



---

## **OBSERVATIONS ON INPUT AND OUTPUT SMOOTHING METHODS:**

How do they affect the funding of defined benefit plans?

---



### EXECUTIVE SUMMARY

The volatility of required pension contributions has been a consistent concern for sponsors of defined benefit plans. As recently as July 2012, legislators modified the law that governs contribution requirements for private single-employer defined benefit plans to reduce the effects of low interest rates on plan sponsors.<sup>1</sup> Deliberations about this legislation raised questions about the merits of stabilizing contribution requirements through input smoothing methods (which smooth volatile elements of pension calculations, such as interest rates or asset values) or output smoothing methods (which smooth the resulting contribution requirements).

This report begins an examination of ways to address volatility in the funding rules by making a few general observations regarding the similarities and differences between input and output smoothing mechanisms. The report notes that:

- In general, the choice between input and output smoothing methodologies does not directly affect the solvency of defined benefit plans or the predictability of statutory requirements.
- An input method smoothes a single source of volatility and may affect multiple statutory requirements, but smoothing the effects of other sources of volatility necessitates additional smoothing methods. For example, an asset smoothing method stabilizes the asset value used to calculate contribution and benefit restriction requirements,<sup>2</sup> but an additional smoothing method would be needed to stabilize the effects of interest rate volatility on the liabilities used to calculate these requirements.
- In contrast, an output method smoothes the effects of multiple sources of volatility for a single statutory requirement, but stabilizing other statutory requirements necessitates additional smoothing methods. So, for example, an output method that stabilizes contribution requirements smoothes the effects of asset and interest rate volatility, but an additional smoothing method would be needed to stabilize benefit restriction requirements.
- Input smoothing methodologies change the relationship between market-based and reported values of pension assets and liabilities. Users of the reported values need to understand their relationship to market-based values to ensure appropriate use of the information.

These observations have implications beyond the selection of input or output smoothing methodologies. They call attention to how smoothing may influence attitudes toward risk in the management and design of retirement programs. They also point out that smoothing complicates understanding of defined benefit plan financial positions, with the potential to mistake smoothed results for a reduction in plan risk when, in fact, smoothing methods merely spread the recognition of volatile experience into a more (perhaps) manageable pattern.

This report is not intended to advocate a position for or against the use of smoothing methodologies, or for or against the use of any particular smoothing methodology. Rather, the purpose of this research is simply to provide objective, actuarial illustrations of the differences between alternative methodologies. Further, the illustrations in this report were designed to highlight observations on the operation of input and output smoothing methodologies, and should not be construed as a full analysis of particular smoothing methods. The illustrations control numerous factors, including correlations between changes in asset and liability values and the effects of MAP-21 interest rate stabilization,<sup>3</sup> which deserve consideration in the analysis of a specific smoothing method.

---

<sup>1</sup> The modifications were part of the Moving Ahead for Progress in the 21st Century Act (MAP-21) legislation enacted in July 2012. The Society of Actuaries published an analysis of its effects in [Proposed Pension Funding Stabilization: How Does It Affect the Single-Employer Defined Benefit System?](#)

<sup>2</sup> Many statutory requirements apply to private single-employer defined benefit plans. This report focuses on two: the requirement that plan sponsors contribute a minimum amount of cash to fund their plans and restrictions on the ability of plans to offer certain benefits as their funded level declines.

<sup>3</sup> The illustrations were designed to negate the effects of the MAP-21 interest rate corridor. Negating the corridor provides a more neutral comparison of the illustrated smoothing alternatives, given the changing nature of the corridor and the likelihood that its effects will be temporary.

### FRAMEWORK

This report investigates the differences between input and output smoothing methods from an actuarial perspective. As a starting point, it identifies some basic differences (and similarities) between these methods by examining how they perform in specific economic scenarios to make some general observations.<sup>4</sup>

The report compares three alternative statutory schemes: current law, current law modified to increase input smoothing, and current law modified to increase output smoothing. The input smoothing modification extends 24-month smoothing of interest rates and asset values to 60 months and increases the 10 percent limit on the difference between the smoothed and market values of assets to 20 percent. For the output smoothing alternative, current law is modified by extending the amortization period from seven to 10 years and graduating the amortization schedule. These modifications were chosen for illustration purposes only, and should in no way be construed as proposed or recommended changes to the law.

Though current law includes the Pension Funding Stabilization provisions of MAP-21, the assumptions used in the illustrations negate their effects.<sup>5</sup> Negating the effects of the MAP-21 interest rate corridor benefits the comparisons in this report in two ways. First, it avoids confusion that may result from mixing the effects of the changing corridor with the effects of the alternative smoothing methods. Second, to the extent the effects of the corridor are temporary, the illustrations show how the alternative smoothing methods would ultimately operate.

The smoothing alternatives are compared in four scenarios, covering two plans, each affected by two economic shocks. The two plans are perfectly identical, except that one plan freezes all future accruals more than one year prior to the economic shock, and the other plan continues to accrue benefits and accept new entrants. Both plans are 95 percent funded on a market basis<sup>6</sup> prior to the shock, which avoids some of the complications that occur for plans with lower funded ratios and highlights the sensitivity of plans with higher funded ratios. Two independent shocks are applied to the experience of each plan—a one-year interest rate decline of 100 basis points and a negative 20 percent return on assets—which are significant enough to illustrate the operation of the smoothing methods and representative of experience in the recent past.<sup>7</sup>

The discussion in this report addresses three key principles of funding regulation from an actuarial perspective. The three principles are the solvency of the plans, the predictability of statutory requirements, and the transparency of financial information about the plans.

