributions when a plan has a large surplus means that plan sponsors cannot contribute to keep up with the continued accruals of benefits.

The remainder of this introduction gives a high level overview of the proposals, model, and outcomes of the analysis. The main body of the paper, section 2, is divided into analysis of the current U.S. funding rules and Proposals 1 – 3. Section 3 contains a summary, conclusion, and areas for future research. Additional details regarding the proposals and the model are contained in the Appendix.

1.2 Proposals

In this paper, we propose three potential solutions to the contribution problem outlined above. A common feature of all the proposals is that "funding holidays" are not mandatory as they are under the current rules. This feature is critical if funding reform hopes to address the negative correlations with the business cycle.

The proposals vary in other ways that impact the plan sponsor's flexibility with contributions as well as the factors outlined in the SOA's Funding System Constraints as outlined below. The proposals considered are listed below.

- Proposal 1 – Maximum Deductible Contribution at least as large as the Normal Cost (with interest).

- Proposal 2 – Minimum Required Contribution at least as large as the Normal Cost (with interest).

- Proposal 3 – Eliminate the Full Funding Limitation.

Proposals 1 – 3 are considered as single changes to ERISA. All other aspects of ERISA still apply in these proposals.

1.3 Objectives of the Model

In Section 2, we explore the relationships between contribution ratio, funded ratio, and the shortfall ratio for a "random" valuation through a simulation. The model simulates multiple economic scenarios and projects a pension fund under various contribution policies to a terminal point (the year of the valuation). By projecting the simulation for many years we move away from any initial conditions of the model and attempt to mimic the long-term use of any one funding policy.

The contribution ratio is the ratio of the contribution (under a specific policy) to the normal cost, the funded ratio is the ratio of the terminal fund amount over the actuarial liability, and the shortfall ratio is the lesser of the funded ratio and 1. At the terminal point, the average of the contribution ratio μ_C, the standard deviation of the contribution ratio σ_C, the average funded ratio μ_F, the standard deviation of funded ratio σ_F, and the standard deviation of shortfall ratio σ_F^- are calculated over all the scenarios. Actuarial liability and normal cost are calculated using the projected unit credit method. Additional details are in the appendix.

The purpose of the projection is to mimic a plan sponsor's consistent application of a funding policy over time. The funding policies considered are weighted averages of the minimum required and maximum deductible contributions for the various proposals.

It is important for us to discuss the risk to the plan sponsor, participants, guaranty agencies, and shareholders. We must characterize these risks systematically. We use the above ratios to get a sense of proportion, rather than an absolute dollar measure of risk. With the additional assumption of a stationary population where all valuation assumptions are met, the normal cost and actuarial liability are constant (net of inflation), so the ratios calculated are scalar multiples of the dollar figures.

For the SOA constraints, we use the following metrics:

- Maximum flexibility to participants – the average funded ratio μ_F,
- Minimal volatility of contributions for plan sponsors – the standard deviation of the contribution ratio σ_C,
- Maximum predictability of contributions for plan sponsors – the standard deviation of the contribution ratio σ_C,
- Minimal risk to shareholders – the standard deviation of funded ratio σ_F,
- Minimal risk to participants – the standard deviation of shortfall ratio σ_F^-, and
- Minimal risk to guaranty agencies – the standard deviation of shortfall ratio σ_F^-.

For flexibility to participants: the larger the fund, the more flexibility. Clearly, volatility of contribution ratio σ_C is a meaningful concept of risk and predictability of contributions for the plan sponsor. Shareholders must ultimately bear the volatility of the fund. For the

participants and guaranty agencies, a shortfall of plan assets poses a greater risk than a surplus. The volatility σ_F does not distinguish between a shortfall and a surplus and a deficit, so we calculate the volatility of just the shortfalls σ_F^-.

One could argue that there are better measures of risk than the ones selected. These were chosen for there applicability and ease of calculation.

In addition to the goal of improving the metrics for the above constraints, an effective set of pension funding rules should provide a range of allowable contributions that gives flexibility in choosing an optimal strategy. We show below that Proposals 1 – 3 do in fact give more flexibility than the current ERISA rules.

We compare the risks under each proposal and calculate optimal contribution strategies for each by maximizing or minimizing the relevant metric.

1.4 Conclusions

Proposal 1, allowing the deduction of the normal cost, provides the greatest improvement over the current rules on all of the factors analyzed. This is the main reason why we believe this proposal is worthy of consideration. Another reason why this proposal is worth consideration is that it is a very minor change. This has the advantages that it can easily be incorporated into the current rules (making it a good candidate for a "quick-fix"), and it can easily be incorporated into other proposals.

Proposals 2 and 3 have mixed results on improving the factors analyzed when compared to the current rules. Nevertheless, the analysis provides valuable concrete information about the pros and cons of each proposal.

2. Analysis of Contribution Policies

As stated in the Introduction, we examine the average of the contribution ratio μ_C, and the standard deviation of the contribution ratio σ_C, the average funded ratio μ_F, the standard deviation of funded ratio σ_F, the standard deviation of shortfall ratio σ_F^- of a random valuation under a consistent contribution policy.

The values of the above metrics are computed through a simulation of several economic scenarios over a period of time. The plan sponsor is assumed to contribute under a policy over time that is a (fixed) weighted average of the minimum required and maximum deductible contributions. The terminal funded ratio and contribution ratio are calculated for each scenario, and averages and standard deviations are computed over all the scenarios.

