State Budget Stress Testing User Guide

A collaborative endeavor of the Kem C. Gardner Policy Institute and the Utah Office of the Legislative Fiscal Analyst

June 2019

The Pew Charitable Trusts sponsored this research.

The Gardner Institute and the Legislative Fiscal Analyst would like to thank the following individuals from Pew for their support of this report: Kil Huh, Vice President; Mary Murphy, Project Director; Alexandria Zhang, Research Officer; and Robert Zahradnik, Principal Officer.

Table of Contents

1. Define the Period of Analysis 1
2. Determine Alternative Economic Scenarios 2
3. Identify Key Independent and Dependent Variables 3
4. Identify Revenue at Risk. 4
5. Identify Expenditures at Risk 7
6. Inventory and Categorize Existing Reserves and Other Contingencies 12
7. Compare Total Value at Risk to Total Contingencies 13
8. Conclusion 13
9. Endnotes 14

Figures

Figure 1. Public Education Enrollment 8
Figure 2. Public Education Enrollment, Year-over-year Percent Change 8
Figure 3. Higher Education Enrollment 8
Figure 4. Medicaid Enrollment 9
Figure 5. Retirement Expenditures 11
Figure 6. Total Value at Risk, 2015 and 2016 13
Figure 7. 2016 State of Utah Budget Stress Test Results 13

Tables

Table 1. Economic Drivers of Revenue at Risk Estimates. 4
Table 2. State Fund Revenue at Risk, 2016 6
Table 3. Expenditures at Risk, 2016. 11

State Budget Stress Testing User Guide

This user guide is a supplemental piece to the Gardner Institute's report "State Budget Stress Testing: How Utah Budget-makers are Shifting the Focus from a Balanced Budget to Fiscal Sustainability." It is intended to assist other states in preparing their own budget stress tests.

Chapter 1: Define the Period of Analysis

Purpose: Define and determine the optimal period of time to test such that potential budget and revenue risks are adequately reflected in the total value at risk and not masked by out-year revenue growth and cost moderation, or other factors.

Discussion: Business cycle downturns are typically not single-year events, they usually impact more than one budget year. While states could do single-year stress tests, a stress test spanning two to five years would better account for the full impact of a typical economic downturn. Determining the optimal period of analysis for budget stress tests will depend upon your state's answers to a number of questions.

1. *Does your state budget on an annual or biennial basis?* For annual budget states, a shorter period of analysis – two to three years – may provide sufficient information for policymakers to judge value at risk. Biennial states may require longer periods of analysis in order to plan for their longer baseline forecast periods.
2. *What data is available on alternative economic scenarios?* A state's stress testing period of analysis might be limited by data availability. Dodd-Frank Act Stress Test economic scenarios, available from the Federal Reserve, offer two to three-year forecasts that are generally sufficient for banks. Economic consulting services might offer alternative economic scenarios with longer timelines, or different periodicities.
3. *What amount of forecast error are you willing to accept?* As with any forecast, increasing the length of the budget stress test forecast period introduces greater uncertainty. However, limiting the length might result in an analysis that does not fully capture the lagged effects of a recession, including differences in the pace of revenue recovery and general growth in enrollment in large programs such as public education.
4. *How time sensitive are high-risk spending programs relative to changes in the economy?* Some of those programs, like Medicaid, might react to a change in economic activity with relatively short lead times. Others, like employer retirement contributions and public education, may not be reflected in budgets until three to five years after an economic event, requiring a longer period of analysis. Later we will discuss how a state might determine which spending programs to test.
5. *Would out-year growth above baseline mask near-term value at risk?* Certain alternative economic scenarios might show a short, mild slow-down followed by a healthy recovery. Testing this type of scenario over a longer period of analysis might result in low value at risk for the entire period. However, the risk occurs at the beginning of the period of analysis and a state would need mechanisms to address that immediate risk in the near-term until its economy recovers.

A three to five-year budget stress test allows states to see upcoming budget positions while keeping projections reasonably accurate. Your state's optimal period of analysis will depend on your own unique circumstances.

Examples of tools:

1. Dodd-Frank Act Stress Tests - Federal Reserve data spreadsheets
2. Moody's Analytics stress testing suite (state specific)
3. State data that includes historical revenue and expenditures
4. MATLAB (for a rolling window)

Examples of data sources (state specific)*:

1. State budget information as reported by the Utah Division of Finance
2. State expenditure forecast as developed and reported by the Utah Office of the Legislative Fiscal Analyst
3. State revenue information as reported by the Utah State Tax Commission
4. State revenue projections as projected by the Utah Revenue Estimating Committee

* Tools and data designations (for all chapters) produce results that are not necessarily mutually exclusive.

Chapter 2: Determine Alternative Economic Scenarios

Purpose: To determine which external shocks are most likely to have an impact on state budgets.

Discussion/Methodology: Three commonly used stress testing techniques are: 1) sensitivity analysis, 2) scenario analysis, and 3) reverse stress testing. Stress testing is used to assess the structure of the state economy to determine potential budget gaps under economic stress scenarios.

1. Sensitivity analysis: Assesses the effect of a large move in one risk factor.
2. Scenario analysis: Uses historical or hypothetical scenarios to determine risk factors.
3. Reverse stress testing: Identifies the point at which a financial institution's business model becomes unviable and then identifies scenarios and circumstances that might cause this to occur.

The severity of stress tests should reflect macroeconomic conditions in place at the time of the testing. The most common approach to stress testing is to formulate structural macroeconomic models that capture relationships across a wide array of variables. All scenarios should begin with a baseline (see Chapter 4 and 5 for establishing baselines for revenues and expenditures).

Scenarios should be designed to demonstrate the risks and vulnerabilities most threatening to state budgets. Since Utah's economy is diverse, they chose to look at a stagflation scenario as a potential "Achilles heel" in their state budget during the 2016 analysis.

Determining which external shocks to look at will depend upon your state's answers to a number of questions.

1. *What is the likelihood of a particular scenario occurring in your state?* A good starting place is looking at DFAST to see what is likely in your economic climate.
2. *Does your state have a high-risk industry that could significantly impact your state budget in an economic downturn?* If your economy is heavily dependent on one industry, e.g. oil or gas, an industry-specific shock will be beneficial to your state's budget stress test.
3. *Does Moody's Analytics, S&P, or others have scenarios that make sense to use?* Are there any scenarios that are already available that your team of analysts can build upon and refine?
    a. Moody's Analytics standard scenarios:
        i. Stronger near-term rebound
        ii. Slower near-term recovery
        iii. Moderate recession
        iv. Protracted slump
        v. Below-trend long-term growth
        vi. Stagflation
        vii. Next-cycle recession
        viii. Low oil price

In addition to answering these questions, talk to organizations such as the Council of Economic Advisors or universities in your state to find high probability events.

