Ensuring a sound fiscal future

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Prepared for House Finance – HB 245
April 5, 2016

The Alaska Department of Revenue has sought an objective assessment of the financial model it built to evaluate an annual draw from the Earnings Reserve of the Permanent Fund, as outlined in the Alaska Permanent Fund Protection Act. The fact-based assessment of the financial model included in this document was conducted by McKinsey & Company, Inc. with support from expert Martin Baily.

Context for this effort

The APFPA proposal would re-route oil revenues to the APFC to help stabilize State spending

- The Alaska Permanent Fund Protection Act (APFPA) calls for directing a steady annual amount to the General Fund to mitigate the impact of oil price volatility on year-to-year budgeting. Specifically, the proposal recommends that:
  - 50% of oil royalty revenues and 100% of production tax revenues flow to the Alaska Permanent Fund Corporation (APFC) for investment
  - A fixed annual draw of $3.3B (adjusted for inflation beginning in 2020) from the APFC to the General Fund to fund State expenditures; the amount would be methodically revisited every 4 years to ensure continued Fund sustainability
  - Dividend payments be paid out of the remaining 50% of oil royalties

The APFPA seeks to improve budget stability

- Given a rising budget deficit and declining oil production revenues, the APFPA seeks to:
  - Protect and grow the State's sovereign wealth to maximize long-term returns, acknowledging the rising importance of investment income in funding its budget
  - Delink public spending from volatile commodity prices and stabilize the budget by establishing a disciplined, formulaic approach to drawing from the State's wealth

State modeling proposes that a $3.3B draw should be sustainable

- The Department of Revenue (DOR) has undertaken an extensive exercise to assess in a financial model what amount of annual draw will be sustainable (i.e., what draw amount can the State expect with greater than 50% confidence to maintain the starting asset's real value over time without depleting the Earnings Reserve)
- Given the Earnings Reserve's current size and the $3B proposed transfer from the Constitutional Budget Reserve, the State can plan with 100% confidence to draw $3.3B annually for at least 4 years (at which point the draw amount will be reviewed)
- The cumulative confidence level of being able to draw $3.3B annually falls to 95% over 10 years and to 69% through 2040. Revisiting the draw on a 4-year cadence will lend additional confidence (e.g., this safeguard has not been factored in to modeling)

The State sought an independent review of this model's rigor

- The State sought an independent evaluation of (i) the soundness of the model's methodology and (ii) critical assumptions underlying the model (most notably those related to expected oil revenues and investment returns)

Overview of conclusions

The DOR model is sound in its methodology

- The model tests whether a $3.3B annual draw will be sustainable
- The DOR used probabilistic analysis, including Monte Carlo simulations, to estimate confidence levels for (i) future oil prices and (ii) investment returns, as well as deterministic analysis to establish a base case scenario for oil production
- The approach taken is reasonable and the model's logic is generally robust in testing the likely impact of a $3.3B draw, based on a review of the model's structure, logic, conceptual soundness, and process for future updates

The assumptions that underlie the model are reasonable

- Key assumptions on future crude oil selling price, oil production, and investment returns (total and statutory) were obtained from credible, objective sources
- These assumptions are all within the range of reasonableness
  - Assumptions on oil production and price are reasonable and, taken together, somewhat more conservative than most
  - Investment returns assumptions are reasonable, though were considered optimistic for the near-term by some members of the APFC investment staff and were higher than those projected by APFC's strategic partners (third-party asset managers)

Certain institutional investor best practices could help improve this plan's long-term sustainability

- The State of Alaska could further strengthen the long-term viability of the APFC and the sustainability of its contributions to the General Fund by leveraging best practice learnings from other SWFs and investors, e.g.:
  - Clear savings-and-spending rules and capital planning
  - Regular communication between investor and sponsor
  - Formal and informal investment education opportunities for government officials and board members
  - Board governance processes with appropriate composition, appointment expertise and roles
  - Well-designed strategy tied to Fund obligations and long-term investing