In order to isolate the effect of the different contribution policies and proposals, all other factors are held fixed. The same economic scenarios are used for each contribution policy and each proposed set of funding rules. We assume a stationary population under fixed demographic assumptions and that all demographic assumption are met each year. We assume a constant valuation rate and salary scale to determine liabilities. This implies that the actuarial liability and normal cost are constant, net of inflation. These assumptions are the same for all the proposals. (Actuarial liabilities and normal cost were calculated with Lynchval, simulations and projections were calculated in MatLab.)

The pension plan considered is a traditional final average pay formula. Benefits are paid at normal retirement at age 65 in the form of a life annuity. There are no early retirement, disability or death benefits. Participants may terminate vested after 5 years with a deferred life annuity. No lump sums are payable from the plan.

For the economic scenarios, we assume that the fund is invested in a mixture of risky stocks and risk-free bonds with an asset mix that is constant over time. The stock returns are random draws from a normal distribution. Bond returns are determined from the prices of 30-year bonds generated from a (discretized) CIR interest rate model. We use the same CIR interest rate model to develop a risk-free yield curve which is used for the 30-year treasury rates used in current liability calculations. We assume that the yield curves and the stock returns are independent.

Additional information regarding the model can be found in the Appendix.

2.1 Analysis of Current U.S. Funding Rules

2.1.1 Summary of U.S. Funding Rules

As a baseline, we consider the problem in the U.S. under ERISA and the Internal Revenue Code. A brief summary of the rules used follows.

Actuarial liability and normal cost are calculated using the projected unit credit method with a constant valuation rate and salary scale. Current liability is calculated using unit credit and a 4-year weighted average of the 30-year treasury rates. The valuation asset method is the fair market value of assets.

The minimum required contribution is the sum of normal cost, 5-year amortizations of gains and losses, and additional funding charge; offset by the credit balance (with interest) and full funding credit.

The maximum deductible contribution is the sum of normal cost and 10-year amortizations with interest. The maximum deductible may not be less than the minimum required, greater than the full funding limit, or less than the projected unfunded current liability.

Note that for the minimum required contribution, only the 5-year amortization of gains and losses is used. The projection assumes that the fund is well past the amortization of any initial unfunded liability and that there are no plan amendments, assumption or method changes. It is interesting to observe that the "basic" contribution rules of 5-year amortization for the minimum required and 10-year amortization of the maximum deductible would usually result in a minimum required contribution that exceeds the maximum deductible for an underfunded plan.

Additional details of the current U.S. rules and those of the other policies are included in the Appendix.

2.1.2 Maximum Flexibility to Participants

We examine the first of the metrics under the current U.S funding rules in our simulation in Figure 2.1. The curve represents the set of all contribution policies possible between the minimum required and maximum deductible contributions. Points on the curve are obtained by assuming that the plan sponsor contributes *x*% of the minimum required contribution and (100% - *x*%) of the maximum deductible contribution for all years in the projection. A contribution policy of *x*% = 100% corresponds to always contributing the minimum required (indicated on the graph with a diamond) and a contribution policy of *x*% = 0% corresponds to always contributing the maximum deductible (indicated on the graph with a square). The optimal contribution policies on all graphs throughout the paper are indicated with a + or x.

A comparison of the average contribution ratio and the average funded ratio shown in Figure 2.1 provides the first counter-intuitive result. In any given year, the maximum deductible contribution cannot be less than the minimum required contribution. However, Figure 2.1 shows that *on average* the maximum deductible is lower than the minimum required. This occurs because by consistently contributing the maximum, the plan sponsor can maintain a more well-funded plan and thus lower future contribution requirements.

