CyCost 1.2 Excel Model Overview

December 2016

Basic Concepts and Definitions

When there is revenue volatility, US state and local annual budgets hit fiscal constraints like balanced budget requirements, debt limits, etc. during the down-cycle ("**Constrained**" period) that will persist for a few years. Once revenues recover (either by growth or tax rises) these constraints are no longer binding ("**Unconstrained**" period). For a 30-year infrastructure analysis, there will likely be several cycles.

During the Constrained period, there will be pressure to cut spending generally. Some spending is elastic (e.g. life-style services) and can be cut. Other spending is completely inelastic (e.g. debt service and essential public-sector operations) and must be done on schedule. In between, there is a category of spending that is somewhat elastic with respect to timing but must eventually be made -- deferred maintenance, delayed capex for obsolete assets, funding for off-balance sheet obligations like pensions and OPEB. This category is the focus of the model and is defined as "**Delayed Essential Spending**".

Delayed Essential Spending accrues to some extent during the Constrained cycle and may (or may not) be remediated during the Unconstrained cycle. It can be costless (e.g. a few years delay on painting the Town Hall doesn't cost anything), somewhat costly (e.g. deferring maintenance on the Town Hall HVAC could require expensive repairs), really costly (e.g. delaying pension funding when the pension's assumed rate of return is 7.5%) or extremely costly (e.g. delayed spending at Flint Michigan caused a health crisis).

You can think of Delayed Essential Spending like a specialized form of off-budget public-sector cyclical borrowing, defined as "**Cyclical Accrual"**. Borrowing is drawn during Constrained cycle and may (or may not) be repaid during the Unconstrained cycle. The cost -- the difference between the principal amount that is drawn and the amount that must be repaid in future -- is like an interest rate. This concept is the core of the "**Cyclical Accrual Cost**" analysis.

To evaluate the cost of financing an infrastructure project (either traditional PSC "**Standard**" or P3-like "**Alternative**") in this context, essential spending at the project level that must be funded by revenues (either tax or user fees) is divided into two categories: Project spending that can be delayed during the Constrained cycle (like some maintenance, capex upgrades, etc. collectively called "**Deferred Maintenance**") or spending that must be made regardless of cycle (debt service, operations). The former is accrued at the project level, and the latter may cause accrual by forcing Delayed Essential Spending at the fiscal level (i.e. spending displaced by project costs: "**Displaced Spending**"). The model demonstrates a way to measure and compare the Cyclical Accrual Cost of Deferred Maintenance and Displaced Spending for Standard and Alternative 30-year infrastructure financings.

Menus

The model works with seven groups of drop-down menus for input. Each drop-down includes a slider for user-specified value option.

1. Budget Cycle

The assumed cyclical context for the evaluation is input first. Note there has to be at least one Constrained cycle for there to be any Cyclical Cost.

This menu also includes an experimental user input interface under the H/S Input button. This goes to a separate dash where user can put budget cycle assumptions in stochastic context of local historical data. In the real world, economic and financial data is always too limited to rely on estimates of risk probabilities to optimize projections. Heuristic input is also necessary to develop a "coping strategy" for expensive fiscal constraints. This interface seeks to combine the two.

2. Standard Case

The Standard financing is defined next as a very simple project finance model for a low-risk $100m infrastructure asset – Operations, Maintenance and Debt Service.

3. Alternative Case

The Alternative is defined the same way as Standard – note that O&M is defined in terms of the Standard assumptions to specifically reflect potential P3 cost-efficiency. Alternative debt choices reflect a range from minimum lease-type 63-20 financing (no risk transfer) to more like demand charge P3 (some risk transfer) with a higher WACC. For both Standard and Alternative, all debt and any outstanding accruals are assumed to be paid off by year 30 – i.e. P3 investors hit their targets. This may not be realistic when risk transfer is permanently realized (e.g. a failed toll road) or accruals are un-remediated (e.g. pensions always underfunded) but it should work for low-risk projects where there is no risk transfer and the public-sector is really trying to do the right thing.

4. Deferred Maintenance

Deferred Maintenance is cyclical accrual and repayment ("Remediation") at the project level. It is permitted up to the full annual maintenance amount for the Standard financing, but *not permitted* for the Alternative case which is assumed to enforce life-cycle costing on schedule.

5. Displaced Spending

Displaced Spending is cyclical accrual and Remediation at the fiscal level. The maximum amount of Displaced Spending is annual spending required by the project -- O&M and debt service, less Deferred Maintenance (if any) in the Standard case. Choices reflect typical fiscal

choices – repay debt, fund OPEB and pensions, economic loss caused by delay and social cost caused by delay.