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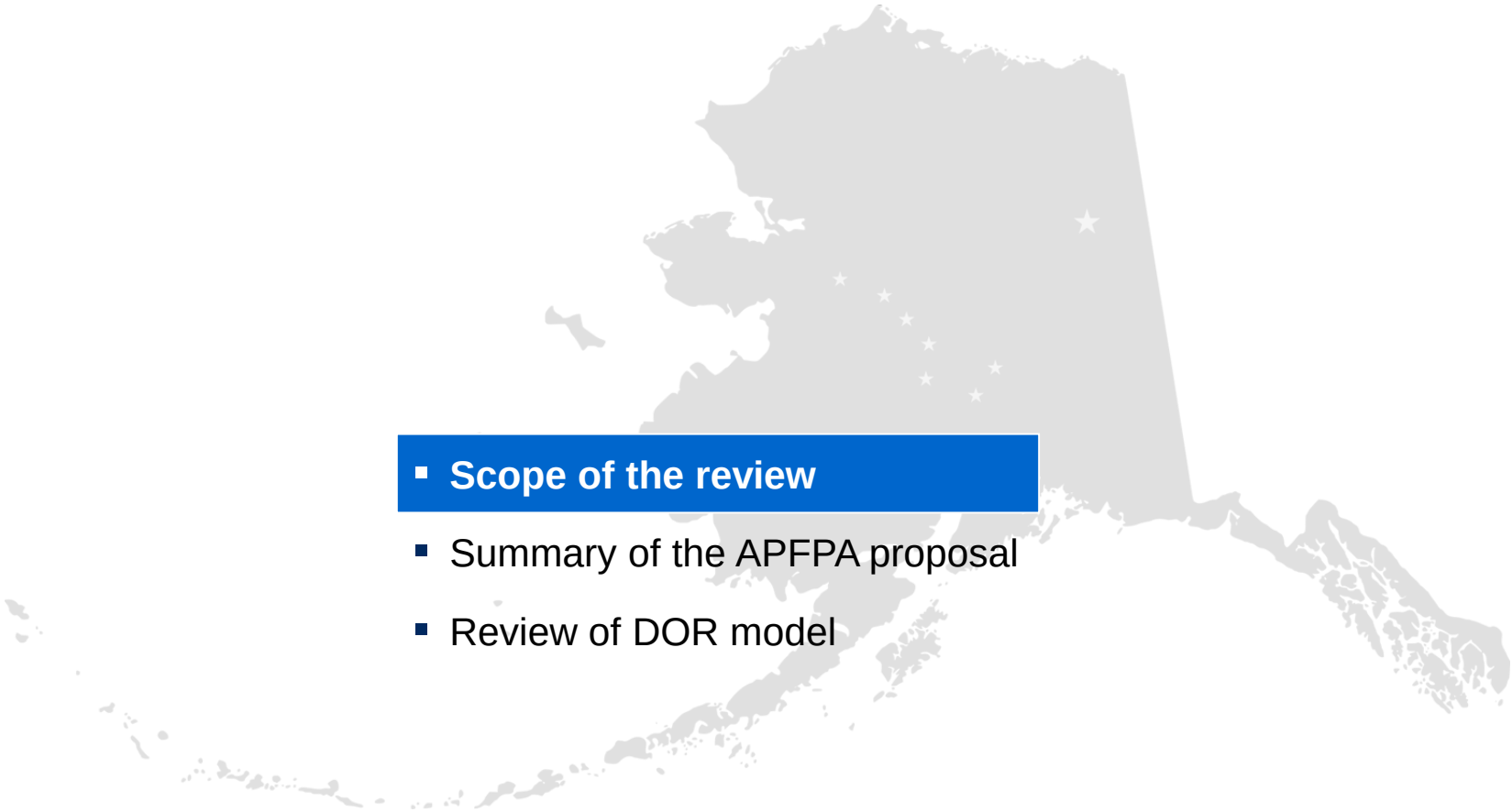


The scope of this assessment

Overview

The Department of Revenue is seeking an objective assessment of its financial model which analyzes a $3.3B fixed annual draw from the Earnings Reserve of the Permanent Fund to finance General Fund spending

In scope

- ✓ Detailed review and vetting of the DOR financial model's **methodology** and construction, including appropriateness of use of Monte Carlo analysis
- ✓ Assessment of the reasonableness of key baseline **assumptions** (oil price, oil production, investment returns) affecting the sustainable draw
- ✓ Perspective on **best practices** of other SWFs which inform consideration of the proposed model

Not in scope

- ✘ Holistic evaluation of the proposed budget or budget deficit
- ✘ Perspectives relating to current or future tax regimes (e.g., Petroleum Value model)
- ✘ Assessment of the Permanent Fund's mandate or its investment management processes
- ✘ Macroeconomic study of future market fundamentals
- ✘ Recommendations for alternative funding models

SWFs benefit from establishing a clear set of disciplined saving and spending rules to invest for the long-term

Establishes a clear set of disciplined saving and spending rules as well as a predefined capital plan

GIC

- Singapore's SWF, GIC, has developed a **proprietary internal model** projecting 20-year sub-asset class level returns
- Government of Singapore is **allowed to spend 50% of the annualized 20-year expected returns** giving Government flexibility on a year-by-year basis on how much to draw, but capping outflows at a low enough level to grow the corpus

- The National Fund of Kazakhstan had previously suffered from discretionary draws from the corpus. Under 2010 reforms **annual draw is fixed at $8 billion** for use both to reduce budget deficits and for economic development. Government can adjust the annual draw by 15% (as it did in 2013)
- If the balance of the National Fund **falls below 20% of Kazakh GDP** in a given fiscal year the Government must reduce the annual draw until the balance has returned to 20% of GDP

NORGES BANK
INVESTMENT MANAGEMENT

- Norway has a bipartisan balanced budget consensus which **limits government non-oil deficits to 4 percentage points**. This prevents the government from drawing down the corpus of Norway's Government Pension Fund Global unless Norges Bank Investment Management beats the long-run expected investment returns of 4%
- Temporary increases in withdrawals are allowed under only limited circumstances, but **requires a specific parliamentary resolution**

SOURCE: Columbia University, Belfer Center

The DOR model was built to establish and test the sustainability of a fixed annual draw from the Earnings Reserve

What are the major inflows into the Fund?

- Production tax revenues
- Royalty revenues
- Investment returns

What are the most important drivers of future inflows?

- Oil production
- Oil price
- Investment returns (total and statutory)

What is the projected spendable output based on cash flow projections?