### EFFECTS ON PLAN SOLVENCY

*Observation 1: Input and output smoothing methodologies can affect plan solvency similarly. Either form of smoothing determines a rate at which sponsors must improve the solvency of their plans. So, to the extent that an input method and an output method determine the same rate of improvement, they will have the same effect on plan solvency.*

---

<sup>4</sup> A more comprehensive comparison of statutory smoothing methods requires a more robust analysis. For example, the effects of a specific proposal may vary by plan design, plan demographic, and future economic scenario.

<sup>5</sup> The illustrations are drawn from experience after 2016, when the corridor expands to 30 percent, and interest rates are assumed to increase such that they are within the corridor by then.

<sup>6</sup> Unless otherwise specified, "market basis" refers to the market value of assets and a market-based measurement of liabilities, accomplished by discounting expected future benefit payments on an unsmoothed corporate spot rate curve.

<sup>7</sup> The illustrations in this report isolate the effects of individual input smoothing mechanisms (interest rate or asset return) for ease of comparison with the output smoothing alternative. Thus, the illustrations do not address the correlation between asset returns and interest rate changes. In reality, there is a correlated interaction between interest rate and asset smoothing methods, which would deserve consideration in the analysis of any specific smoothing proposal.

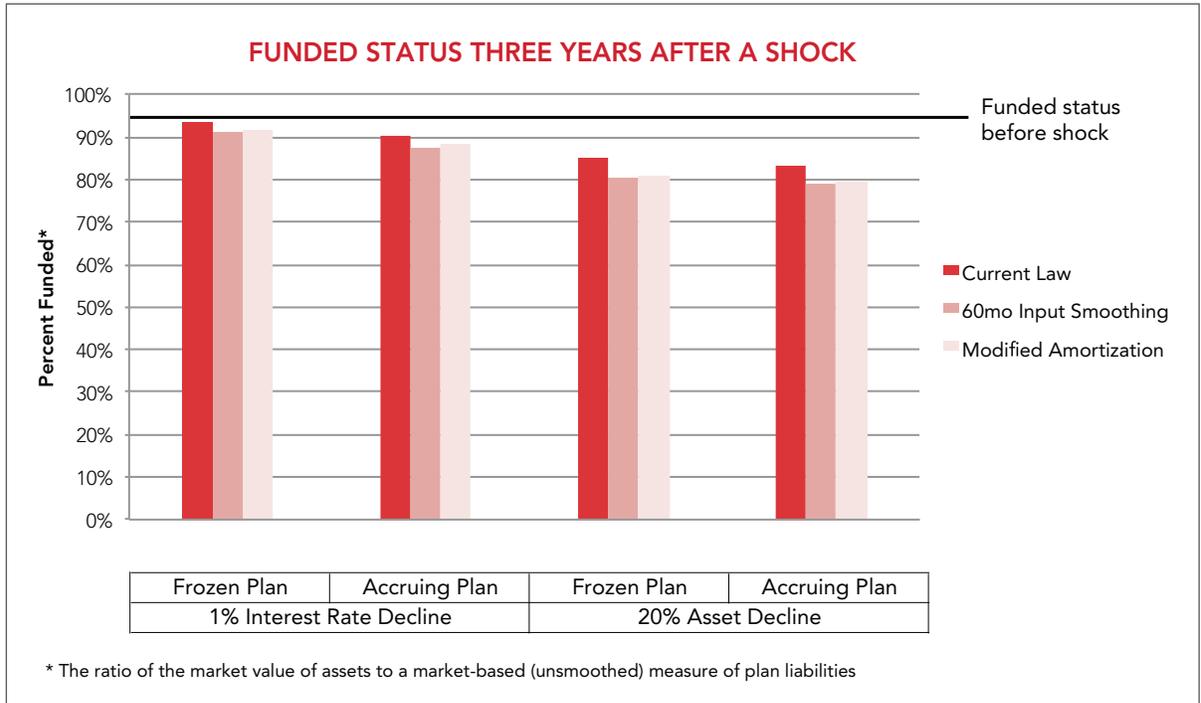


EXHIBIT 1

Exhibit 1 compares plan funding under each statutory alternative three years after encountering severe economic shocks.<sup>8</sup> The funded status calculations use market-based measures of assets and accrued benefit liabilities. The shocks cause the funded status to fall from 95 percent to 85 or 86 percent in the case of the interest rate shock and to 72 percent in the case of the asset shock. From those lows, the plans recover to the levels shown in the chart three years later.

The exhibit shows that the input and output smoothing alternatives lag current law with respect to improving solvency. Both alternatives increase the period over which losses are recognized and decrease the initial rate of recognition, slowing the pace at which plan sponsors are required to fund their plans.<sup>9</sup> Because the input and output alternatives recognize losses at approximately the same rate, they have similar funded statuses at the end of three years. These effects apply to any smoothing alternative and are not necessarily a consequence of whether the smoothing is accomplished through input or output methods.

*Observation 2: Input methods smooth specific sources of volatility, such as asset returns or interest rate changes, and affect multiple statutory requirements, such as minimum funding requirements and benefit restrictions. In contrast, output methods smooth the effects of multiple sources of volatility for specific statutory requirements.*

By definition, input smoothing methods target specific sources of volatility, such as interest rate movements or deviations from expected asset returns. If allowed, the effects of input smoothing will flow into multiple statutory determinations, such as cash contribution requirements or additional disclosure requirements. For example, under

<sup>8</sup> To see how the funded status compares at other time periods, see Appendix A, which shows how the funded status improves over the entire projection period.