6. Counter-Cyclical Borrowing Facility

The CCBF menu reflects the capability (or lack thereof) of the Alternative financing to absorb project costs during the Constrained cycle and enforce remediation during the Unconstrained cycle. To highlight the financing (vs. risk transfer) aspect of this, defined as "Counter-Cyclical Borrowing Facility" or CCBF. When there is some CCBF capability (defined by a maximum drawdown amount), the Alternative can avoid causing Displaced Spending at the fiscal level. When the rate assumed by the CCBF is lower than the assumed cost of the Displaced Spending (e.g. 3.5% CCBF rate vs. 7.5% pension funding rate) then there is some cost savings. Most importantly, the CCBF also forces full remediation during the Unconstrained cycle – minimum repayment period is one year but maximum is Unconstrained cycle length.

7. Value for Money

This menu allows term and discount rate inputs for VfM analysis.

Output

The accrued balances of the Standard and Alternative cases are displayed graphically over the 30-year period in the right half of the dashboard – this is the main graphic output. In addition to balances, the weighted average cost of financing ("WACF") for each year and the full-term "Realized Financing Rate" ("Realized Rate") are also shown. The Realized Rate is an approximation of full-term financing rate for project capitalization when both term debt and Cyclical Accrual Cost are included. In effect, it is likely close to the realistic public-sector "Cost of Capital".

The Standard and Alternative cases are also compared on a PV basis in the Value for Money bar chart in the dashboard middle. In this pure cost-comparison context, VfM actually works well – there are no discount rate games possible and no permanent risk transfer assumed. Nevertheless, the overall model fundamentally reflects a "Value for Funding" approach because it includes fiscal context about cycles and the fiscal impact of Displaced Spending.

In many realistic cases, the VfM analysis will show that the Alternative is a "second-best solution" because *without including* real-world Cyclical Cost the Standard Case has lowest PV cost (i.e. "first-best"). When Cyclical Cost *is included* the Standard Case has highest PV cost (in effect, "third-best"). The Alternative Case PV cost is in the middle when Cyclical Cost is included – hence second-best.

In addition, there is a separate dashboard for Displaced Spending "what-if' scenarios under the DSS button.

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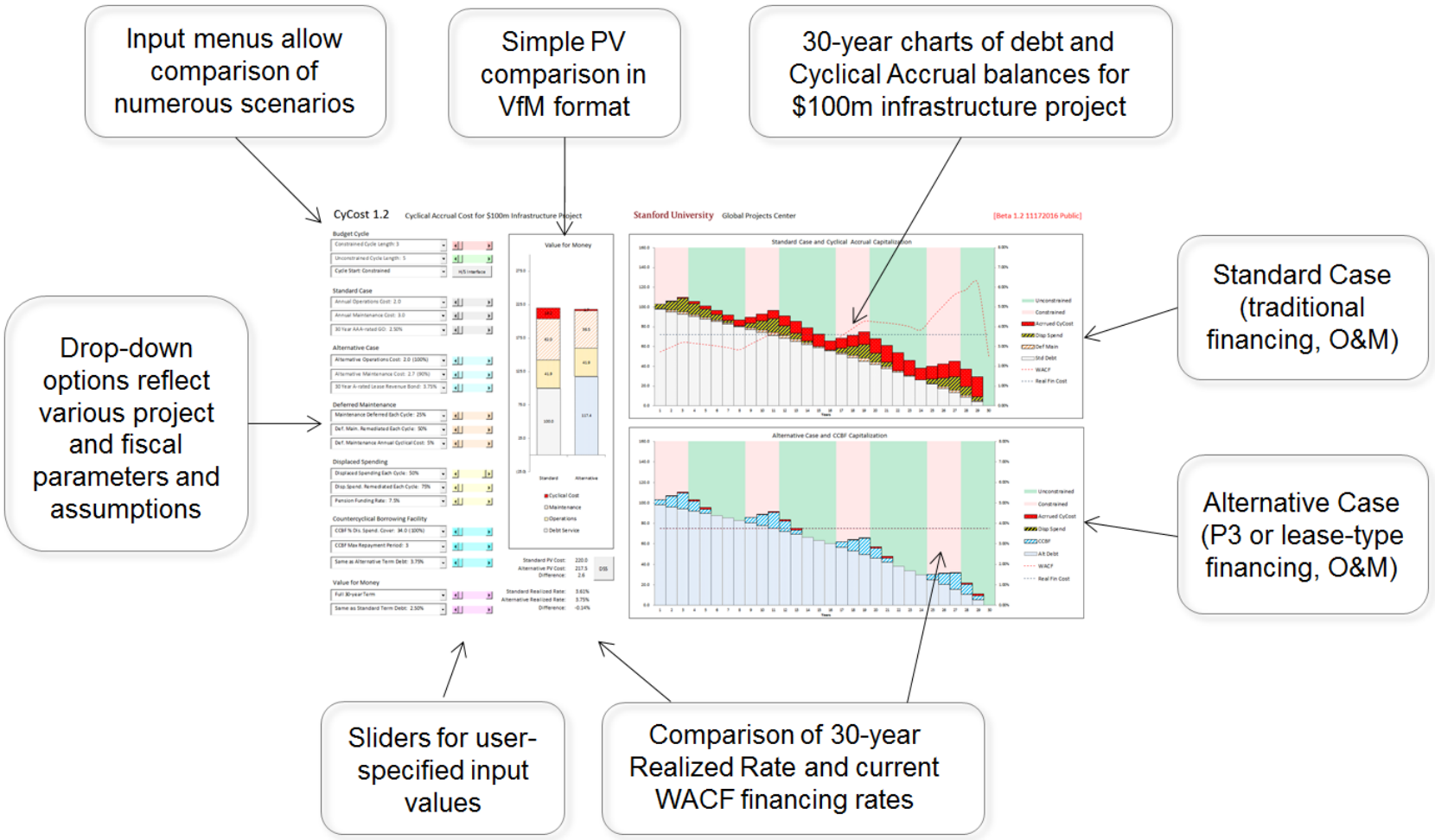
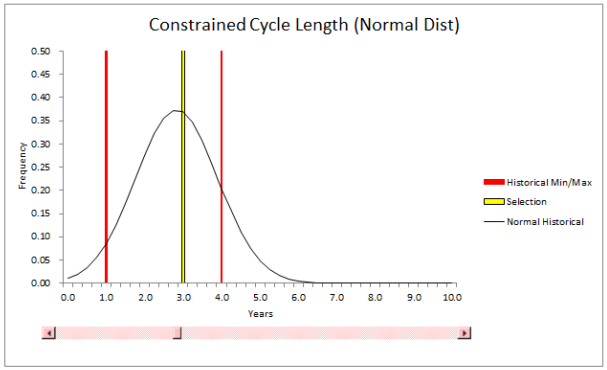
CyCost 1.2 Main Dashboard