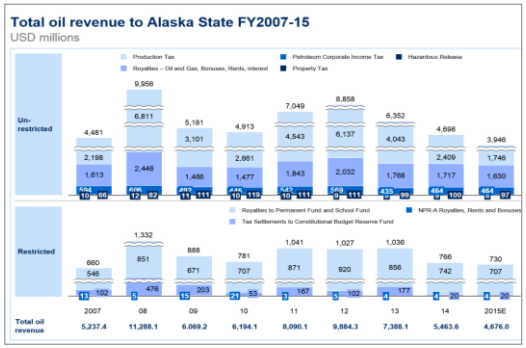
- Sustainable draw amount must ensure:
  - >50% confidence that real value of starting assets is preserved over time
  - Earnings Reserve durability (confidence that the annual draw can be taken from ER)

The DOR conducted advanced probabilistic ("Monte Carlo") modeling to better understand the Fund's ability to sustain the draw

High-level description of the DOR modeling process

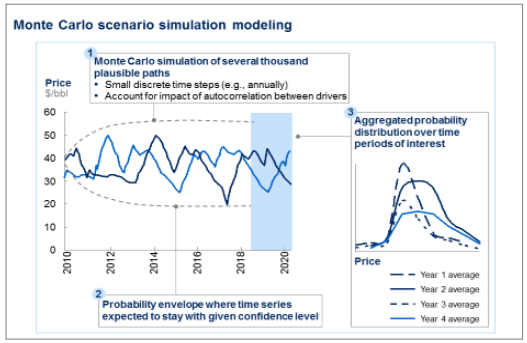
Step 1

Understand the critical revenue drivers of the model – in terms of restricted and unrestricted revenue sources



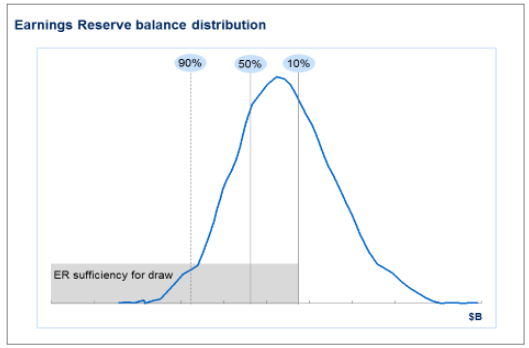
Step 2

Build a probabilistic model of expected oil price and investment returns fluctuations

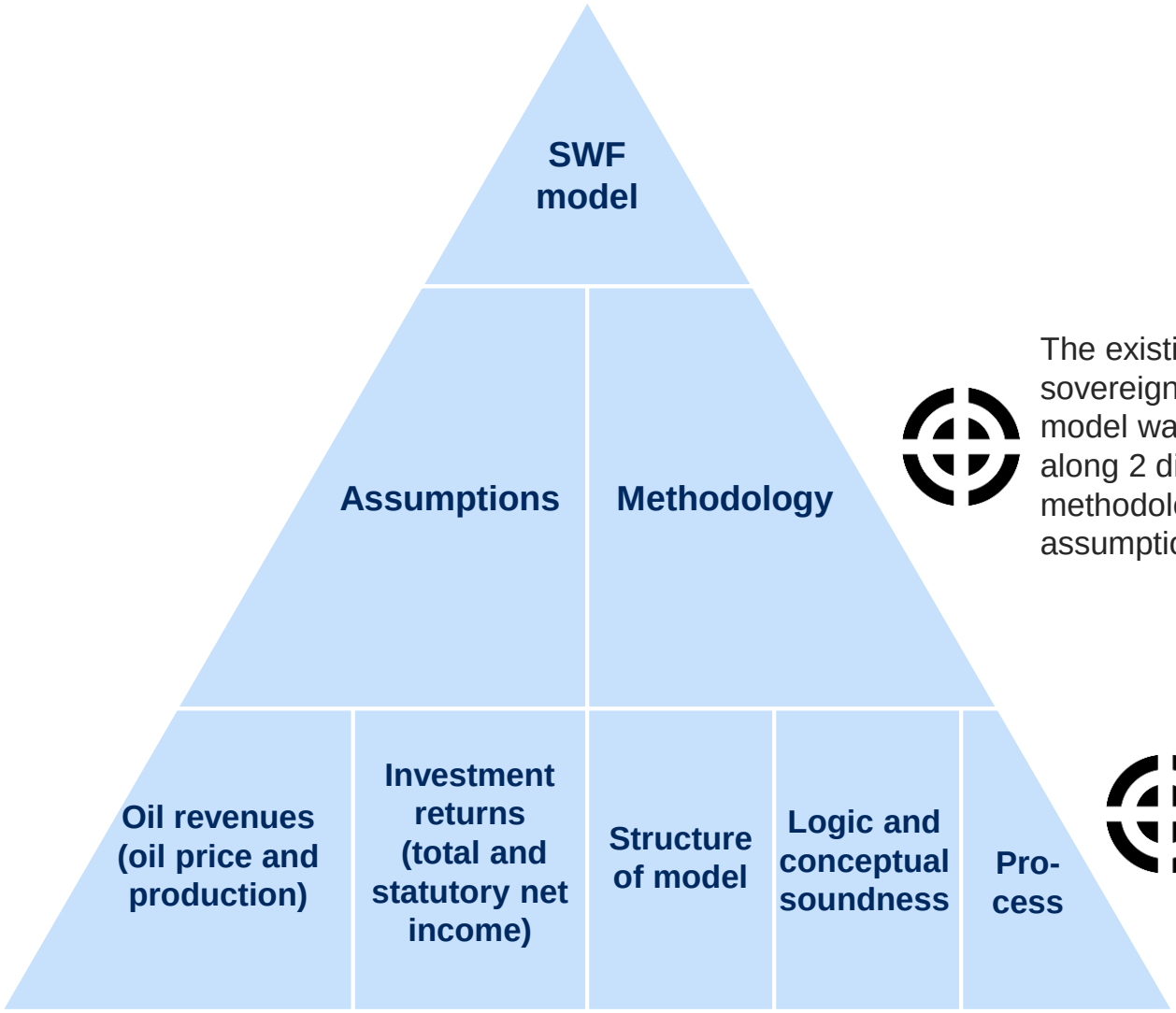


Step 3

Understand impact on revenue flows into the Fund and Earnings Reserve available for the annual draw