<sup>9</sup> Also noteworthy: In the case of a gain, both alternatives would accelerate funding relative to current law.

## OBSERVATIONS ON INPUT AND OUTPUT SMOOTHING METHODS

current law, a single smoothed asset value enters into the determination of cash contribution requirements and the determination of restrictions on the benefits a plan may offer.

Output smoothing methods effectively capture multiple sources of volatility and manage their effects for a single statutory requirement. The amortization of unfunded benefit liabilities is an example of an output smoothing mechanism. It captures numerous factors contributing to the volatility of unfunded benefit liabilities—interest rates, asset returns and demographic experience, to name a few—and spreads their effects over several years for purposes of determining contribution requirements. However, it has no direct effect on the determination of disclosure requirements or whether benefit restrictions should apply.

The collection of input and output smoothing mechanisms in the funding rules determines which sources of volatility are smoothed and the degree to which they are smoothed. This has implications for incentives built into the funding rules, because smoothing the effects of risk factors may diminish the consequences (good or bad) of taking those risks. It also has implications for the complexity of regulations, as efforts to manage the degree of smoothing for certain risks may lead to multiple rules and increased complexity.

### COMMENTARY

Smoothing methods have a major effect on the rate at which sponsors must improve the solvency of their plans. When poor experience causes a shortfall in funding, smoothing of that experience determines how soon it is recognized in contribution requirements. More generally, smoothing methods determine a rate at which plan experience is recognized.

An individual smoothing method—input or output—can determine any rate for recognizing plan experience, as demonstrated in Exhibit 1. However, the funding rules contain multiple smoothing mechanisms that interact, like the combination of asset smoothing and amortization under current law, so the overall rate of recognition depends on the aggregate effect of all mechanisms in the law. Some mechanisms are conditional, so they may only apply to certain plans or under certain circumstances. The illustrations in this report control for many of these circumstances, but a few that apply, such as the limit on smoothed asset values,<sup>10</sup> are the primary sources of differences between the input and output alternatives shown in Exhibit 1. A full analysis of a smoothing method would consider all of the potential interactions and circumstances to determine the proposal's effect on the solvency of the system.

Observation 2 has implications for the complexity of funding rules, as efforts to manage the degree of smoothing for certain types of volatility may lead to multiple rules and increased complexity. Because input methods only smooth a single source of volatility, smoothing the effects of other sources requires additional smoothing methods (input or output). For example, an asset smoothing method stabilizes the asset value used to calculate contribution and benefit restriction requirements. An additional smoothing method would be needed to stabilize the effects that interest rate movements or changes in longevity estimates have on the liabilities used to calculate these requirements.<sup>11</sup>

Likewise, because output methods only affect a single statutory requirement, stabilizing other statutory requirements necessitates additional smoothing methods. So, for example, an output method that stabilizes

---

<sup>10</sup> Current law and the output smoothing alternative limit the smoothed asset value to within 10 percent of the market value of assets. The input smoothing alternative limits smoothed assets to be within 20 percent of the market value.

<sup>11</sup> Analysis of a specific input smoothing method should consider how the source of volatility may affect both asset and liability values, since increased smoothing of one or the other may not reduce the volatility of statutory requirements. For example, an interest rate smoothing method may reduce the volatility of a plan's liability value but not reduce the volatility of the plan's asset value, which is also affected by interest rate movements. This could result in a greater difference between the asset and liability values than otherwise would have been the case, and the greater difference would translate into more volatile statutory requirements.

contribution requirements, such as the amortization of unfunded benefit liabilities, does not stabilize benefit restriction requirements. Additional smoothing methods, whether input or output, are needed to stabilize benefit restrictions.

For either type of smoothing method, input or output, attempts to limit the application of smoothing result in additional complexity, too. With respect to input smoothing methods, the interest rate stabilization provisions of MAP-21 exemplify this issue. The provisions apply to the determination of contribution requirements and benefit restrictions, but they do not apply to the determination of minimum lump sum benefits, maximum deductible contributions, or PBGC variable-rate premiums, for example. The specification of where the interest rate stabilization does or does not apply adds significant complexity to the funding rules. The need for exceptions could complicate output smoothing methods, too. For example, a change to the amortization period for contribution requirements might apply to actuarial gains or losses, but not apply to liability changes resulting from a sponsor-initiated change in plan provisions.

Clearly, no general rule exists for whether an input method or an output method provides the less complex approach to smoothing. The complexity depends on too many specific, and perhaps subjective, factors, such as the complexity of the rule itself and how deeply it is intertwined with existing rules. However, Observation 2 provides a guidepost for direction. Input smoothing methods allow for universal smoothing of the effects of a few, targeted sources of volatility, but may need restrictions on the statutory requirements to which they apply. Alternatively, output smoothing methods allow legislators to set the level of smoothing applicable to a specific statutory requirement, but may need restrictions on which asset or liability changes are smoothed.

### EFFECTS ON THE PREDICTABILITY OF STATUTORY REQUIREMENTS

*Observation 3: Input and output smoothing methodologies can produce similar effects on the predictability of statutory requirements, such as contribution requirements and benefit restrictions. Either form of smoothing determines when plan experience is reflected in the statutory requirements and, therefore, the amount of time sponsors have to adjust for their effects. So, to the extent that an input method and an output method provide the same amount of time to adjust, they have the same effect on the predictability of a statutory requirement.*

The predictability of statutory requirements affects the ability of plan sponsors to manage their business operations efficiently.<sup>12</sup> Two statutory requirements that have a significant effect on business operations are contribution requirements and restrictions on the availability of certain benefits as funded ratios decline (hereafter referred to as “benefit restrictions”).<sup>13</sup> More predictable contribution requirements allow sponsors to more efficiently allocate their cash resources, potentially affecting the growth and competitiveness of their businesses. And there are similar implications for the predictability of benefit restrictions.