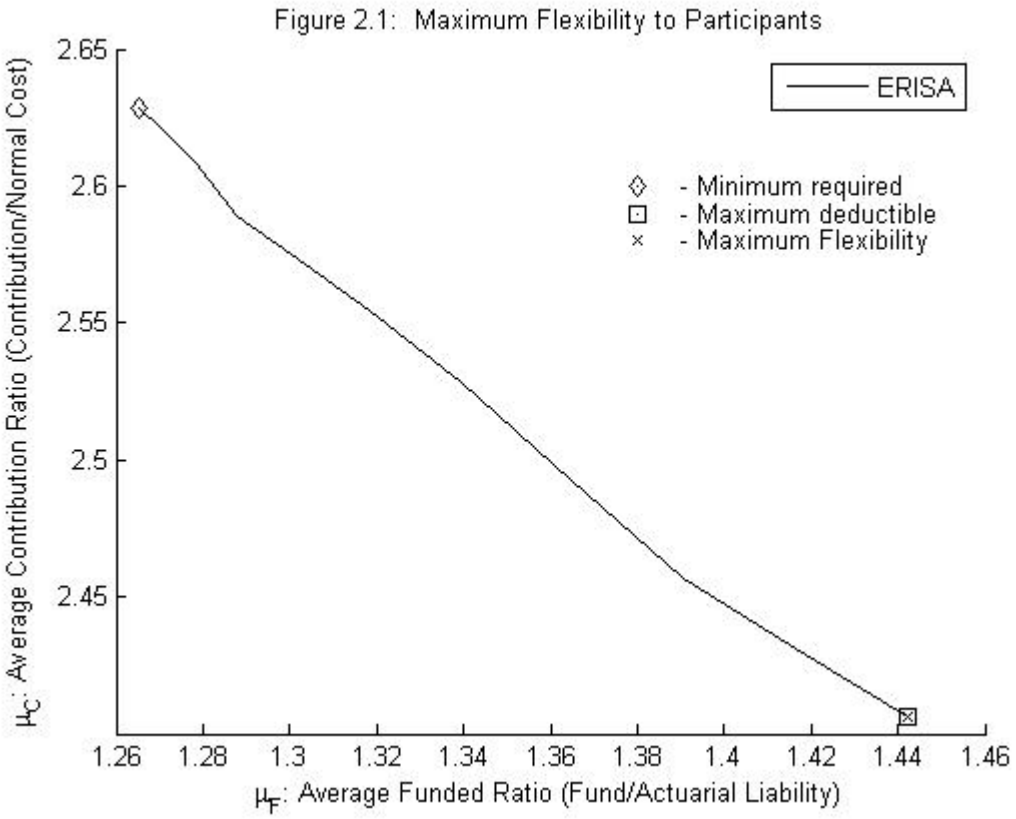

Figure 2.1

It is important to note that the scale of Figure 2.1 as shown exaggerates the difference in average contribution ratio over the various policies. The minimum required contribution ratio is 2.63 and the maximum deductible contribution ratio is 2.41, within 10% of each other.

We also note that the average funded ratio was comfortably above 1 for all policies. This came as a surprise, given the current situation for U.S. pension plans. We selected the valuation rate to be within the reasonable range of expected outcomes of the simulated fund return, consistent with ERISA. Upon examination of the terminal funded ratios in the scenarios, the majority had ratios exceeding 1 (surplus). We conjecture that (1) the assumption that the stock and bond returns are independent may not be appropriate or (2) the "real world" conditions of the past few years are unlikely occurrences. The second conjecture may not be much consolation to plan sponsors, but it may emphasize the growing role of extreme value theory in risk-management.

Optimal Policy: Maximum Deductible Contribution.

From the perspective of plan participant's flexibility, the optimal contribution policy is the maximum deductible policy giving the highest average fund value. This comes as no

surprise.

2.1.3 Minimum Volatility & Maximum Predictability of Contributions, Minimum Risk to Shareholders

We now consider the relationship between the contribution ratio volatility and the fund volatility in Figure 2.2.

Clearly, minimizing σ_C, the standard deviation of the contribution ratio, is the same as minimizing the standard deviation of contributions themselves since the normal cost is constant (net of inflation). By the same argument, the minimal value of σ_C will occur for a policy that has maximum predictability of contributions.

For the shareholders' perspective, we use σ_F as the characterization of risk. Shareholders must ultimately bear the burden of an underfunded plan and, on the other hand, a large surplus may not be the best use of corporate assets. For these reasons, the two-sided nature of σ_F is appropriate.

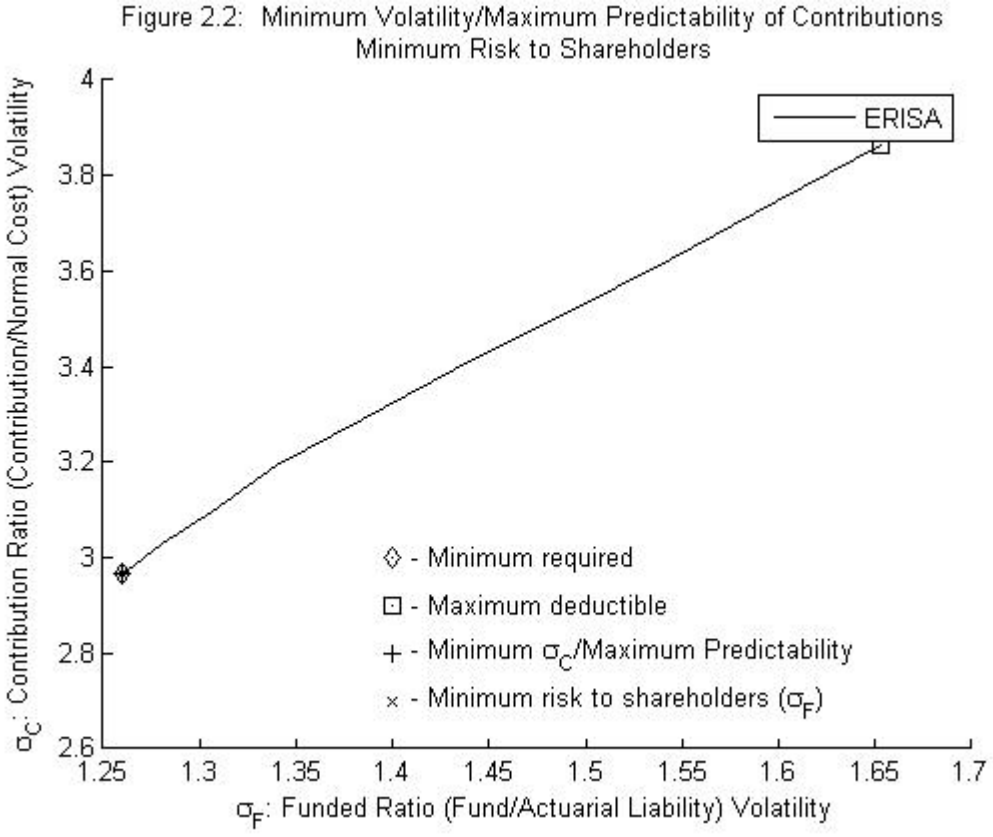

Figure 2.2

In Figure 2.2 we see that contributing the maximum deductible contribution greatly increases the volatility of the contributions, while at the same time increases the volatility of the fund.