Over 4 weeks, a detailed review of the most critical elements of the DOR's modeling methodology and assumptions was conducted



The existing DOR sovereign wealth fund model was reviewed along 2 dimensions: methodology and assumptions

Key elements of the model were prioritized and pressure-tested using industry experts, third-party projections and proprietary modelling assessment framework

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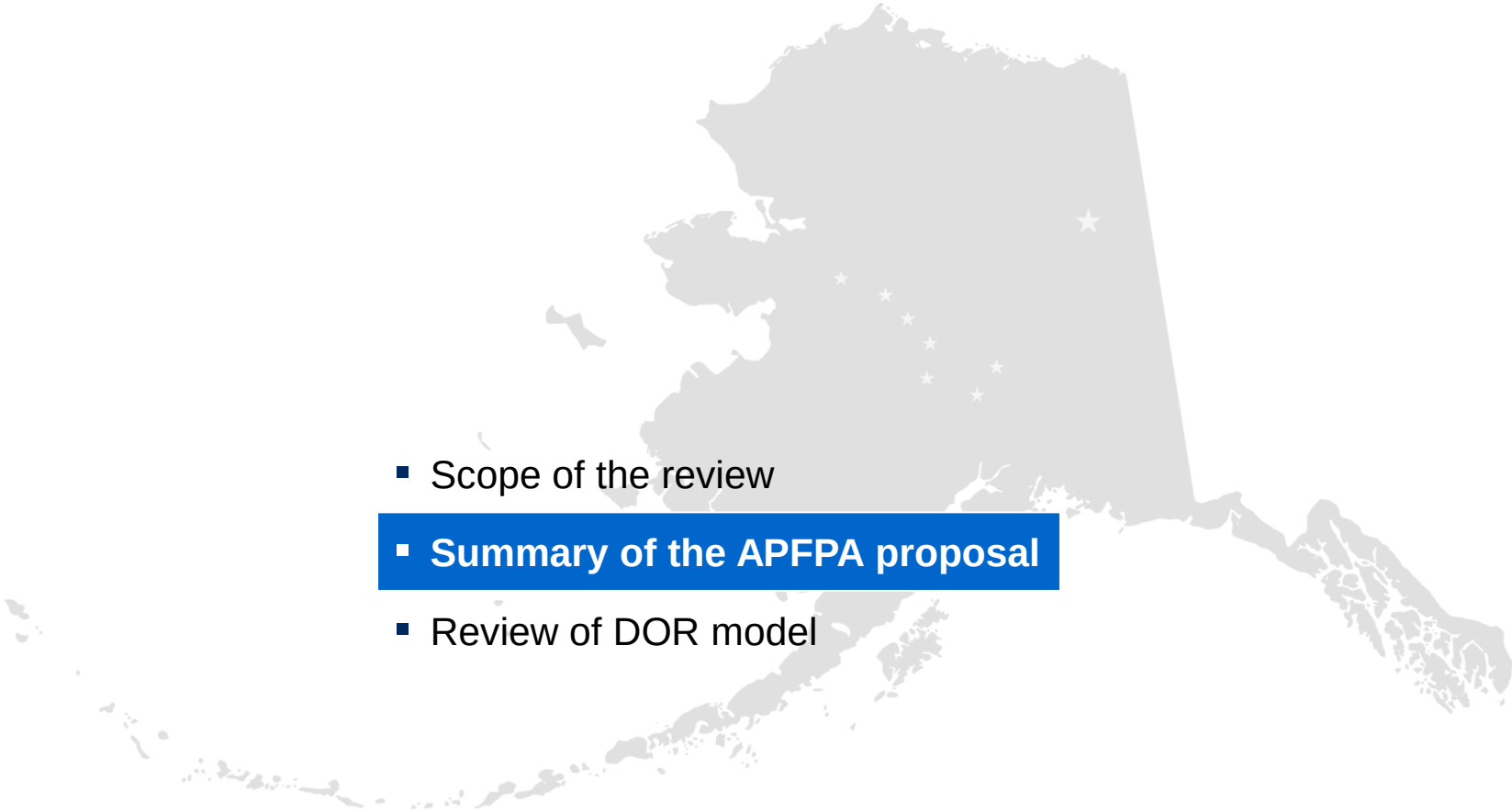
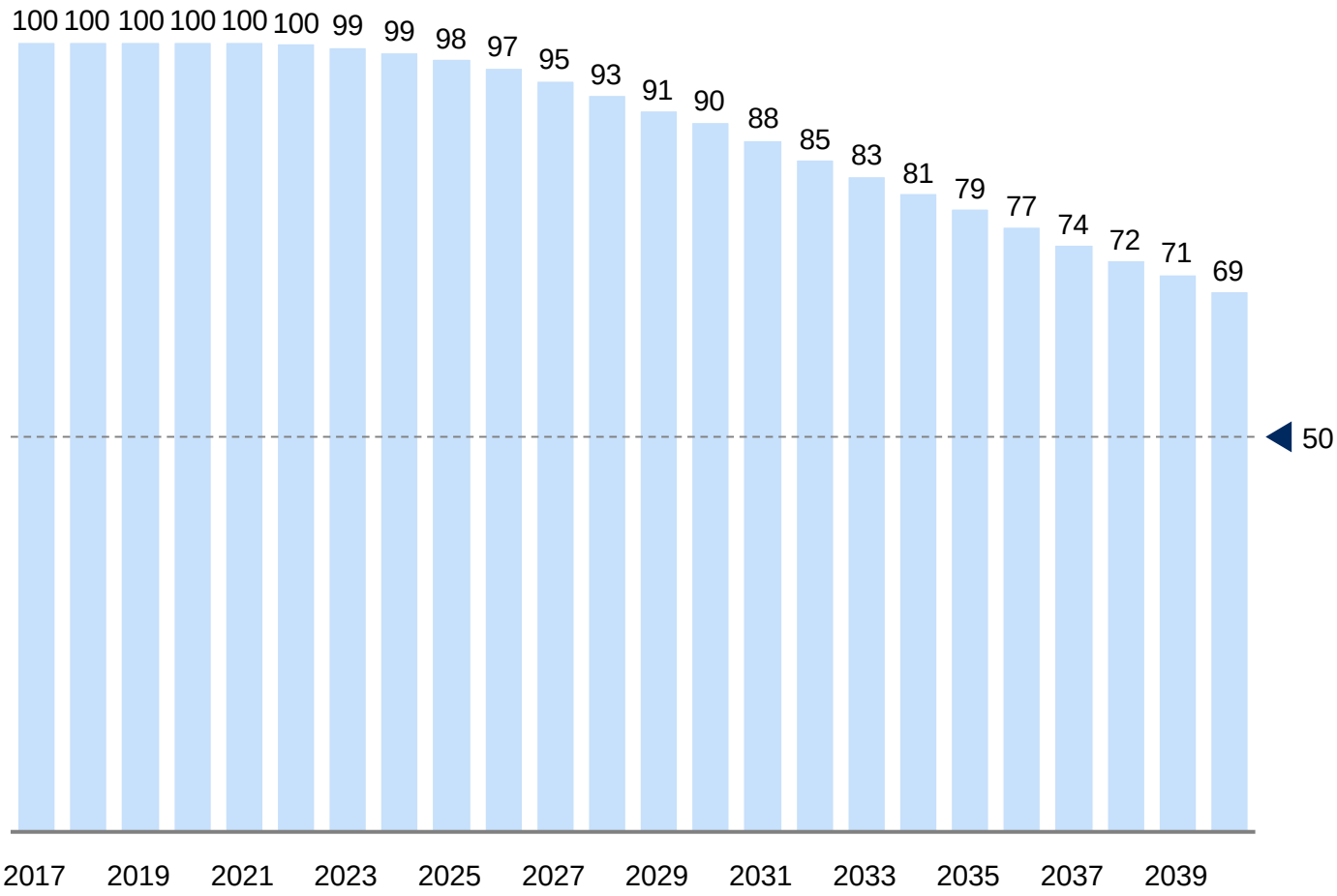