Table 1 shows the effects of severe economic shocks on cash expenditures for the illustrative plan sponsors. It shows the change in contribution requirements (as a percentage of payroll) for the year following the shocks, the most critical year for purposes of predictability since sponsors have the least time to adjust their budgets. A smaller change indicates greater predictability because less of the unexpected funding is required in the first year and the sponsors have more time to plan for the ultimate increase.

---

<sup>12</sup> A discussion of the predictability of funding requirements must consider that sponsors have the ability to significantly increase predictability through plan design and investment options available to them. However, the predictability of statutory requirements remains important for several reasons. First, sponsors offering defined benefit plans ultimately retain some amount of risk, so statutory provisions will have some influence commensurate with the amount of risk they take. Second, the predictability of statutory requirements may influence sponsor behavior with respect to risk, including the steps they take to manage their risks.

<sup>13</sup> These provisions were intended to limit the exposure of other stakeholders (e.g., plan participants and the PBGC) to unfunded plan benefits, for which they become liable in the event a sponsor defaults on plan obligations.

## OBSERVATIONS ON INPUT AND OUTPUT SMOOTHING METHODS

CONTRIBUTION REQUIREMENT (PERCENT OF PAYROLL)	1% INTEREST RATE DECLINE		20% ASSET DECLINE	
	FROZEN PLAN	ACCRUING PLAN	FROZEN PLAN	ACCRUING PLAN
BEFORE LOSS	0.0%	6.9%	0.0%	6.9%
YEAR FOLLOWING LOSS				
Current Law	0.7%	8.6%	5.6%	13.4%
60mo Input Smoothing	0.1%	7.8%	3.2%	10.7%
Modified Amortization	0.3%	7.9%	2.8%	10.2%
<b>CHANGE</b>				
Current Law	0.7%	1.7%	5.6%	6.5%
60mo Input Smoothing	0.1%	0.9%	3.2%	3.8%
Modified Amortization	0.3%	1.0%	2.8%	3.3%

TABLE 1<sup>14</sup>

The input and output smoothing alternatives significantly reduce the change in contribution requirements relative to current law but show little difference in relation to each other. As explained in the section on solvency, both alternatives decreased recognition of the shocks in the first year for purposes of determining contribution requirements. And, because they decreased recognition by approximately the same amount, they have about the same effect on the predictability of contribution requirements. The alternatives show that either form of smoothing can be adjusted to a desired amount of predictability.

Table 2 shows how the economic shocks affect the smoothed funded ratios for the sample plans, which determine the application of benefit restrictions,<sup>15</sup> in the year following the shocks. Some benefit restrictions begin to apply when the ratio falls below 80 percent. The plans illustrated in this report are 95 percent funded prior to experiencing a shock, and so seem secure from restrictions. However, the asset return shock is great enough to drive the smoothed ratio to just below 80 percent under current law and the output smoothing alternative, but it does not do so under the input smoothing alternative.

SMOOTHED FUNDED RATIO	1% INTEREST RATE DECLINE		20% ASSET DECLINE	
	FROZEN PLAN	ACCRUING PLAN	FROZEN PLAN	ACCRUING PLAN
BEFORE LOSS	95.0%	95.0%	95.0%	95.0%
YEAR FOLLOWING LOSS				
Current Law	94.7%	93.4%	79.7%	79.4%
60mo Input Smoothing	96.2%	94.9%	86.9%	86.7%
Modified Amortization	94.7%	93.4%	79.7%	79.4%

TABLE 2

The illustration implies that input smoothing improves the predictability of benefit restrictions and output smoothing does not. However, this occurs because the output smoothing alternative used in the illustration only applies to contribution requirements, not because output smoothing methods cannot improve the predictability of benefit restrictions. Observation 2 noted that output smoothing alternatives affect specific statutory requirements, and an additional output smoothing method is needed to affect benefit restrictions. So, for example, adding provisions

<sup>14</sup> The contribution requirements shown in Table 1 exclude amortization of gains and losses that occurred prior to the economic shocks.

<sup>15</sup> In this case, the smoothed funded ratios represent the Adjusted Funding Target Attainment Percentages (AFTAPs) for the illustrative plans. The characteristics of the sample plans are such that the AFTAPs equal the Funding Target Attainment Percentages (FTAPs) for the plans.

## OBSERVATIONS ON INPUT AND OUTPUT SMOOTHING METHODS

that delay restrictions until there have been two consecutive years of funded ratios less than 80 percent would be a way to address the predictability of benefit restrictions through an output smoothing approach.

### EFFECTS ON THE TRANSPARENCY OF FINANCIAL INFORMATION

*Observation 4: Input smoothing methodologies change the relationship between market-based and reported values of pension assets and liabilities. Users of the reported values need to understand their relationship to market-based values to ensure appropriate use of the information.*

Input smoothing methods change the relationship between smoothed funded ratios and market-based measurements of funded ratios.<sup>16</sup> To show this, Table 3 compares the difference between the smoothed and market-based funded ratios in the year following the illustrative shocks, when the differences are greatest. So, for example, in the year following the interest rate shock, the accruing plan has a market-based funded ratio of 85 percent and a smoothed funded ratio of 93 percent under current law—a difference of 8 percentage points. For the output smoothing alternative, the smoothed ratio differs from the market-based ratio by exactly the same amount as it differs under current law. But for the input smoothing alternative, the smoothed ratio differs from the market-based ratio by a greater amount in all cases. So, changing the amount of input smoothing changed the relationship between the smoothed and market-based ratios.