Examples of tools:

1. REMI (used to regionalize a national shock since Utah's economy is diverse)
2. Microsoft Suite
3. EViews

Examples of data sources (state specific):

1. Dodd-Frank Act Stress Tests - Federal Reserve data spreadsheets
2. Moody's Analytics stress testing suite (state specific)
3. Utah Economic Report to the Governor

Chapter 3: Identify Key Independent and Dependent Variables

Purpose: To gather independent and dependent variables and decipher which key independent variables may be useful in predicting the relevant dependent variables.

Methodology:

Step 1: Determine the largest revenue sources and expenditure categories to forecast

The initial step is to review the overall spending and revenue sides of the state budget, respectively. The revenue and spending sets are identified by Equations 1 and 2 below.

Equation 1:

Revenue = {Sales tax, income tax, corporate tax, others}

Equation 2:

Spending = {Public education, higher education, Medicaid, retirement,others}

Step 2: Gather all potential indicator variables

The second step is to gather all independent variables that may be useful in predicting revenue and spending, identified by Equation 3.

Equation 3:

Indicators = {Personal income, corporate profits, retail sales, oil prices, others}

Step 3: Evaluate the usefulness of independent variables

The third step is to evaluate the usefulness of all the independent variables in predicting changes in revenue and spending. Two of the methods employed to perform the analysis are Principal Component Analysis and variable specification battery tests.

The Principal Component Analysis estimates the sample variance explained by the kth principal component using Equation 4, where λ_k represents the kth principal component and $\lambda_1 + \lambda_2 + ... + \lambda_p$ represents the number variables up to the pth variable. The dimensionality reduction method helps establish the most useful variables in a complex dataset.

Equation 4:

$$PC = \frac{\lambda_k}{\lambda_1 + \lambda_2 + ... + \lambda_p}$$

Step 4: Arrive at a final list of dependent and independent variables

After performing the variable selection steps, the final step is to exclude irrelevant variables and subsequently arrive at a group of dependent and independent variables useful for time-series modeling.

Examples of tools:

1. REMI
2. Forecast Pro
3. SAS
4. EViews
5. Internet research/web scraping

Examples of techniques:

1. Regression models
2. Principal Component Analysis

Examples of data sources (state specific):

1. REMI
2. Moody's Analytics
3. Global Insight
4. Federal government sources
5. Financial market sources
6. Potential private sources

Chapter 4: Identify Revenue at Risk

Purpose: Identify revenue growth/shortfalls under baseline analysis and alternate scenarios. Develop models for forecasting those revenue over period of analysis under baseline and alternative scenarios. Compare revenue under alternative scenarios to revenue in baseline scenario. Evaluate potential risks in the revenue picture under the alternative scenarios.

Methodology:

Step 1: Determine which revenue sources to forecast

The state sources utilized in the Utah analysis were tied to unrestricted General and Education Fund categories. This included revenues streams from sales tax, corporate tax, income tax and a category for all other sources considered by GASB as unrestricted. Your state may want to include other revenue sources based on your state's budget structure.

Table 1. Economic Drivers of Revenue at Risk Estimates

Economic Drivers	Sales Tax	Personal Income Tax	Corporate Income Tax	All Other Revenue
2015 Analysis				
Utah Employment	■			■
Utah Personal Income	■	■		■
Utah Personal Consumption Expenditures	■			
Utah Population		■		■
Dow Jones Total Stock Market Index		■	■	
Oil Prices				■
2016 Analysis				
Utah Employment	■			■
Utah Personal Income	■	■		■
Utah Retail Sales	■			
Utah Population		■		■
Dow Jones Total Stock Market Index			■	
S&P 500 Price Earnings Ratio			■	
Oil Prices				■

Source: Utah Office of the Legislative Fiscal Analyst

Step 2: Estimate of baseline for each revenue source identified

For each category of revenue, develop a model for projecting baseline revenue over the period of analysis.

The general formula for estimating the baseline revenue is as follows in Equation 1:

Equation 1:

$$\begin{aligned} Rev^0_{i=TaxType,t+1} = \; & \tau + \beta_0 Rev^0_t + \beta_1 UR^0_t \\ & + \beta_k OtherFactors^0_t \\ & + \beta_l OtherFactors^0_{t-n} \\ & + \cdots + \varepsilon^0_{t-1} \end{aligned}$$

where UR^0_t represents the baseline Unemployment Rate in period *t*, τ represents a linear or non-linear trend, $OtherFactors^0_t$ represents other projected factors in period *t*, $OtherFactors^0_{t-n}$ represents other factors in period *t-n*, and ε_{t+1} represents the autoregressive term on the model residuals. The four tax specific formulas are given in Equations 2 through 5:

Equation 2:

$$\begin{aligned} CorporateRev^0_{t+1} = \; & \tau + \beta_0 CorporateRev^0_t + \beta_1 Equities^0_t \\ & + \beta_2 PERatio^0_t + \beta_k OtherFactors^0_t \\ & + \beta_k OtherFactors^0_{t-n} + \cdots + \varepsilon^0_{t-1} \end{aligned}$$

Equation 3:

$$\begin{aligned} IncomeRev^0_{t+1} = \; & \tau + \beta_0 IncomeRev^0_t \\ & + \beta_1 Equities^0_t + \beta_2 Population^0_t \\ & + \beta_3 (Population^0_t \cdot PersonalIncome^0_t) \\ & + \beta_k OtherFactors^0_t \\ & + \beta_k OtherFactors^0_{t-n} + \cdots + \varepsilon^0_{t-1} \end{aligned}$$

Equation 4:

$$\begin{aligned} SalesRev^0_{t+1} = \; & \tau + \beta_0 SalesRev^0_t + \beta_1 Employment^0_t \\ & + \beta_2 PersonalConsumptionExpenditures^0_t \\ & + \beta_3 (InteractionTerms) + \beta_k OtherFactors^0_t \\ & + \beta_k OtherFactors^0_{t-n} + \cdots + \varepsilon^0_{t-1} \end{aligned}$$

Equation 5:

$$\begin{aligned} AllOtherRev^0_{t+1} = \; & \tau + \beta_0 AllOtherRev^0_t + \beta_1 Employment^0_t \\ & + \beta_2 PersonalIncome^0_t + \beta_3 Population^0_t \\ & + \beta_4 OilPrices^0_t + \beta_5 (InteractionTerms) \\ & + \beta_k OtherFactors^0_t \\ & + \beta_k OtherFactors^0_{t-n} + \cdots + \varepsilon^0_{t-1} \end{aligned}$$

where *InteractionTerms* controls for the collinearity of certain independent variables.