The DOR model implies a 69% cumulative confidence that a $3.3B annual draw can be made from the Earnings Reserve each year through 2040

Cumulative confidence of making an annual $3.3B draw from Earnings Reserve

% likelihood

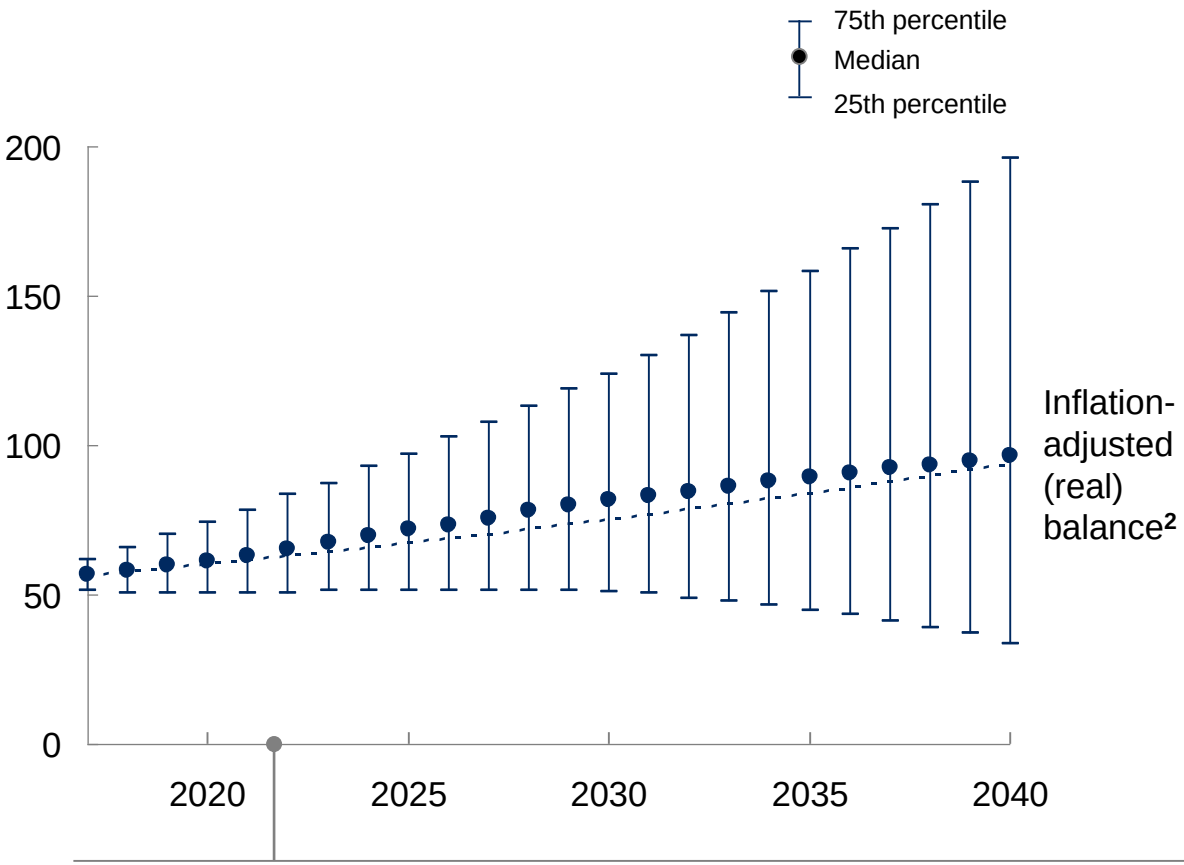


- Earnings Reserve acts as a buffer to short-term investment return and oil revenue volatility
- $10B starting balance means near 100% confidence of being able to draw $3.3B per year for first four years even with negative investment returns
- APFC has only had negative total investment returns four times in the past 30 years
- Effects of cumulative volatility and declining oil production reduce confidence over time – but even in 2040 cumulative confidence that a $3.3B annual draw can be made from Earnings Reserve is 69% (confidence would be even higher if adjusted for periodic review)