<b>DIFFERENCE BETWEEN SMOOTHED AND MARKET- BASED FUNDED RATIOS</b>	<b>1% INTEREST RATE DECLINE</b>		<b>20% ASSET DECLINE</b>	
	<b>FROZEN PLAN</b>	<b>ACCRUING PLAN</b>	<b>FROZEN PLAN</b>	<b>ACCRUING PLAN</b>
BEFORE LOSS	0%	0%	0%	0%
YEAR FOLLOWING LOSS				
Current Law	9%	8%	8%	7%
60mo Input Smoothing	10%	10%	15%	15%
Modified Amortization	9%	8%	8%	7%

**TABLE 3**

This is a direct result of input smoothing methodologies. Input smoothing methodologies alter market inputs to the calculation of asset and liability values, thereby changing how calculated asset and liability values relate to the markets. As the amount of input smoothing increases, the relationship gets weaker. So, under the input smoothing alternative, the smoothed ratios deviate from the market-based ratios by greater amounts because they are less sensitive to changes in market conditions.

In contrast, output methodologies do not affect the calculation of asset and liability values, leaving their relationship to the markets unchanged. Current law differences between the smoothed and market-based ratios shown in Table 3 are attributable to the input smoothing already allowed under current law. The output smoothing alternative has the same differences as current law because the calculation of asset and liability values remains the same as under current law.

The relationship between financial markets and estimates of asset and liability values has implications for the users of plan information. Users who prefer a market-based measure of plan information would prefer less input smoothing in the reported values they use.

<sup>16</sup> For this illustration, market-based ratios equal the market value of plan assets divided by plan liabilities calculated using an unsmoothed corporate spot rate curve

## OBSERVATIONS ON INPUT AND OUTPUT SMOOTHING METHODS

*Observation 5: The funding rules use plan information, and therefore need to be considered when the nature of plan information changes.*

For example, the rules for applying benefit restrictions rely on a smoothed funded ratio to determine whether and to what degree restrictions should apply. The use of plan information for purposes of statutory requirements such as this is written into law, and is likely based on a relationship between smoothed and market-based measures. A change in that relationship warrants consideration of whether such requirements function as intended under the new relationship.

Table 4 provides an illustration of this consideration. It shows the relationship between statutory and market-based measures for activation of benefit restrictions by summing the number of years during the projection period when those ratios would fall below 80 percent. Under current law and the output smoothing alternative, benefit restrictions would apply during one less year than they would if a market-based measure of funded status determined their application. This reflects the amount of input smoothing under current law. Under the input smoothing alternative, benefit restrictions would never apply during the projection period. So, to the extent legislators intend to apply benefit restrictions based on a current, market-based measure of plan funding, increasing the amount of input smoothing would counter this intention.

NUMBER OF YEARS THE FUNDED RATIO IS BELOW 80%	FROZEN PLAN		ACCRUING PLAN	
	STATUTORY	MARKET-BASED	STATUTORY	MARKET-BASED
Current Law	1	2	2	3
60mo Input Smoothing	0	3	0	4
Modified Amortization	1	3	3	4

**TABLE 4**

### COMMENTARY

The principle of transparency allows stakeholders in the system to make decisions based on the financial status of the plans, such as how to value benefit promises, whether to provide capital to a sponsoring organization, and whether additional regulatory scrutiny is warranted. Essentially, it enables different stakeholders to manage their risks with respect to the plans.

The long-term risks associated with defined benefit plans complicate determination of financial information about a plan and, therefore, the question of how to communicate plan information. The financial markets provide a strong indication of the current price for defined benefit obligations and the assets backing them, but financial markets can be volatile and the prices for obligations and assets may change substantially in a short period of time. So, while some users prefer plan information consistent with current markets, other users may desire information consistent with another basis.<sup>17</sup> Their purpose notwithstanding, stakeholders need to understand the relationship between reported data and the financial markets because the markets ultimately determine the cost of settling a plan's obligations.

Input smoothing methods affect the transparency of plan financial information, as they change how the information relates to financial markets. To the extent that users desire market-based information, they need to understand

---

<sup>17</sup> Stakeholders may have access to preferable data on a plan's financial status from sources other than statutory disclosures. For example, to the extent plan sponsors disclose plan financial information under pension accounting standards, stakeholders with access to the accounting disclosure may find its data preferable to the data disclosed under statutory standards.

how input smoothing has affected the information they receive. Where the funding rules use plan information, legislators must consider whether smoothed values provide appropriate information for their laws to function.

### SUMMARY AND AREAS FOR FUTURE ANALYSIS

The illustrations in this report show that, at a basic level, the choice between input and output forms of smoothing does not directly affect the solvency of plans or the predictability of statutory requirements. Rather, the rate at which any smoothing method requires plan sponsors to take plan experience into account determines how the method affects these principles. Legislators can adjust the rate under either form of smoothing, input or output.

In contrast, the choice between input and output smoothing methods has real implications for the transparency of a plan's financial information. Because output methods do not alter the calculation of assets or liabilities, they do not affect the relationship between these key data elements and the markets that ultimately determine their value. However, input methods do alter the calculation of assets and liabilities, so changes to input smoothing must consider whether the altered values provide an appropriate measure for their intended use.

The discussion in this report hinges on a narrow set of circumstances in the private single-employer defined benefit system that highlights these general observations. But it also provides ideas for further consideration and analysis in choosing any smoothing method, including decisions about input or output methods.