This is perhaps counter-intuitive but is explained by the fact that frequently the maximum deductible contribution is the projected unfunded current liability which is a target more volatile than just fund itself since current liability is dynamic. In other words, the funded ratio is with respect to the (constant) actuarial liability, but the maximum policy is funding to the (dynamic) current liability. Thus for the maximum deductible contribution policy, the ratio as plotted reflects the volatility of the assets and the current liability.

It is also interesting to note that the smallest value of σ_C occurs with the minimum required contribution policy. This may be surprising since many plan sponsors who contributed at the minimum required level for years are currently frustrated at the recent volatility of contributions. However, the recent volatility of the minimum required contributions says nothing about the volatility of the maximum deductible contribution. Most sponsors would agree that fully funding the current liability each year in the present environment would be extremely volatile.

Optimal Policy: *Minimum Required Contribution.*

From the perspective of minimizing contribution volatility, maximizing contribution predictability, and minimizing shareholders' risk, the optimal contribution policy is the minimum required policy.

2.1.4 Minimum Risk to Participants and Guaranty Agencies

Volatility of the funded ratio σ_F does not distinguish between an overfunded and an underfunded plan. For this reason, we consider the volatility of the shortfall ratio σ_F^- for the characterization of the risk to participants and guaranty agencies. The metric σ_F^- is the volatility of the lesser of the funded ratio and 1, to only take into account underfunded plans.

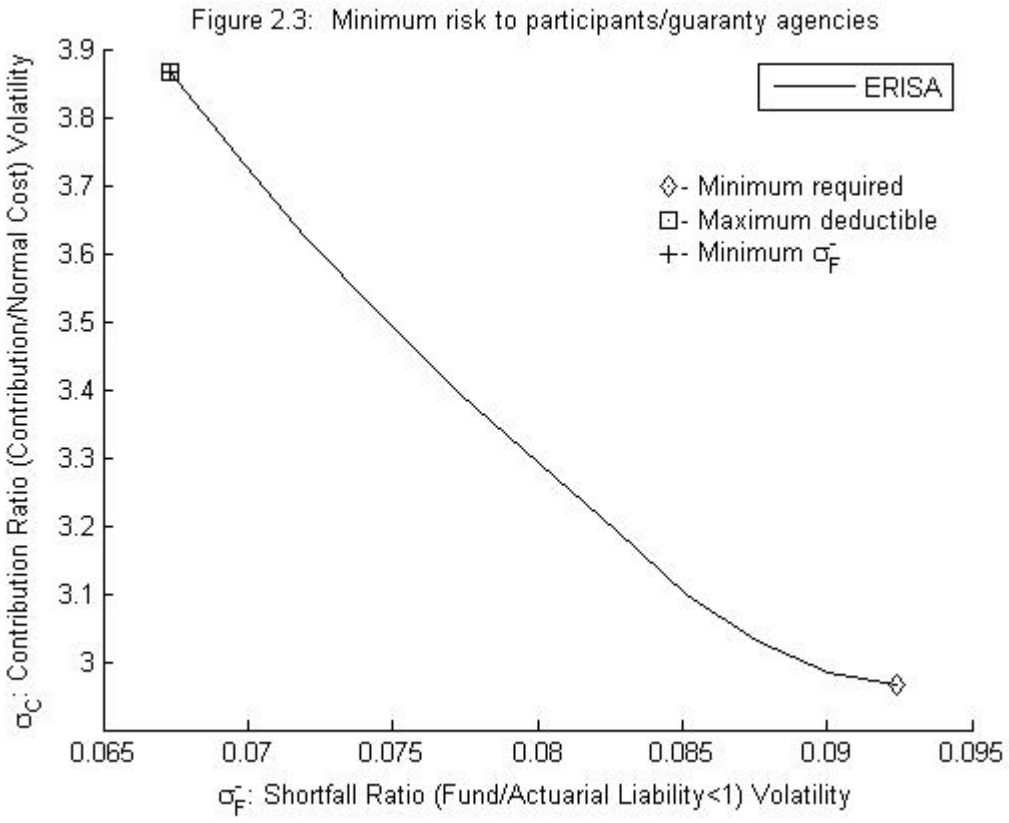

Figure 2.3

Figure 2.3 conforms to conventional wisdom that contributing higher amounts reduces the risk of shortfall. Note that the magnitude of σ_F^- is rather small. This is because the shortfall ratio equals one in the majority of scenarios and even if a deficit occurs it generally does not become very large because the current funding rules react very quickly to eliminate shortfalls.

Optimal Policy: *Maximum Deductible Contribution.*

From the perspective of minimizing risk to participants and guaranty agencies, the optimal contribution policy is the maximum deductible policy.

2.1.5 Summary of Results for Current Law

A summary of the optimal contribution policies for the various factors for current ERISA law is shown in the following table. A final comment on the current law is that for all the factors studied, the optimal contribution ended up being at one end or the other of the allowable range of contributions. One could argue that an optimal contribution policy being strictly between the minimum and the maximum show that the system of rules is flexible enough to allow the plan sponsor more discretion.