Step 3: Forecast revenue under alternative scenarios for each revenue source identified

Replace baseline revenue with the revenue estimated under the alternative scenarios.

The revenue forecast for period *t+1* for $TaxType_i$

Equation 6:

$$Rev_{i=TaxType,t+1}^{Alt} = \beta_0 Rev_t^{Alt} + \beta_1 UR_t^{Alt} + \beta_k OtherFactors_t^{Alt} + \beta_l OtherFactors_{t-n}^{Alt} + \cdots + \varepsilon_{t-1}^{Alt}$$

where *Alt* represents the given scenario. The specific tax type formulas are given below.

Equation 7:

$$CorporateRev_{t+1}^{Alt} = \tau + \beta_0 CorporateRev_t^{Alt} + \beta_1 Equities_t^{Alt} + \beta_2 PERatio_t^{Alt} + \beta_k OtherFactors_t^{Alt} + \beta_k OtherFactors_{t-n}^{Alt} + \cdots + \varepsilon_{t-1}^{Alt}$$

Equation 8:

$$IncomeRev_{t+1}^{Alt} = \tau + \beta_0 IncomeRev_t^{Alt} + \beta_1 Equities_t^{Alt} + \beta_2 Population_t^{Alt} + \beta_3 \left(Population_t^{Alt} \cdot PersonalIncome_t^{Alt}\right) + \beta_k OtherFactors_t^{Alt} + \beta_k OtherFactors_{t-n}^{Alt} + \cdots + \varepsilon_{t-1}^{Alt}$$

Equation 9:

$$SalesRev_{t+1}^{Alt} = \tau + \beta_0 SalesRev_t^{Alt} + \beta_1 Employment_t^{Alt} + \beta_2 PersonalConsumptionExpenditures_t^{Alt} + \beta_3 (InteractionTerms) + \beta_k OtherFactors_t^{Alt} + \beta_k OtherFactors_{t-n}^{Alt} + \cdots + \varepsilon_{t-1}^{Alt}$$

Equation 10:

$$AllOtherRev_{t+1}^{Alt} = \tau + \beta_0 AllOtherRev_t^{Alt} + \beta_1 Employment_t^{Alt} + \beta_2 PersonalIncome_t^{Alt} + \beta_3 Population_t^{Alt} + \beta_4 OilPrices_t^{Alt} + \beta_5 (InteractionTerms) + \beta_k OtherFactors_t^{Alt} + \beta_k OtherFactors_{t-n}^{Alt} + \cdots + \varepsilon_{t-1}^{Alt}$$

Step 4: Subtract Baseline from Alternative

The difference between $Rev_{i=TaxType,t+1}^{Alt}$ and $Rev_{i=TaxType,t+1}^{0}$ captures the amount at risk in the given economic scenario, summarized in Equation 11:

Equation 11:

$$Rev_{t+1}^{Alt-0} = Rev_{i=TaxType,t+1}^{Alt} - Rev_{i=TaxType,t+1}^{0}$$

The three and five-year sums of the difference between the baseline and alternative economic scenarios is summarized in Equation 12:

Equation 12:

$$Rev_{TaxType_i}^{Period_j} = \sum_{j=1}^{j=J} Rev_{t+1,j}^{Alt-0}$$

Equations 13 through 16 capture the revenue difference by tax type, and Equations 17 through 20 capture the three and five-year difference.

Equation 13:

$$CorporateRev_{t+1}^{Alt-0} = CorporateRev_{i=TaxType,t+1}^{Alt} - CorporateRev_{i=TaxType,t+1}^{0}$$

Equation 14:

$$IncomeRev_{t+1}^{Alt-0} = IncomeRev_{i=TaxType,t+1}^{Alt} - IncomeRev_{i=TaxType,t+1}^{0}$$

Equation 15:

$$SalesRev_{t+1}^{Alt-0} = SalesRev_{i=TaxType,t+1}^{Alt} - SalesRev_{i=TaxType,t+1}^{0}$$

Equation 16:

$$AllOtherRev_{t+1}^{Alt-0} = AllOtherRev_{i=TaxType,t+1}^{Alt} - AllOtherRev_{i=TaxType,t+1}^{0}$$

Equation 17:

$$CorporateRev_{TaxType_i}^{Period_j} = \sum_{j=1}^{j=J} CorporateRev_{t+1,j}^{Alt-0}$$

Equation 18:

$$IncomeRev_{TaxType_i}^{Period_j} = \sum_{j=1}^{j=J} IncomeRev_{t+1,j}^{Alt-0}$$

Equation 19:

$$SalesRev_{TaxType_i}^{Period_j} = \sum_{j=1}^{j=J} SalesRev_{t+1,j}^{Alt-0}$$

Equation 20:

$$AllOtherRev_{TaxType_i}^{Period_j} = \sum_{j=1}^{j=J} AllOtherRev_{t+1,j}^{Alt-0}$$

The total revenue at-risk is the sum of the tax type differences, represented in Equation 21.

Equation 21:

$$TotalRev_{TaxType_i}^{Period_j} = \sum_{j=1}^{j=J} \left(\sum_{j=1}^{j=J} CorporateRev_{t+1,j}^{Alt-0}{}_j, \sum_{j=1}^{j=J} IncomeRev_{t+1,j}^{Alt-0}{}_j \; \sum_{j=1}^{j=J} SalesRev_{t+1,j}^{Alt-0}{}_j, \sum_{j=1}^{j=J} AllOtherRev_{t+1,j}^{Alt-0}{}_j \right)$$

The results of the analysis follow.