Discussion of this limited set of circumstances indicates the need for a robust analysis of specific smoothing proposals. Numerous factors—such as the diversity in plan demographics and designs, the interaction of multiple smoothing mechanisms, and the number of potential scenarios for future experience—may influence how a specific proposal affects a given plan or the system as a whole.

The discussion of the principles of predictability and transparency provides some insight to how the degree of smoothing in funding rules may influence sponsor behaviors. To the extent volatility discourages a plan sponsor from taking a risk, smoothing the effects of that risk reduces the impediment. At the highest level, the overall amount of smoothing may influence sponsor decisions about whether to offer a defined benefit plan, which always entails some degree of financial risk. And the degree of smoothing for individual sources of volatility may also influence behaviors. For example, asset returns generally receive an added degree of smoothing through an input smoothing method, which may encourage sponsors to take more investment risk than if the additional smoothing were not available.

Finally, discussion of the rules for benefit restrictions may suggest a need for further analysis of thresholds in the funding rules. Thresholds change the rules once they are crossed, like when benefit restrictions begin (or cease) to apply after the funded ratio crosses 80 percent. The change in rules can cause volatility or disruption, such as significant changes in contribution requirements or sudden elimination of benefit options that were previously available to participants. To the extent this type of volatility is not desired, an analysis of thresholds in the funding rules may help identify solutions for avoiding it.

APPENDIX A: PROJECTED FUNDED STATUSES FOR ILLUSTRATIVE SCENARIOS

Exhibit 1 in the section titled “Effects on Plan Solvency” compares the funded status of the illustrative plans three years after they encounter severe economic shocks. The comparison varies over time, as the statutory alternatives do not recognize experience at exactly the same rate, and contribution requirements differ under each alternative.

Exhibits 2 through 5 show how the funded status under each statutory alternative compares across time. In each case, the funded status improves more rapidly under current law than it does under the input and output smoothing alternatives. While the input and output alternatives were calibrated to improve solvency at approximately the same rate in the short term, slight differences develop in later years, which are attributable to several factors, including differences in the rate of experience recognition built into each statutory alternative, differences between frozen and accruing plans, and differences in how assumed experience affects the frozen and accruing plans.