SOURCE: DOR Probabilistic Model Output, APFC annual reports, Bloomberg data

The DOR model predicts that the Permanent Fund will be $96B in 2040 with an interquartile range of $34B and $196B

Expected total balance of Permanent Fund[1] in given year
$ billion (est. 2017 values)



- Permanent Fund balance will grow or shrink in any given year because of volatility in investment returns and oil revenues
- DOR goal is to maintain the real value of starting assets by seeing the median balance grow with inflation of 2.25%
- Modelled output meets this threshold, predicting median balances rising to ~$96B in 2040 (nominal value)
- Given expected volatility, 2040 ending balance is predicted to be between $34B and $196B with a 50% confidence level (the threshold set by DOR)

Over time, the ability to revisit the draw on a 4-year cadence will lend additional confidence in the ability to preserve the Fund's balance (e.g., this additional safeguard has not been factored in to modeling)

1 Includes Earnings Reserve 2. Draw amount is adjusted for inflation beginning in 2020

SOURCE: DOR Probabilistic Model Output, APFC annual reports

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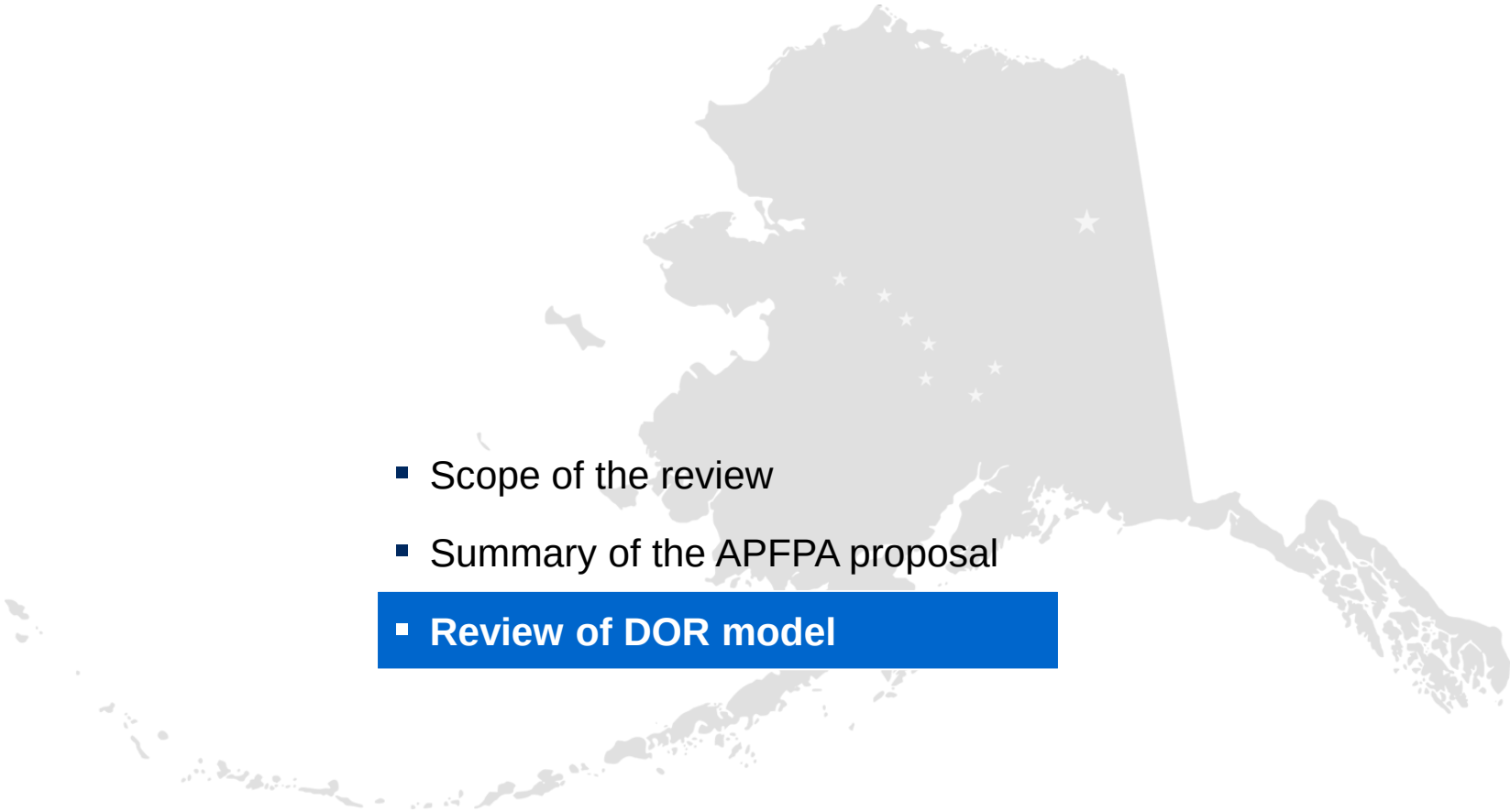