Optimal Contribution Policies – Current Law		
Objective	**Parameter**	**ERISA**
Maximum flexibility to participants	μ_F	Maximum Deductible
Minimal volatility of contributions for plan sponsors	σ_C	Minimum Required
Maximum predictability of contributions for plan sponsors	σ_C	Minimum Required
Minimal risk to shareholders	σ_F	Minimum Required
Minimal risk to participants	σ_{F-}	Maximum Deductible
Minimal risk to guaranty agencies	σ_F^-	Maximum Deductible

2.2 Analysis of Proposed Solutions 1 – 3

2.2.1 Summary of Proposals 1 - 3

Proposals 1 – 3 involve changes to the existing U.S. funding rules without a complete overhaul. Because of there inherent similarity, these proposals are included on the same graphs below. A brief summary of the proposals follows. More detailed descriptions can be found in the Appendix.

- Proposal 1 – Maximum Deductible Contribution at least as large as the Normal Cost (with interest). The rationale for this rule is that accruals continue to occur, so a plan sponsor should always be able to fund those new accruals. This has the added advantage that "normal cost" can be understood by stakeholders as it was meant to be – the current cost of this year's accruals – and other contributions can be more clearly seen as responses to underfunding or sponsor's elective pre-funding.

- Proposal 2 – Minimum Required Contribution at least as large as the Normal Cost (with interest). This proposal extends the idea of paying for the new accruals to a requirement rather than an option. Any credit balance built up would only reduce contributions in excess of the normal cost (with interest). This proposal is perhaps less desirable in the sense that it removes flexibility for the plan sponsor by narrowing the range of allowable contributions.

- Proposal 3 – Eliminate the Full Funding Limitation. One of the primary reasons for the full funding limitation is to limit corporate deductions. In an academic sense, the full funding limit has no purpose in pure funding. In practicality, the full funding limit prohibited many plan sponsors from managing their pension risk during the economic boom of the late 1990s.

2.2.2 Maximum Flexibility to Participants

As with ERISA, we examine the same metrics under the same factors described in section 2.1.2. Figure 2.1a shows a comparison of the average funded ratio and the average contribution ratio for contribution policies under the current ERISA rules and Proposals 1-3.

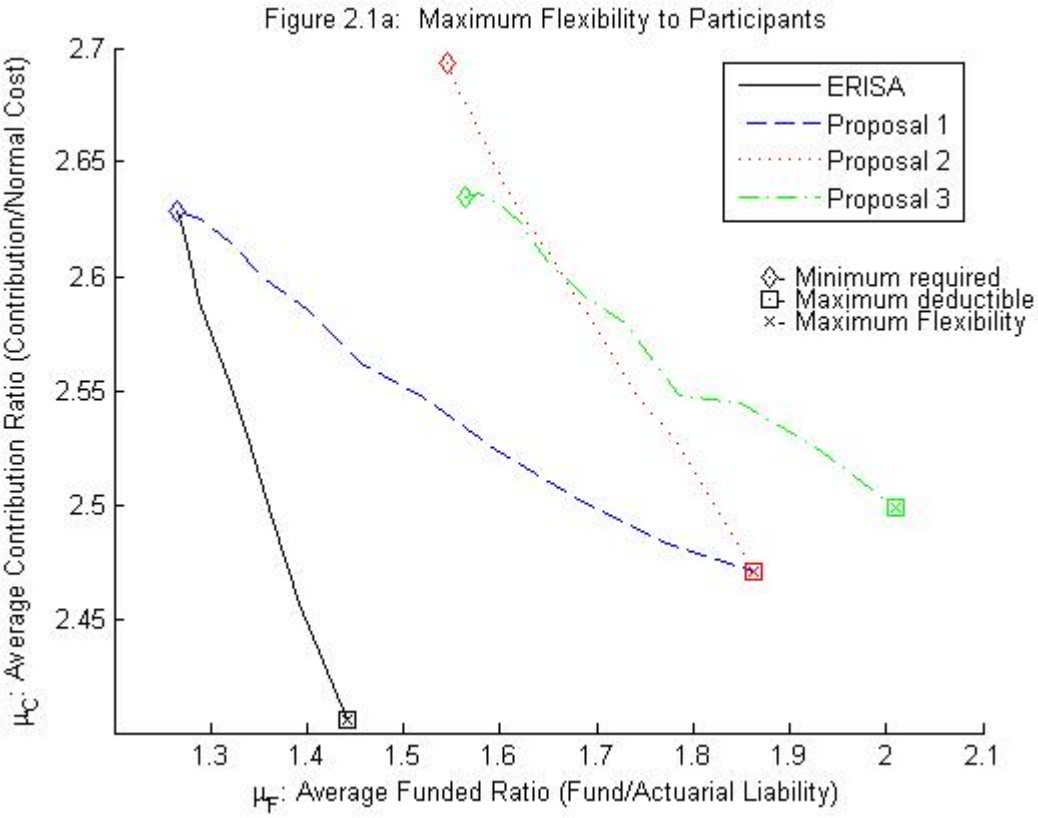

Figure 2.1a

Each proposal increases (or maintains) the average funded ratio across all policies compared to ERISA. The average contribution ratios increase for the maximum deductible (as expected) in all three scenarios and in Proposals 2 and 3 (particularly 2) for the minimum required.

It is interesting to note that Proposal 3, eliminating the full funding limitation, does not greatly affect μ_C for the minimum required, but does improve μ_F. This indicates that plan sponsors would be better able to maintain a surplus without radical changes to the average contributions. Since plan participants gain more flexibility with a larger fund, this is a win-win proposal.

Optimal Policy: *Maximum Deductible Contribution,*
Greater Flexibility than ERISA for all three proposals.

As with ERISA, from the perspective of plan participant's flexibility, the optimal contribution policy is the maximum deductible policy giving the highest average fund value.