Table 2. State Fund Revenue at Risk, 2016

Difference between baseline and scenarios from FY 17 State Fund appropriations

Scenario	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Total
Adverse Scenario						
Sales Tax	$0.00	$161.88	$123.33	-$44.81	-$68.93	$171.47
Personal Income Tax	$104.04	$311.19	$191.52	$104.75	-$226.25	$485.25
Corporate Income Tax	$9.69	$28.99	$10.27	$42.03	-$37.20	$53.78
All Other Revenue	$14.99	$44.85	$40.52	-$38.82	-$6.24	$55.30
Total Adverse Scenario	**$128.72**	**$546.90**	**$365.65**	**$63.15**	**-$338.62**	**$765.80**
Severely Adverse Scenario						
Sales Tax	$81.94	$239.59	$195.14	$126.39	-$32.93	$610.13
Personal Income Tax	$157.52	$460.56	$328.53	$84.10	-$131.46	$899.24
Corporate Income Tax	$24.32	$42.90	$22.86	-$19.02	-$23.97	$47.09
All Other Revenue	$22.70	$66.37	$60.56	$56.99	$0.22	$206.84
Total Severely Adverse Scenario	**$286.48**	**$809.41**	**$607.09**	**$248.44**	**-$188.13**	**$1,763.30**
Stagflation Scenario						
Sales Tax	-$17.63	$97.13	$87.41	-$62.97	-$225.89	-$121.95
Personal Income Tax	-$33.89	$186.71	$60.36	-$174.31	-$538.70	-$499.83
Corporate Income Tax	-$3.16	$17.39	-$12.26	-$25.24	-$68.15	-$91.42
All Other Revenue	-$4.88	$26.91	$39.24	-$10.08	-$48.25	$2.93
Total Severely Adverse Scenario	**-$59.56**	**$328.13**	**$174.74**	**-$272.60**	**-$880.99**	**-$710.27**

Source: Kem C. Gardner Policy Institute analysis of Utah Office of the Legislative Fiscal Analyst data

Examples of tools:

1. Forecast Pro
2. SAS
3. Stata
4. R
5. Microsoft Suite

Examples of data sources (state specific):

1. REMI
2. Moody's Analytics
3. Budget of the State of Utah for revenue forecast
4. Utah State Tax Commission
5. Utah Division of Finance Data Warehouse

Chapter 5: Identify Expenditures at Risk

Purpose: Identify significant spending categories that are countercyclical to the economy or mandatory/essential in nature. Develop models for forecasting those costs over the period of analysis under baseline and alternative scenarios. Compare costs under alternative scenarios to costs in the baseline scenario. Test the ability to maintain the appropriated base budget and anticipated natural growth.

Methodology:

Step 1: Enumeration of Services

Determine for your government which program/benefit residents demand more of in an economic downturn and which, while they may not demand more of them, they cannot do without them and continue to grow. A good example of this is Medicaid or other key social service programs. Look at last two recessions and see which broad categories grew or remained constant relative to other categories of spending.

Step 2: Estimate of Baseline for Each Service

For each area, develop a model for projecting baseline cost over the period of analysis.

Area 1: Public Education[1]

Utah has a growing school-age population and the lowest median age in the nation. Funding the cost of public education enrollment growth, while not mandated by law, is almost impossible politically to ignore. So, while it does not necessarily change relative to the economy, regular cost increases must be accommodated in downturns.

Independent variables driving public education expenditures: five-year lag of Utah births, lag of enrollment, ratio for weighted pupil unit to head count, and the value of the weighted pupil unit (WPU).

The forecast for public education begins with the number of enrolled students as of October 1.

The first step in projecting public education costs under different potential economic situations is to project enrollment growth. Equation 1 captures the enrollment growth forecast:

Equation 1:

$$E_{t+1}^{0} = \beta_0 E_t^0 + \beta_1 B_{t-4}^0 + \cdots + \varepsilon_{t-1}^0$$

where E_{t+1} is the projected enrollment in period *t+1*, E_t is the enrollment count just prior to the enrollment forecast period, B_{t-4} represents the births in four periods prior to the forecast period, and ε_{t-1} represents the autoregressive term on the model residuals. The "…" captures other variables that may be useful in projecting enrollment growth. The baseline period is represented by the superscript *0*.

Equation 1 directly implies that enrollments are dependent upon births. In the second year of budget stress testing, forecasts for births under separate economic conditions were purchased from Moody's Analytics. In the initial year, births were derived from REMI's output section.

After establishing the baseline enrollment forecast, the alternative scenarios' forecasts were performed, represented in Equation 2 by the *alt* superscript.

Equation 2:

$$E_{t+1}^{alt} = \beta_0 E_t^{alt} + \beta_1 B_{t-4}^{alt} + \cdots + \varepsilon_{t-1}^{alt}$$

The difference between E_{t+1}^{alt} and E_{t+1}^{0} is $D_{E,t+1}^{alt-0}$. From this enrollment difference, we can calculate the enrollment growth cost difference, $DC_{E,t+1}^{alt-0}$.

The enrollment growth cost difference in period *t* is then given by Equation 3:

Equation 3:

$$DC_{E,t+1}^{alt-0} = D_{E,t+1}^{alt-0} \cdot r \cdot V_t$$

where V_t is the dollar value of each WPU in period *t* and *r* is the ratio of weighted pupil units to enrollment, defined formally in Equation 4:

Equation 4:

$$r = E\left(\frac{WPU_{t-n\ldots t}}{E_{t-n\ldots t}}\right)$$

where the expectation operator (E) represents the expected value of the ratio of WPUs to enrollment. Historical averages could also be used as a substitute for the projected ratio.

After arriving at the enrollment growth cost different, this difference is added to the baseline ongoing appropriations (*d*) for an absolute dollar comparison.