Heuristic/Stochastic Input User Interface

Budget Cycle Heuristic/Stochastic Interface [Demonstration Input Interface]



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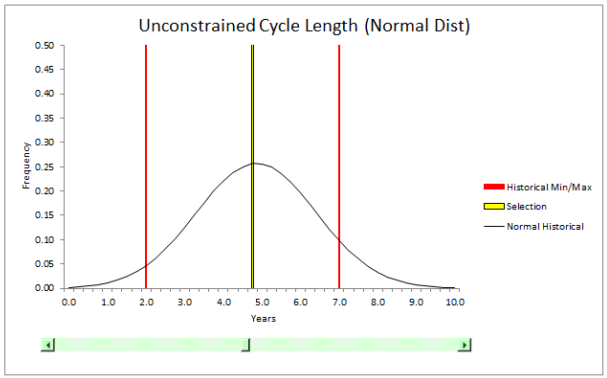

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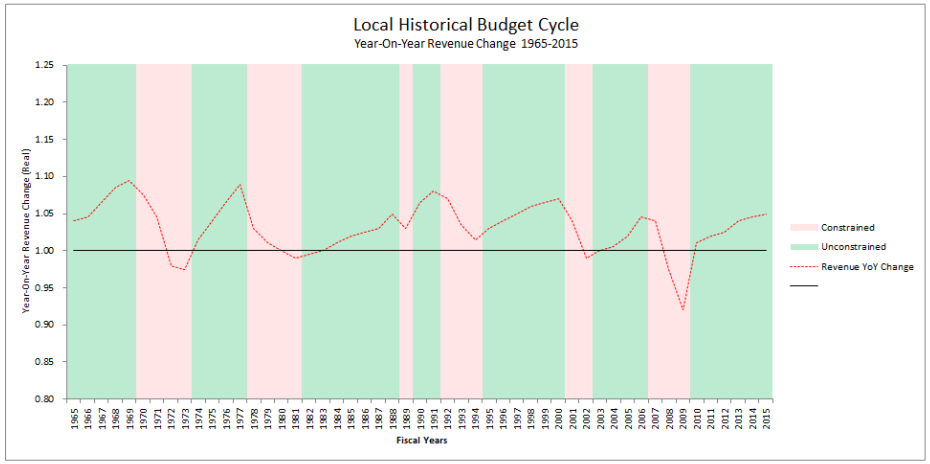


Data Summary

Return to Dash

	Mean	Stan Dev	Max	Min
Revenue Change YoY	1.032	0.034	1.095	0.920
Constrained Cycle Length	2.8	1.1	4.0	1.0
Unconstrained Cycle Length	4.9	1.6	7.0	2.0
Data Sources:		*[CAFRs 1965-2015; other]*		

Cycle Start Information	
Current Phase:	Uncon
Age of Current Phase	6.0
Chance of Phase Change [2016]:	[90%]