2.2.3 Minimum Volatility & Maximum Predictability of Contributions, Minimum Risk to Shareholders

We now consider the relationship between the contribution ratio volatility and the funded ratio volatility in Figure 2.2a, comparing the three proposals and ERISA. As expected, Figure 2.2a shows an increase in volatility σ_F for all three proposals.

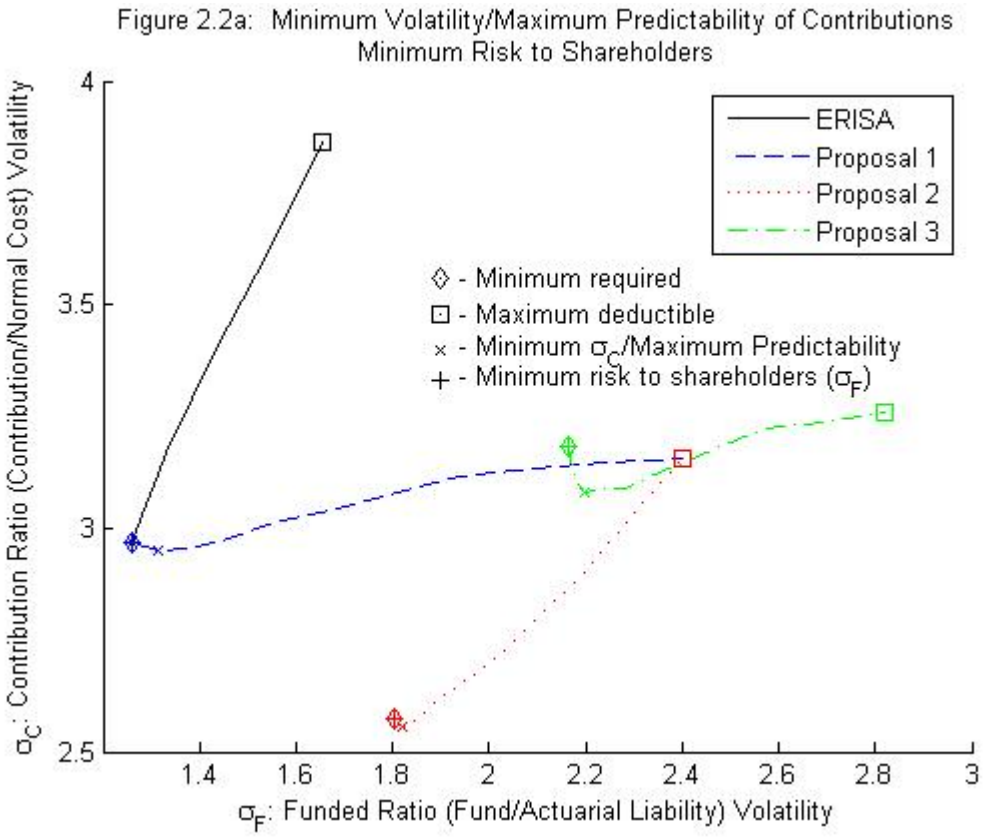

Figure 2.2a

Of considerable interest is the fact that for all three proposals, the minimum volatility σ_C occurs for contribution policies other than the minimum or maximum. This property is critical for creating a set of funding rules that gives the plan sponsor the flexibility to take advantage of the allowable range of contributions.

All three proposals reduce the contribution volatility. In particular, Proposal 1 has the narrowest range of values for σ_C. This is also desirable from the plan sponsor's perspective since any policy chosen should have similar volatility.

Optimal Policy: *Minimum Volatility & Maximum Predictability of Contributions:*
Intermediate Contribution,
Improvement over ERISA for proposals 1&2;

Minimum Risk to Shareholders:
Minimum Required Contribution,
Same as ERISA for proposal 1.

From the perspective of minimum volatility and maximum predictability of contributions, Proposal 1 has optimal σ_C with a contribution weighted 90% minimum/10% maximum; Proposal 2 has optimal σ_C with a contribution weighted 90% minimum/10% maximum; and Proposal 3 has optimal σ_C with a contribution weighted 80% minimum/20%. The specific weightings are not greatly significant since different plan formulas, populations, assets mixes, etc., may give rise to different optimal policies. The significance lies in the fact that the optimal policy is not constrained by the rules.

As with ERISA, from the perspective of minimum risk to shareholders, the optimal contribution policy is the minimum required policy.

2.2.4 Minimum Risk to Participants and Guaranty Agencies

We now consider the relationship between the contribution ratio volatility and the shortfall ratio volatility in Figure 2.3a, comparing the three proposals and ERISA. As expected, Figure 2.3a shows a decrease in volatility σ_F^- for all three proposals in the case of the maximum deductible contribution.