- Scope of the review
- Summary of the APFPA proposal
- **Review of DOR model**

Review of the DOR model indicates that the assumptions and methodology underlying Fund projections are sound

Conclusions from the review

- **The DOR modeling assumptions and methodology are reasonable**
  - Key assumptions on future oil price, oil production, and investment returns (total and statutory) were obtained from objective sources and are within the range of reasonableness
  - The methodological approach taken, including use of Monte Carlo simulations, is reasonable, and the model logic is generally robust in testing the likely impact of a $3.3B draw
- **Future iterations of the model could benefit from the following changes:**
  - Build functionality to account for second-order relationships (e.g., year-on-year correlation between variables[1] and the impact on production of reaching certain breakeven prices for crude[2])
  - Establish consistent process and ownership for model construction and sources
  - Assumptions may be periodically revisited based on changes to Fund strategy and investment management, or changes to the tax regime affecting Fund inflows

1. Analysis of historic year-on-year correlations of oil prices and investment returns from 1985-2015 returned statistically insignificant relationships (e.g., adding this complexity would have minimal impact on the model outcome)
2. The relationship between production levels and the theoretical break-even price of crude is unlikely to have material impact on the model outcome because the marginal price varies considerably across producers and production does not tend to vary with short-term oil price volatility

The review considered the modeling methodology and assumptions behind critical drivers of inflows to the Fund

Driver	Explanation of DOR approach	How approach was assessed
Crude selling price	▪ DOR has employed a Monte Carlo analysis using ERG crude oil price projections to determine the likelihood of price evolution in the future based on a survey of expert forecasts[1]	▪ Comparison of projections with multiple third-party objective sources (e.g., Woodmac, Rystad)
Production volume	▪ DOR has employed a deterministic analysis using ERG oil production projections – this approach takes a fairly conservative approach (e.g., approach reflects the uncertainty of future production projects)	▪ Comparison of projections with multiple third-party sources
Total return rate	▪ DOR has relied on Monte Carlo analysis based on projections from Callan Associates (the third-party financial consultant that the Permanent Fund has used for 20+ years) to estimate the likelihood of future Fund performance based on current Fund strategy	▪ Comparison of projections with historic performance and third-party projections ▪ Interviews with Permanent Fund investors to understand view of projections and potential for change to future fund performance
Statutory net income rate		

1 DOR Probabilistic Model oil revenue inputs based on probabilistic PERT analysis of oil price (use of estimates for P10, P50 and P90 estimated values as per DOR sampling methodology and proprietary company specific data); may differ slightly from publically published DOR RSB estimates.

Source: DOR Probabilistic Model Output

Two types of analysis are used in the DOR model: “probabilistic” and “deterministic” analysis

Type of analysis methodology	Explanation	When is it best used?
Deterministic	▪ **Describes the outcome of some scenario given appropriate inputs** (in this case, based on the average or median value and the degree to which that value varies over time)	▪ **When projections are based on an assumed trend** given variance from that trend within certain standard deviation (e.g., use of a conservative baseline case for oil production)
Probabilistic “Monte Carlo”	▪ Monte Carlo analysis is a modeling technique **that runs multiple trials and gives a distribution of potential outcomes.** Running a Monte Carlo model creates a probability distribution that **indicates the likelihood that an outcome will occur**	▪ **When attempting to project highly volatile and less predictable drivers** where the impact of “randomness” is important to understanding risk (e.g., oil price, investment returns)

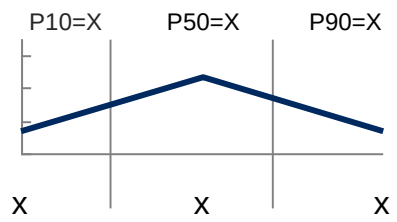
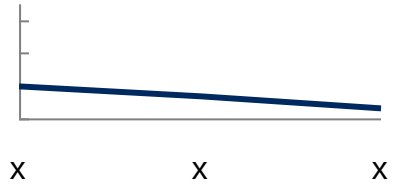
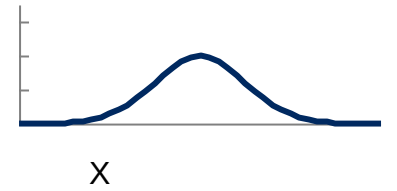
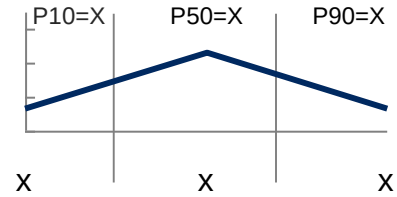
Model methodology is robust, with some potential opportunities for future improvement