Equations 2 through 4 capture a specific year's expenditure pressures. The total spending pressure is the sum of the differences over the ongoing appropriated base, previously defined as *d*. Equation 5 presents this formally:

Equation 5:

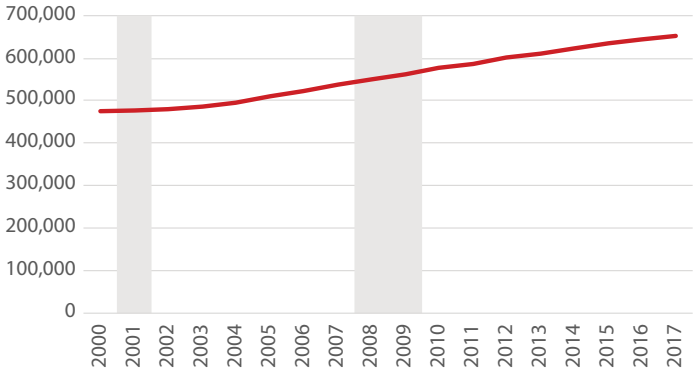
$$TC_{E_j} = \sum_{j=1}^{j=J} DC_{E,j}$$

where *j* through J may take on a three or five-year period. For appropriations purposes, total costs are therefore:

Equation 6:

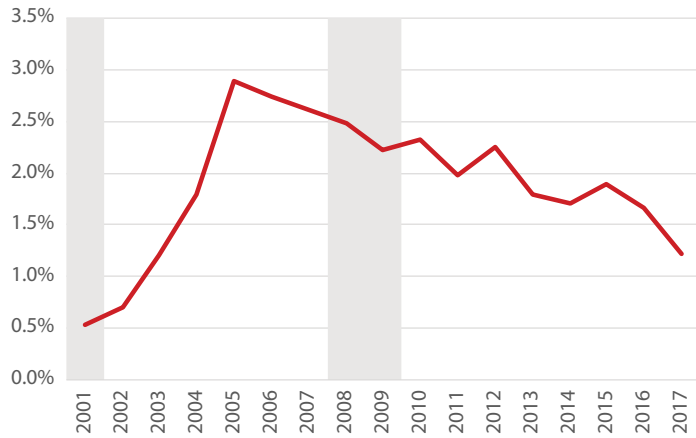
$$Total\ Costs_E = d + TC_{E_j}$$

Figure 1: Public Education Enrollment



Note: Gray bars indicate a recession.
Source: Utah Office of the Legislative Fiscal Analyst

Figure 2: Public Education Enrollment, Year-over-year Percent Change



Note: Gray bars indicate a recession.
Source: Utah Office of the Legislative Fiscal Analyst

Utah did not explicitly include factors for in/out migration. This effect was assumed to be captured in the historical model fitting with enrollment and autoregressive errors. Another state – like Wyoming – may wish to do so.

Area 2: Higher Education[2]

The forecast for spending on higher education is the product of assumed cost per student (as measured by FTE) and the number of students. Formally, the first step is to project the baseline number of students enrolled in higher education: presented in Equation 7:

Equation 7:

$$EnrHE_{t+1}^{0} = \beta_0 EnrHE_t^0 + \beta_1 UR_t^0 + \beta_k OtherFactors_t^0 + \cdots + \varepsilon_{t-1}^0$$

where $EnrHE_{t+1}^{0}$ is the projected baseline enrollment figure for period *t+1*. The forecasts for the alternative scenarios are given in Equation 8.

Equation 8:

$$EnrHE_{t+1}^{Alt} = \beta_0 EnrHE_t^{Alt} + \beta_1 UR_t^{Alt} + \beta_k OtherFactors_t^{Alt} + \cdots + \varepsilon_{t-1}^{Alt}$$

The difference between Equation 7 and Equation 9, multiplied by the constant cost per FTE is the assumed spending pressure under alternative economic scenarios.

Equation 9:

$$DiffHE_{t+1}^{Alt-0} = \left(EnrHE_{t+1}^{Alt} - EnrHE_{t+1}^{0}\right) \cdot \overline{Cost_{FTE_0}}$$

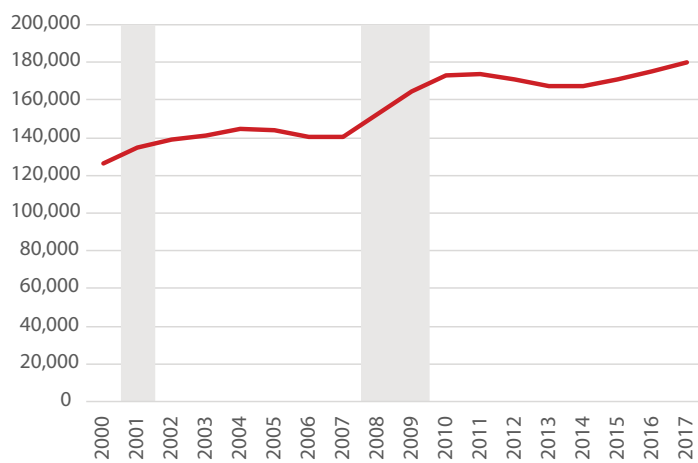
The explicit demarcation of $\overline{Cost_{FTE_0}}$ is meant to show that the model assumed a constant cost per FTE for each of the alternative economic scenarios. This assumption may not prove viable under further inspection because institutions of higher education see increased revenue from tuition in the event more students enroll. The increased tuition – without a tuition rate increase – may put less pressure on the state and less pressure on higher education institutions to raise tuition.

The difference is then summed over three or five years (*j=3* or *j=5*), as shown in Equation 10.

Equation 10:

$$DiffHE_{t+1}^{Alt-0} = \sum_{j=1}^{j=J} DiffHE_{t+1,j}^{Alt-0}$$

Figure 3. Higher Education Enrollment
Fall Third-week Headcount



Note: Gray bars indicate a recession. Includes the number of students at institutions in the Utah System of Higher Education (fall semester, third week). The year represents the calendar year of fall semester, e.g. Fall 2000 is from the 2000-2001 academic year.
Source: Utah System of Higher Education

Area 3: Medicaid

Medicaid demand, as measured by caseloads, depends upon eligibility and the state of the economy. One approach that was considered was to avoid the caseload demand and simply project total state expenditures under alternative economic conditions. Utah analysts chose to be more detailed in their modeling framework, opting to first project assumed enrollment and then to apply costs to alternative Medicaid caseload estimates.

The time-series start with Medicaid caseloads by eligibility group, represented in Equation 11:

Equation 11:

$$Cld^{0}_{Group_{i,}t+1} = \beta_0 Cld^{0}_{t} + \beta_1 UR^{0}_{t} + \beta_k OtherFactors^{0}_{t} + \cdots + \varepsilon^{0}_{t-1}$$

where $Cld^{0}_{Group_{i,}t+1}$ represents the baseline forecast for the *i*th caseload group for period *t+1*. The UR^{0}_{t} represents the assumed unemployment rate in the *t*th period and the $OtherFactors^{0}_{t}$ represents other factors employed to project caseloads by group. The ε^{0}_{t-1} is the autoregressive term.

Equation 12 captures the caseload group forecasts for alternative economic scenarios.