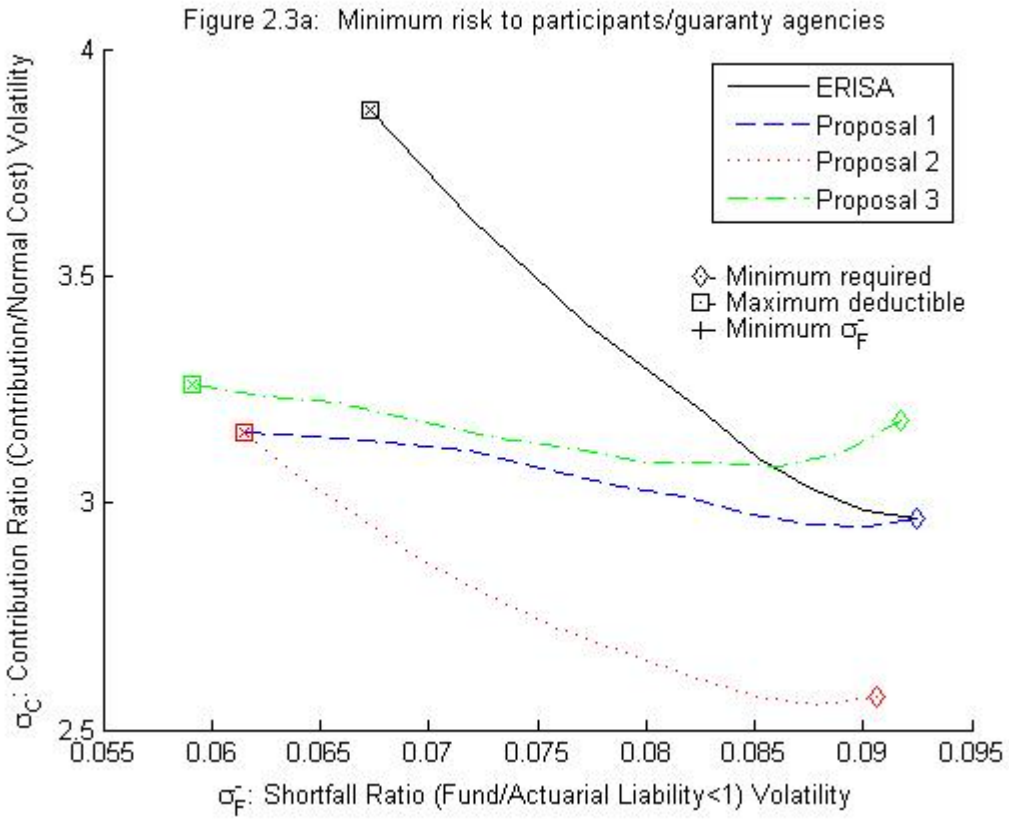

Figure 2.3a

Although there are improvements in the metric for each proposal in the case of the maximum deductible contribution policy, they are not material. However, for all three proposals the improvement of $\boldsymbol{\sigma_F^-}$ occurred simultaneously with improvement of $\boldsymbol{\sigma_C}$.

In the case of Proposal 2, the contribution ratio volatility increased in the case of the minimum required policy. This is the price for the "win-win" situation of the average contribution ratio remaining relatively the same (as noted in 2.2.2) – more volatility.

Optimal Policy: *Maximum Deductible Contribution,*
Improvement over ERISA for all three proposals.

As with ERISA, from the perspective of minimum risk to participants and guaranty agencies, the optimal contribution policy is the maximum deductible policy.

2.2.5 Summary of Results for Proposals 1 - 3

A summary of the optimal contribution policies for the various factors for Proposals 1-3 is shown in the following table. In addition, the table shows whether the relevant metric improved, stayed the same, or worsened compared to ERISA.

Optimal Contribution Policies – Proposed Changes			
Objective	**Proposal 1**	**Proposal 2**	**Proposal 3**
Maximum flexibility to participants	Maximum Improved	Maximum Improved	Maximum Improved
Minimal volatility of contributions for plan sponsors	90/10 Improved	90/10 Improved	80/20 Worsened
Maximum predictability of contributions for plan sponsors	90/10 Improved	90/10 Improved	80/20 Worsened
Minimal risk to shareholders	Minimum Same	Minimum Worsened	Minimum Worsened
Minimal risk to participants	Maximum Improved	Maximum Improved	Maximum Improved
Minimal risk to guaranty agencies	Maximum Improved	Maximum Improved	Maximum Improved

Proposal 1 is the only proposal that improves over or is the same as ERISA.

3 Summary and Conclusion

3.1 Summary

The purpose of this paper was to analyze four proposals for U.S. pension funding reform under six risk factors identified in the SOA's Funding System Constraints. We proposed six metrics for the different factors and determined optimal contribution policies between the minimum required and maximum deductible contributions for each proposal through use of a simulation.

A summary of the metric used and the optimal contribution policies for ERISA is shown in the table below. These results were verified in Section 2.1.

Optimal Contribution Policies – Current Law		
Objective	**Parameter**	**ERISA**
Maximum flexibility to participants	μ_F	Maximum Deductible
Minimal volatility of contributions for plan sponsors	σ_C	Minimum Required
Maximum predictability of contributions for plan sponsors	σ_C	Minimum Required
Minimal risk to shareholders	σ_F	Minimum Required

Minimal risk to participants	σ_{F-}	Maximum Deductible
Minimal risk to guaranty agencies	σ_{F}^{-}	Maximum Deductible

In Section 2.2, we examined the same metrics for the four proposals and arrived at the following conclusions.

Optimal Contribution Policies – Proposed Changes			
Objective	**Proposal 1**	**Proposal 2**	**Proposal 3**
Maximum flexibility to participants	Maximum Improved	Maximum Improved	Maximum Improved
Minimal volatility of contributions for plan sponsors	90/10 Improved	90/10 Improved	80/20 Worsened
Maximum predictability of contributions for plan sponsors	90/10 Improved	90/10 Improved	80/20 Worsened
Minimal risk to shareholders	Minimum Same	Minimum Worsened	Minimum Worsened
Minimal risk to participants	Maximum Improved	Maximum Improved	Maximum Improved
Minimal risk to guaranty agencies	Maximum Improved	Maximum Improved	Maximum Improved

Proposal 1 improves over or stays the same as ERISA for all factors considered.