Displaced Spending Scenario Output Dashboard

Displaced Spending Scenarios [Demonstration Output Interface]

Input Summary

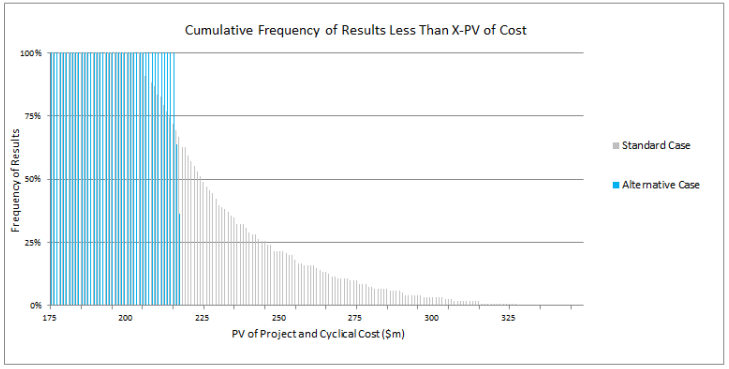
	Tables	Live Dash
Budget Constrained	3	3
Budget Unconstrained	5	5
Cycle Start	1	1
Standard Operations	2.0	2.0
Standard Maintenance	3.0	3.0
Standard Debt Rate	2.50%	2.50%
Alternative Operations	2.0	2.0
Alternative Maintenance	2.7	2.7
Alternative Debt Rate	3.75%	3.75%
Deferred Main. Accrual	25%	25%
Deferred Main. Remediation	50%	50%
Deferred Main. Accrual Rate	5%	5%
CCBF Amount	34.0	34.0
CCBF Repayment	3	3
CCBF Rate	3.75%	3.75%
VfM Term	30	30
VfM Discount Rate	2.50%	2.50%

DSS Output Summary

	Standard	Alternative	*Delta*
Best Case (Lowest PV Cost)	206.3	216.0	(9.7)
Worst Case (Highest PV Cost)	328.7	218.9	109.8
Delta	(122.4)	(2.9)	
% Share of Lower PV Cost Results	31%	69%	
Average	234.0	217.5	16.6
Median	225.3	217.5	7.9
Stan Dev	26.5	0.9	25.6
DS% User Spec Option Check	6		
DSRem% User Spec Option Check	6		
Same as Live Dash Input?	Yes		

Recalculate Tables

Return to Dash



Results Tables

Minimum PV Results of Both Cases

	Displaced Spending %										
Remediation%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	206.3	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
10%	206.3	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
20%	206.3	214.7	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
30%	206.3	213.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
40%	206.3	212.0	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
50%	206.3	211.0	215.7	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
60%	206.3	210.1	213.9	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
70%	206.3	209.3	212.4	215.5	217.2	217.5	217.8	218.0	218.3	218.6	218.9
80%	206.3	208.7	211.2	213.7	216.1	217.5	217.8	218.0	218.3	218.6	218.9
90%	206.3	208.2	210.2	212.2	214.2	216.1	217.8	218.0	218.3	218.6	218.9
100%	206.3	207.9	209.4	211.0	212.6	214.1	215.7	217.3	218.3	218.6	218.9

Standard Case PV Results

	Displaced Spending %										
Remediation%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	206.3	218.5	230.8	243.0	255.3	267.5	279.7	292.0	304.2	316.5	328.7
10%	206.3	216.4	226.4	236.5	246.6	256.7	266.8	276.9	286.9	297.0	307.1
20%	206.3	214.7	223.0	231.4	239.8	248.2	256.5	264.9	273.3	281.7	290.1
30%	206.3	213.3	220.3	227.4	234.4	241.4	248.5	255.5	262.5	269.5	276.6
40%	206.3	212.0	217.8	223.6	229.4	235.1	240.9	246.7	252.4	258.2	264.0
50%	206.3	211.0	215.7	220.4	225.1	229.8	234.5	239.2	243.9	248.6	253.3
60%	206.3	210.1	213.9	217.7	221.5	225.3	229.1	232.9	236.8	240.6	244.4
70%	206.3	209.3	212.4	215.5	218.6	221.6	224.7	227.8	230.8	233.9	237.0
80%	206.3	208.7	211.2	213.7	216.1	218.6	221.1	223.5	226.0	228.5	230.9
90%	206.3	208.2	210.2	212.2	214.2	216.1	218.1	220.1	222.1	224.0	226.0
100%	206.3	207.9	209.4	211.0	212.6	214.1	215.7	217.3	218.9	220.4	222.0

Alternative Case PV Results

	Displaced Spending %										
Remediation%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
10%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
20%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
30%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
40%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
50%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
60%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
70%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
80%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
90%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9
100%	216.0	216.3	216.6	216.9	217.2	217.5	217.8	218.0	218.3	218.6	218.9