Equation 12:

$$Cld^{Alt}_{Group_{i,}t+1} = \beta_0 Cld^{Alt}_{t} + \beta_1 UR^{Alt}_{t} + \beta_k OtherFactors^{Alt}_{t} + \cdots + \varepsilon^{Alt}_{t-1}$$

The difference, $D_{Cld^{Alt-0}_{Group_{i,}t+1}}$ between the two caseload forecasts is the given by Equation 13.

Equation 13:

$$D_{Cld^{Alt-0}_{Group_{i,}t+1}} = Cld^{Alt}_{Group_{i,}t+1} - Cld^{0}_{Group_{i,}t+1}$$

This caseload difference is then summed and multiplied by per member per month (PMPM) costs, represented in Equation 14.

Equation 14:

$$DC^{alt-0}_{Group_{i,}t+1} = \sum_{i=1}^{i=N} D_{Cld^{Alt-0}_{Group_{i,}t+1}} \cdot PMPM_t$$

In one version, each group's base year PMPM costs were multiplied by the given group. A separate version, given in Equation 15, uses an overall PMPM figure by finding the result of the operation in Equation 15:

Equation 15:

$$PMPM_t = \frac{\sum_{i=1}^{i=N} Cld_{t,i}}{TC_t}$$

where $\sum_{i=1}^{i=N} Cld_{t,i}$ is the sum of caseloads across all *i*th groups and TC_t is total costs in period *t*.

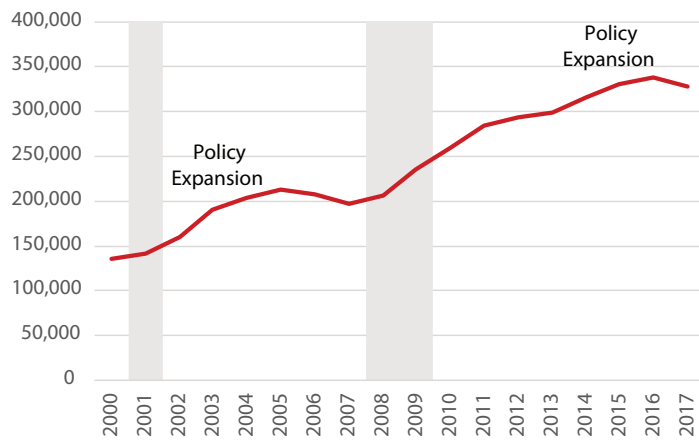
After deriving the cost differential for the *t*th periods, the spending pressure over a three or five-year period represents the sum of the individual years, presented by Equation 16 below.

Equation 16:

$$TC_{Cld_j} = \sum_{j=1}^{j=J} DC_{Cld,j}$$

Figure 4. Medicaid Enrollment

Persons



Note: Gray bars indicate a recession. Includes children and adults. Medicaid enrollment data represents the averave annual count of persons receiving benefits on the third working day of each month.
Source: Utah Office of the Legislative Fiscal Analyst

Area 4: Retirement Contributions

The retirement modeling was driven by the method employed by the Utah Retirement Systems actuarial consultants.

The amount at risk is the difference between the baseline contribution and the alternative scenarios contribution amounts, defined in Equation 17 below:

Equation 17:

$$Ret_{t+1}^{Alt-0} = Ret_{t+1}^{Alt} - Ret_{t+1}^{0}$$

Arriving at Ret_{t+1}^{Alt} and Ret_{t+1}^{0} involves the following steps. The first step is to project the baseline and alternative scenarios' wage picture.[3] The following captures the projection in formal form, where *E* represents the expectation of wages.

Equation 18:

$$Wages_{t+1}^{0} = E(Wages_{t+1}^{0})$$

The wages given in Equation 18 are then multiplied by either the baseline or alternative contribution rates (cr_0). Formally, the contribution costs are therefore:

Equation 19:

$$Contribution_{t+1}^{0} = E(Wages_{t+1}^{0}) \cdot cr_0$$

The contribution rate is not constant across the scenarios. Instead, it is projected based upon the assumed market returns and the wage bill, detailed in Equation 20:

Equation 20:

$$cr_{t+1}^{0} = \frac{1}{5}\sum_{t=1}^{5}\left(cr_t^0 f(Eq_t^0), \dots, cr_{t-4}^0 f(Eq_{t-4}^0)\right)$$

where $cr_t^{Alt} f(Eq_t^0)$ represents the contribution rate for period *t*, which is a function of the equity markets. The contribution rate is calculated as a five-year moving average.

Step 3: Forecast of Potential Cost Under Various Scenarios

After performing the baseline calculations in Equations 18 through 20, the next step was to perform the same calculations for the alternative scenarios, detailed in Equations 21 through 23.

Equation 21:

$$Wages_{t+1}^{Alt} = E\left(Wages_{t+1}^{Alt}\right)$$

Equation 22:

$$Contribution_{t+1}^{Alt} = E\left(Wages_{t+1}^{Alt}\right) \cdot cr_0$$

Equation 23:

$$cr_{t+1}^{Alt} = \frac{1}{5}\sum_{t=1}^{5}\left(cr_t^{Alt} f\left(Eq_t^{Alt}\right), \dots, cr_{t-4}^{Alt} f\left(Eq_{t-4}^{Alt}\right)\right)$$

Step 4: Subtract Baseline from Alternative

The final step was to find the difference between the given alternative scenarios and the baseline scenario and sum up the difference. This is shown formally by Equations 24 and 25:

Equation 24:

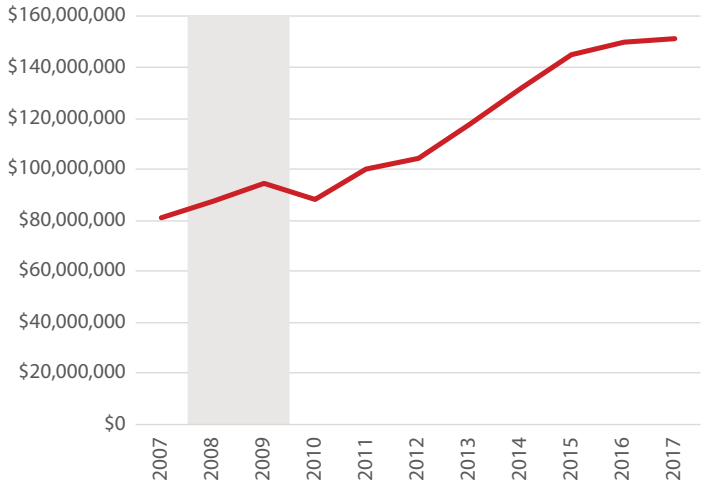
$$DC_{Retirement_{t+1}} = Ret_{t+1}^{Alt} - Ret_{t+1}^{0}$$

Equation 25:

$$TC_{Retirement_J} = \sum_{j=1}^{j=J} DC_{Retirement,j}$$

where $TC_{Retirement_J}$ captures the sum of the risk over J^{th} periods.