3.2 Conclusion

The current pension funding crisis is the result of the unlikely simultaneous occurrence of poor stock returns and low interest rates. A good set of funding rules would allow for contingency planning to protect plans from such adverse conditions. Unfortunately, there is almost universal agreement that the current U.S. pension funding rules prohibited such contingency planning. The need for funding reform has never been greater in the U.S.

We hope to help the debate over the best way to draft new rules by introducing clear and consistent analysis of risk factors for various proposals. The outcome of our analysis shows that all four proposals have some advantages and our methodology provides a meaningful way of comparing the pros and cons of the proposals relative to each other.

Proposal 1 shows the most promise for improving the risk factors considered. We believe that Proposal 1 has the added advantages that it is parsimonious, effective, politically feasible, and flexible enough to be combined with other approaches.

It is our hope that the final consensus on pension funding rules in the U.S. will include a provision for plan sponsors to deduct the plan's normal cost each year, enabling the funding of new benefit accruals as they occur.

3.3 Areas for future research

The analysis used in this paper can be easily extended to include other pension plan formulas such as cash balance plans, plans offering lump sums, early retirement subsidies, disability benefits, etc. Moreover, additional funding methods and asset valuation methods could be added to the model.

The economic scenarios used could be improved to allow correlation between stock and bond returns and/or correlation between assets and liability cash flows. Different or varying asset mixes could also be examined. The impact of inflation and variable wage grow and salary scale consistent with the economic scenarios would enhance the model significantly.

The assumption of a stationary population with all assumptions being met each year could be replaced by dynamic demographic assumptions. For example, plans early retirement windows for plans with early retirement subsidies could be modeled with a Monte Carlo simulation. This method has been successfully used to value early retirement features as options in the pension plan.

The model could also simulate whether a company is healthy or weak. This could be correlated with the economic scenarios.

Appendix

A.1 Valuation

The funding method for the valuation of liabilities for ERISA and Proposals 1 – 3 is projected unit credit. Current liability is calculated using unit credit. The asset valuation method is fair market value.

A stationary population was assumed based on the demographic assumptions listed below.

Retirement: 100% at age 65,
Mortality: 1983 Group Annuity Mortality (Male/Female),
Withdrawal: Table T-7 (from the Actuary's Handbook) less 1951 GAM,
Disability: 1975 Social Security Disability.

New entrants occur only at age 20 with a salary of $20,000.

Economic assumptions used in the valuation are a funding rate of 7%, a salary scale of 4.5%, and inflation of 3%.

Valuation liabilities were calculated using Lynchval Systems Worldwide Inc.'s LVWin valuation system.

Current liability interest rates are the 4-year weighted average of 30-year treasury rates.

The pension plan formula is 1.5% of the final average 5 years of salary times years of service paid as a life annuity at age 65. Benefits are paid at normal retirement at age 65 in the form of a life annuity. There are no early retirement, disability, or death benefits. Participants may terminate vested after 5 years with a deferred life annuity. No lump sums are payable from the plan.

A.2 Economic Scenarios

The assets of the pension fund are assumed to be invested 60%/40% in stocks and bonds.

The stock return each year is independently generated from a normal distribution with mean 6% and standard deviation 20%.

The interest rates are generated from a one-parameter (discretized) CIR interest rate model. The CIR interest rate model assumes the short rate will follow a Wiener process

$$dr = a\,(b - r)\,dt + \sigma\, r^{\frac{1}{2}}\, dz,$$

where a = 14%, b = 6%, σ = 5%, and dz is normally distributed, independent of the normal random stock return.

A.3 Funding Rules

The ERISA funding rules in more detail are as follows.

The minimum required contribution is the sum of normal cost (with interest at the funding rate), 5-year amortizations of gains and losses (with interest at the funding rate), and additional funding charge; offset by the credit balance (with interest at the funding rate) and full funding credit.

The additional funding charge occurs if the plan's funded current liability ratio (assets over current liability at the valuation date) is less than 80% or is between 80% and 90% and has not been over 90% for two of the last three plan year. The additional funding charge is the Applicable Percentage multiplied by the unfunded current liability plus the current liability normal cost, offset by the ERISA normal cost and amortization charges less credits adjusted with interest to the end of the year at the current liability interest rate. The Applicable Percentage is 30% less 40% of the funded current liability ratio in excess of 60%.

The full funding credit is the excess, if any, of the minimum required contribution (disregarding the credit balance) over the projected unfunded actuarial liability (or the unfunded value of 90% of the current liability, if greater) where the assets are reduced by the credit balance. In the event of a full funding credit, all bases for the minimum required contribution are eliminated in the following year's valuation.

The maximum deductible contribution is the sum of normal cost and 10-year amortizations with interest. The maximum deductible may not be less than the minimum required, greater than the full funding limit, or less than the projected unfunded current liability.

The full funding limit is the projected unfunded actuarial liability (or 90% the unfunded value of 90% of the current liability).

Note that for the minimum required contribution, only the 5-year amortization of gains and losses is used. The projection assumes that the fund is well past the amortization of any initial unfunded liability and that there are no plan amendments, assumption or method changes.

Proposals 1 – 3 use the ERISA rules with the exception of the changes as noted previously.

The asset method must be the fair value of assets, the liabilities must be calculated as the present value of cash flows based on accrued benefits (unit credit) discounted with a corporate yield curve. No credit balance is allowed.

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