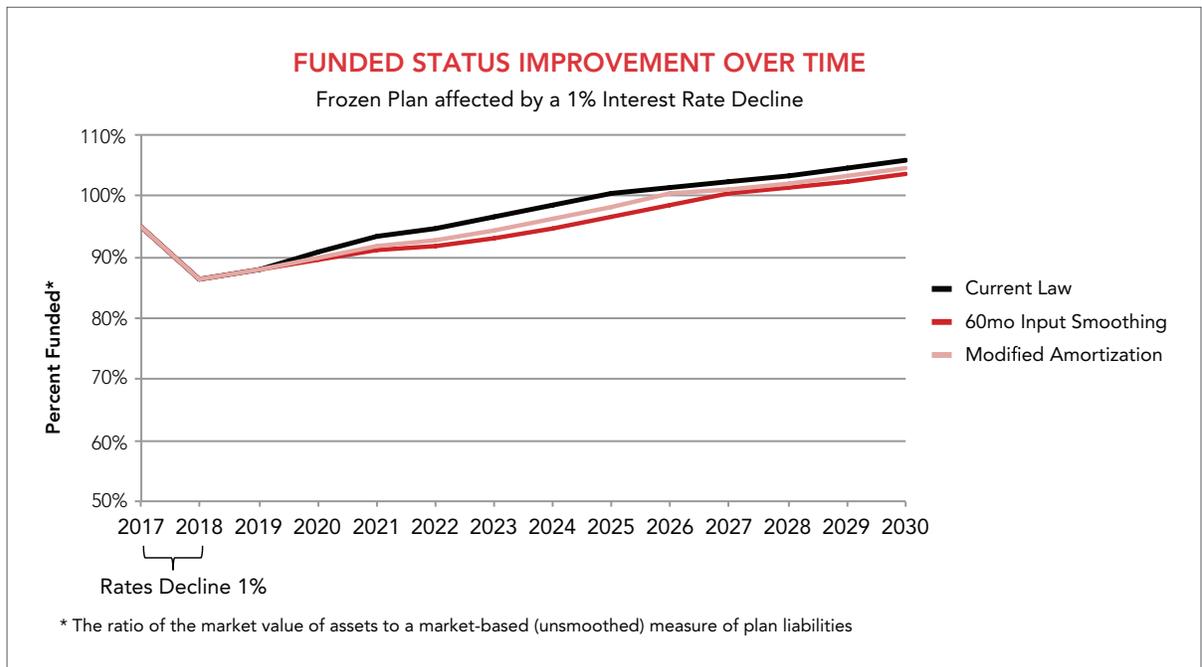


EXHIBIT 2

Appendix A

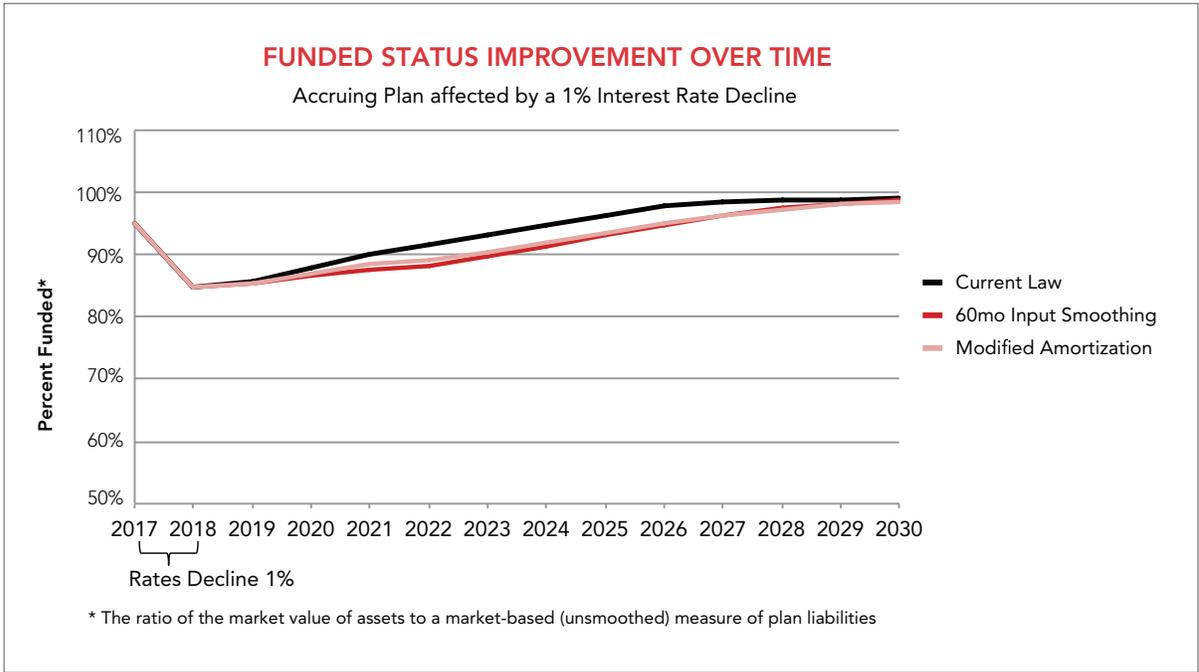


EXHIBIT 3

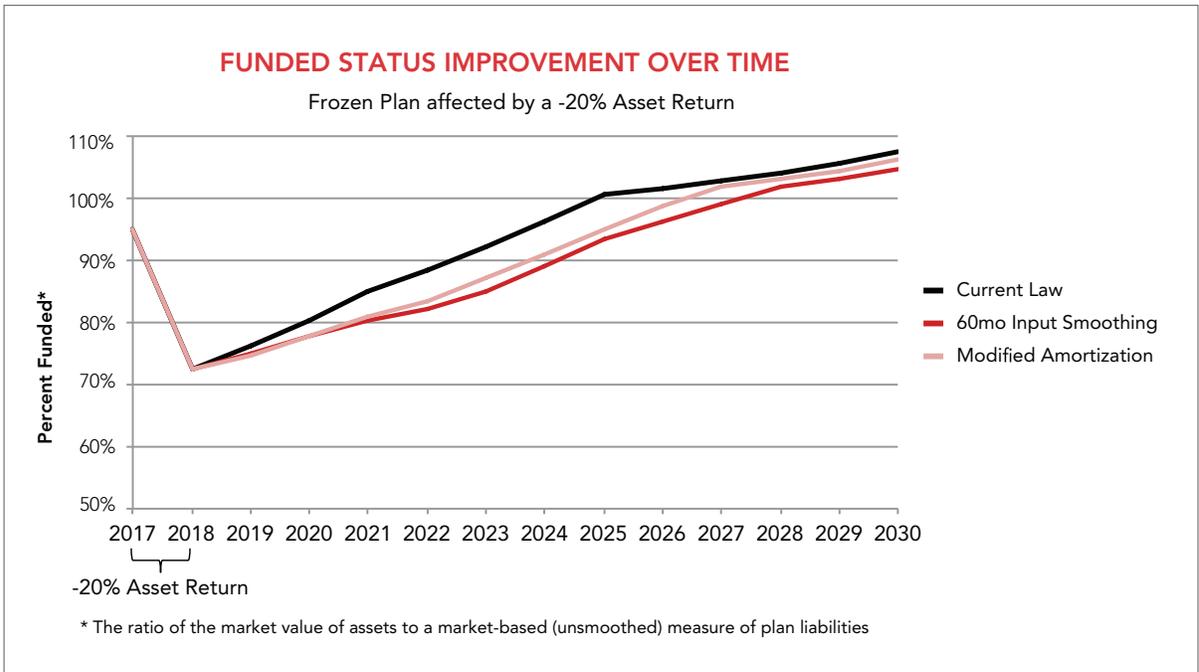


EXHIBIT 4

Appendix A

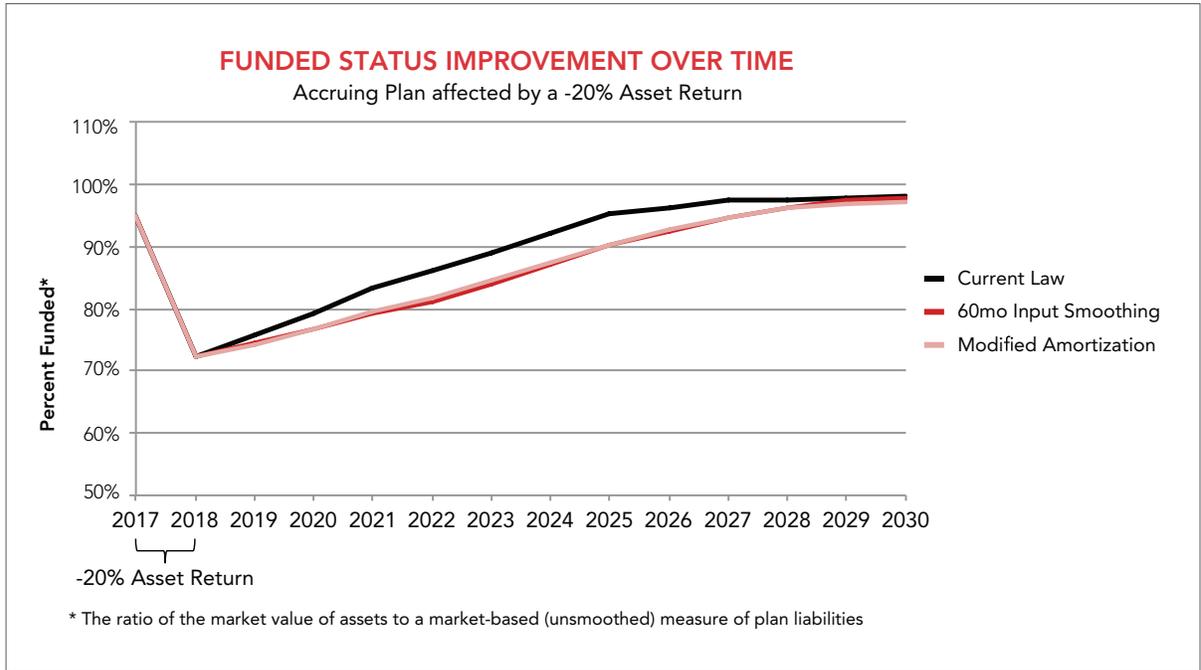


EXHIBIT 5

## APPENDIX B: METHODS AND ASSUMPTIONS

This report used several deterministic projections of plan experience for two hypothetical plans in the U.S. single-employer defined benefit system, with the intent of comparing smoothing methodologies. The projections were developed using the Pension Insurance Modeling System (PIMS), originally developed for the PBGC, and modified for purposes of this study.

With a few exceptions, the illustrations assumed plan experience matched valuation assumptions. Exceptions included:

	VALUATION	EXPERIENCE
<b>DEMOGRAPHIC</b>		
MORTALITY RATES (PRE- AND POST-RETIREMENT)	RP2000 projected 10 years beyond the valuation date, assuming 60/40 male/female population	RP2000 projected to the valuation date, assuming 60/40 male/female population
<b>ECONOMIC</b>		
WAGE INCREASES	Based on age and service. For the starting active population, a 4.81% pay-weighted average.	4.00%

Each scenario deviated from the baseline assumptions to generate the economic shocks illustrated in this report. The baseline effective interest rate (EIR) was 6 percent, and the baseline asset return equaled the third segment rate (without 24- or 60-month averaging) for the month preceding the valuation date. For scenarios illustrating the effects of a 100 basis point decline in interest rates, the EIR was assumed to decline linearly from 6 percent at January 1, 2017 to 5 percent at January 1, 2018, and remain a constant 5 percent thereafter. Inflation and experienced wage increases were assumed to decline by 100 basis points in parallel with interest rate declines. For scenarios illustrating the effects of a negative 20 percent return on plan assets, the assumed asset return for 2017 was negative 20 percent.

Both hypothetical plans provided identical final average pay accruals through 2015. The frozen plan was assumed to close to new entrants as of January 1, 2015 and cease accruals as of January 1, 2016, such that active participant benefits did not increase for pay or service. However, the employee populations for both hypothetical plan sponsors were assumed to develop consistently with each other, so that projected payroll remained identical after 2015.