Figure 5: Retirement Expenditures



Note: Gray bar indicate a recession. Includes General Fund and Education Fund. Due to system changes at the State of Utah, unable to get data prior to 2007.
Source: Utah Office of the Legislative Fiscal Analyst

In future analysis, an improvement to the analysis may be developing a systematic way to determine whether benefits are business-cycle sensitive.

Examples of tools:

1. Microsoft Suite
2. SAS
3. Stata
4. R
5. Forecast Pro

Examples of data sources (state specific):

1. Utah Division of Finance expenditure data
2. Budget of the State of Utah for appropriated years
3. Utah Department of Health
4. Utah State Board of Education
5. Utah System of Higher Education
6. Utah Retirement Systems
7. Moody's Analytics
8. REMI

Table 3. Expenditures at Risk, 2016

Difference between baseline and scenarios from FY 17 State Fund appropriations

Scenario	2017	2018	2019	2020	2021	Total
Adverse Scenario						
Medicaid	$30.7	$45.4	$76.6	$112.4	$139.7	$404.8
Public Education	$0.8	$1.6	$108.1	$207.3	$301.5	$619.3
Higher Education	$31.2	$56.4	$111.7	$184.8	$234.2	$618.3
Retirement	-$0.4	$2.2	$19.2	$37.9	$58.5	$117.5
Total Adverse Scenario	**$62.3**	**$105.6**	**$315.6**	**$542.5**	**$733.9**	**$1,759.9**
Severely Adverse Scenario						
Medicaid	$38.1	$53.3	$92.2	$139.4	$166.5	$489.6
Public Education	$0.8	$1.6	$108.1	$207.3	$301.5	$619.3
Higher Education	$33.2	$62.3	$122.0	$215.5	$270.6	$703.6
Retirement	-$0.7	$5.1	$16.4	$32.1	$48.2	$101.0
Total Severely Adverse Scenario	**$71.3**	**$122.3**	**$338.7**	**$594.4**	**$786.8**	**$1,913.5**
Stagflation Scenario						
Medicaid	$24.1	$32.7	$60.9	$92.6	$118.2	$328.4
Public Education	$0.8	$1.6	$108.1	$207.3	$301.5	$619.3
Higher Education	$21.4	$18.6	$71.2	$139.6	$227.8	$478.6
Retirement	$0.0	-$0.5	$15.1	$28.0	$42.9	$85.5
Total Stagflation Scenario	**$46.3**	**$52.4**	**$255.3**	**$467.5**	**$690.4**	**$1,511.8**

Source: Kem C. Gardner Policy Institute analysis of Utah Office of the Legislative Fiscal Analyst data

Chapter 6: Inventory and Categorize Existing Reserves and Other Contingencies

Purpose: In order to assess the adequacy of budget buffers relative to value at risk, a state must identify those buffers, measure their size, and determine their availability.

Discussion: All states have existing contingencies for economic events, even if those contingencies are simply budget cuts and revenue increases. Most outside observers think immediately of formal "rainy day funds." However, as all budget analysts know, informal reserves exist elsewhere in the budget. National organizations that may have assessed your state's level of preparedness know only about the former. Only an informed analyst within a state can identify, enumerate, and measure all budget buffers. Answering the following questions might help in doing so.

1. *What are your state's formal reserves?* This is the easy one. Most states, at the prompting of bond buyers and rating agencies, have established formal budget reserves. Some states, like Vermont and Utah, have several formal reserves for various purposes. Documenting the size of those formal reserves and conditions under which they can be used is a great first step in inventorying buffers.

2. *How did your state survive the last economic downturn?* Another easy way to identify buffers is to look at what your state did in response to past downturns. Researching the mechanisms your state used to close revenue shortfalls in the dot-com bubble and housing busts, for example, might reveal informal, disaggregated buffers that have been rebuilt in the current expansion.

3. *What informal, disaggregated buffers exist in your state's budget?* Most states have consequences for managers that overspend their budget. As a result, government managers build their own, informal, and often disaggregated budget buffers, sometimes from lower than expected program costs, from timing lags, or from employee turnover. Measuring, reporting, and summing year-end program balances might reveal a significant state-wide budget contingency. Similarly, in most state's fees, fines, and other non-general tax revenue accrues to restricted accounts within the General Fund, or to stand-alone special revenue funds. Higher than anticipated revenue collections, or lower than anticipated costs, might lead to accrued balances within those restricted funds – another potential buffer.

4. *What formal spending relief valves exist in statute?* Some states have statutory requirements for spending, and on occasion those requirements have built-in relief valves for economic downturn. Utah, for example, requires that 1.1 percent of the value of all state buildings be placed in a fund to address deferred building maintenance. That requirement falls to 0.9 percent in an economic downturn. If your state has similar mechanisms, those budget decreases could offset increased budget demands in a downturn and should be included in your list of buffers.

5. *To what extent does your state fund cash infrastructure and does your state have debt capacity to swap cash for debt in a downturn?* By funding buildings and roads on a pay-as-you-go basis and paying-down debt in expansionary periods, states can create a "working rainy day fund" of sorts. In downturns, a state might use the cash to address operating budget shortfalls and go to the bond market for infrastructure funding, perhaps at favorable terms depending upon timing.

6. *What is your state's willingness to raise taxes or cut existing budgets?* Looking at past recessions or regional economic downturns, determine the extent to which your state raised revenue or reduced spending. Applying those ratios to current revenue collections and current spending could give you an idea of how much of a downturn could be addressed with similar actions in the future.

7. *Can policymakers access trust and agency fund principle balances?* Many states have endowments for things like education or health care. In some cases, state constitutions and statutes create conditions – like vote thresholds – upon which policymakers can access not just the earnings on those endowments, but the principle balance. This is likely the last action a state would want to take in a downturn, but the existence of conditions upon which they can be accessed suggests that doing so is an option.

Once you have asked and answered these questions, make a list of your state's formal and informal budget reserves. Next, categorize them by ease of access – very easy, easy, moderate, difficult, and very difficult. Ease of access might be measured in terms of defined statutory conditions, or by political willingness, or both. Knowing the dollar size of these categories will help you determine the adequacy of reserves when you compare them to value at risk in the next chapter.

Examples of tools:

1. Microsoft Suite

Examples of data sources (state specific):

1. Budget of the State of Utah
2. Utah Division of Finance Data Warehouse
3. State statutes for formalized reserves (e.g. rainy day funds, capital improvements, etc.)

Chapter 7: Compare Total Value at Risk to Total Contingencies

Purpose: By comparing the total value at risk to total contingencies, the state can measure its preparedness for an economic downturn.

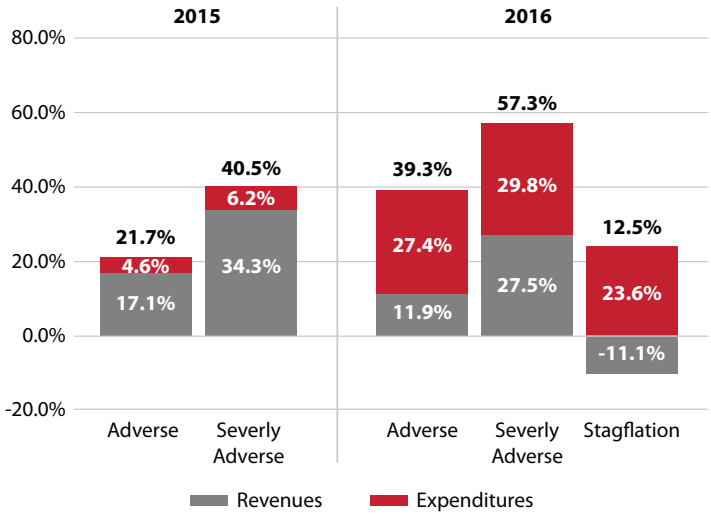
Discussion/Methodology: Building on the work and analysis that has been completed in Chapters 4 through 6, compare each year's total value at risk against total contingencies for all scenarios and by ease of accessibility to complete the stress test.

By doing an annual comparison, analysts and policymakers are able to see how long the state can withstand an economic downturn. Figure 6 shows the budget gap from Utah's analysis.

In addition to looking at the total value at risk against total contingencies, a key factor to consider is your governing body's willingness to exercise different types of contingencies. Does your state have established thresholds of pain, e.g. delaying or eliminating projects/programs versus raising a tax or fee versus dipping into a formal rainy day fund? Depending on the severity and volatility of the situation, the appetite of your governing body to use one type of contingency may change—you and your policymakers will have to decide your propensity to exercise certain contingencies.

Figure 6. Total Value at Risk, 2015 and 2016

3-year cumulative total as a percent of FY 16 State Fund appropriations, 2015; and 5-year cumulative total as a percent of FY 2017 State Fund appropriations, 2016



Source: Kem C. Gardner Policy Institute analysis of Utah Office of the Legislative Fiscal Analyst data

Examples of tools:

1. Microsoft Suite

Data sources:

1. Results of Chapter 4 (revenue at risk)
2. Results of Chapter 5 (expenditures at risk)
3. Results of Chapter 6 (contingencies)

Chapter 8: Conclusion

State budget stress tests help policymakers to plan for and create appropriate, measured responses to economic volatility. Utah is the first state to implement comprehensive budget stress testing, evaluating the sufficiency of reserves and other budget contingencies to cover recession-spurred revenue shortfalls and countercyclical cost hikes.

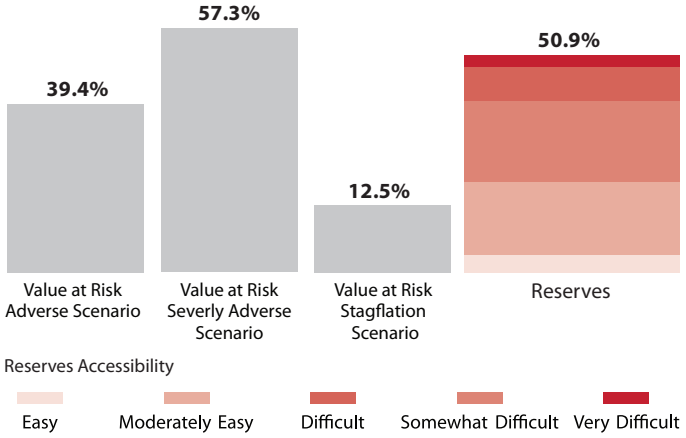
The analysis suggests that Utah is prepared for a moderate recession or extended period of stagflation; coping with a more severe recession, like the Great Recession, would be more difficult.

It is an ideal time for states to prepare for the next downturn while excess revenues exist. States that take the opportunity to shore up revenues, and identify options for addressing budget gaps now, will be more resilient in the next recession and will have greater long-term fiscal health and sustainability.

Figure 7: 2016 State of Utah Budget Stress Test Results

Value at risk under 3 economic scenarios and available reserves by ease of accessibility

Percent of State Fund appropriations



Source: Kem C. Gardner Policy Institute analysis of Utah Office of the Legislative Fiscal Analyst data

Endnotes

1 In the state of Utah, the weighted pupil unit (WPU) acts as the common factor used to determine the cost of basic education programs on a uniform basis and to distribute state revenues to local education agencies. The WPU represents one pupil in average daily membership (ADM). Each year, the Utah State Legislature establishes the dollar value for each WPU for the upcoming fiscal year. Funding levels for each of the Basic School Programs is determined by the number of WPUs allocated to the program multiplied by the value of the WPU. Utah statute has a funding mechanism, "prior-year plus growth" that determines money distributed to local education agencies. It is based on current enrollment in the prior year plus any growth in enrollment. This helps to create predictable funding stream.

2 Higher education funding in Utah comes from legislative appropriations (state General and Education funds), dedicated credits (tuition and fees), and other General Fund restricted accounts. Currently, the state supports about half of public higher education through state fund appropriations and tuition covering the remainder. The Utah System of Higher Education (USHE) is comprised of eight public colleges and universities and is governed by the Board of Regents. The Board sets tuition, fees, and charges for Utah System of Higher Education (USHE) institutions at levels necessary to meet budget requirements. In addition to USHE, the state is also home to the Utah System of Technical Colleges, eight individual colleges that provide career and technical education.

3 The wage picture being forecasted in wages paid to state workers that earn retirement benefits.