Where the report referenced results under current law, funding requirements were modeled on the provisions in the Pension Protection Act of 2006 (PPA), as amended through the Moving Ahead for Progress in the 21st Century (MAP-21) legislation. Both hypothetical plans utilized the maximum permissible interest rate and asset smoothing periods.

Where the report referenced the "input smoothing alternative" or "60mo input smoothing," the maximum smoothing period for interest rates and asset values increased from 24 months to 60 months, and the 10 percent limit on the difference between the smoothed and market values of assets increased to 20 percent, effective with the 2018 valuation. Pre-2017 asset and interest rate experience continued to be recognized on the 24-month schedule, and post-2016 experience was recognized on the 60-month schedule.

Where the report referenced the "output smoothing alternative" or "modified amortization," the amortization period increased from seven to 10 years, and the schedule was graduated, effective with the 2018 valuation.

## OBSERVATIONS ON INPUT AND OUTPUT SMOOTHING METHODS

### Appendix B

The graduated amortization schedule funded interest on the outstanding balance plus a portion of the original principal each year. The portion of the original principal funded each year was:

<b>YEAR</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>PRINCIPAL FUNDED</b>	2.9%	5.9%	8.8%	11.8%	14.7%	14.7%	14.7%	11.8%	8.8%	5.9%

The percentages in this schedule were selected to approximate the rate of interest rate and asset return experience recognition in the input smoothing alternative. Funding shortfalls for valuations prior to 2018 continued to amortize on their original schedules.

Modifications to current law were chosen for illustration purposes only, and should in no way be construed as proposed changes to the law.

## SOCIETY OF ACTUARIES

475 N. Martingale Road, Suite 600  
Schaumburg, Illinois 60173  
[www.soa.org](http://www.soa.org)

### **Disclaimer**

This report is not intended to advocate a position for or against the use of smoothing methodologies, or for or against the use of any particular smoothing methodology. Rather, the purpose of this research is simply to provide objective, actuarial illustrations of the differences between alternative methodologies. While we hope that this report will help inform policymakers on some implications of the illustrated methodologies, we recognize there are many other issues they must also consider, which are not illustrated in this report. Consequently, the Society of Actuaries does not take any position on the merits of using the methodologies illustrated in this report.