Requires review
Requires no substantial review

Element of methodology assessment		Assess-ment	Explanation	Potential steps to improve model
Structure	Check for errors	●	▪ No major mechanical errors found	▪ None
	Dependencies on other models	◑	▪ Petroleum Model model sub-optimally structured ▪ Oil production projections are not linked to price projections	▪ Consider full audit of Petroleum Model (particularly in light of tax / royalty regime) ▪ Wire model to account for price/production relationship in future model iterations
	Single use of source	◕	▪ Sources consistently used with exception of some oil price inputs (e.g., median used in Petroleum Model vs. probabilistic price used in SWF model)	▪ Validate Petroleum Model for consistency in oil pricing (e.g., using probabilistic model vs. median)
Logic and conceptual soundness	Calculation of inputs	◑	▪ Underlying data sources are objective (e.g., Callan) ▪ Does not account for impact of unrealized returns on Earnings Reserve balance)	▪ Consider impact unrealized returns that are apportioned to Earnings Reserve on the funds available for spend
	Deterministic vs. probabilistic	●	▪ Current use of Monte Carlo methods is defensible given behavior of oil price and investment returns	▪ None
	Probabilistic methodology	◕	▪ Pert distribution of oil price (i.e., 3 points) is sufficient but highly sensitive to accuracy of underlying inputs to the distribution (P10, P50, P90) ▪ Does not account for year-on-year correlations in oil prices (e.g., “gamblers dilemma”)	▪ Consider exploring more sophisticated probabilistic methodology (e.g., revisit accuracy of Delphi-style method used in PERT distribution) ▪ Account for year-on-year correlations in probabilistic analysis
Process	Repeatable and consistent process	◑	▪ Informal construction process (partly driven by ongoing iterative policy process) ▪ Governance procedures to ensure systematic auditing/updating not yet developed	▪ For future sustainable draw re-visitations, create set of rules / guidelines for timeline / triggers of update and develop design principles to guide construction
	Ownership	◑	▪ Unclear future ownership (partly driven by unclear end use of model)	▪ For future sustainable draw re-visitations, articulate clear owner(s) with auditing / updating rights

Source: DOR Probabilistic Model Output

Each of the modeling methodology used by the DOR model to project critical fund inflow drivers is technically sound

Fund inflow driver projections		Description of DOR model methodology	Rationale for methodology
Crude selling price		Use of **probabilistic** analysis (PERT distribution) based on P10=$31/bbl, P50=$56/bbl, P90=$87/bbl	▪ Probabilistic analysis accounts for volatility ▪ Distribution method leverages preexisting DOR/ERG crude oil price projections
Production volume		Use of **deterministic** analysis based on conservative base case (e.g., assuming no new project-driven increase in production)	▪ Not much volatility in the projections and hence no need for probabilistic analysis
Total return rate		Use of **probabilistic** analysis (normal distribution) based on 6.9% mean rate of return and 13.9% standard deviation	▪ Objective and transparent methodology ▪ Distribution method based on mean reversion methodology used by Callan
Statutory net income rate		Use of **probabilistic** analysis (PERT distribution) based on based on P10=3.7%, P50=6.01%, P90=8.14%	▪ Probabilistic analysis accounts for volatility ▪ Distribution based on data available from Callan statutory model (P10/50/90 distribution)

Source: DOR Probabilistic Model Output

Based on the recommendations that came out of the model review, a series of actions were executed

Improvement identified	Changes made to model
▪ Build Earnings Reserve sufficiency test into the master model (versus using separate models to test Fund balance and ER sufficiency)	▪ Expanded model to include ER sufficiency analysis
▪ Adapt fully objective, repeatable source for investment returns (versus prior use of blended projected and historic returns rates)	▪ Changed source from a 50% historic/50% projected return to a 10 year deterministic projection from 3rd party (Callan)
▪ Update standard deviation of returns assumption to match Fund returns projections	▪ Changed standard deviation from use of Power Cost Equalization Fund deviation to deviation matched to returns source (Callan)
▪ Use most technically correct formulas and @Risk functions (e.g., calculation for geometric mean, @Risk and risk target function cross check)	▪ Executed tactical improvements (e.g., updated the formula to calculate geometric mean, revised at risk function to calculate cumulative confidence)

Source: DOR Probabilistic Model Output

Assumptions appear generally reasonable; returns projections are perhaps aggressive in the near term

● Requires no substantial review
◔ Need for review

	Assumption	Source[2]	Assessment of viability	Explanation
Crude oil price	▪ 10th percentile @ $31/bbl ▪ Median @ $56/bbl ▪ 90th percentile @ $87/bbl	▪ Annual expert conference held by DOR/ERG[1]	◔	▪ Roughly in-line with third-party estimates, albeit conservative ▪ Objective use of DOR/ERG projections
Crude production	▪ Declining from 500k bbl/day in 2017 to 112k in 2040	▪ Survey of O&G companies (with likelihood adjustments)	◔	▪ In line with or below third-party estimates in short term; below 3rd parties in long-term due to AK LNG exclusion ▪ Objective use of DOR/ERG projections
Total returns	▪ Mean 6.9% ▪ Standard deviation 13.9%	▪ Callan deterministic model (Dec 2015)	◔	▪ In line with other available projections (e.g., 6.4% historic returns, 7.45% alternative probabilistic projection)
Statutory net returns	▪ 10th percentile at 3.7% ▪ Median @ 6.01% ▪ 90th percentile @ 8.14%	▪ Callan probabilistic model (Dec 2015)	◔	▪ Only viable estimate available (e.g., no other multi-year projections available)

1 Conference conducts Delphi-style methodology to arrive at PERT distribution
2 DOR Probabilistic Model oil revenue inputs based on probabilistic PERT analysis of oil price (use of estimates for P10, P50 and P90 estimated values as per DOR sampling methodology and proprietary company specific data); may differ slightly from publically published DOR RSB estimates.

SOURCE: DOR Probabilistic Model, Callan Associates

Future iterations of the model could account more rigorously for future trends and second-order relationships

Potential model update	Description	Observations on impact
Future shifts in fund target or mandate	▪ SWF proposal requires Permanent Fund to **manage toward fixed stream of liabilities** (i.e. like a pension fund) ▪ Likely to entails **shift in strategy and potentially returns projections**	▪ Investment earnings are **single largest driver of success of SWF** (vs. O&G taxes and royalties) ▪ Even small % changes in earnings therefore imply significant changes to fund value and sustainability
Future shifts in fund allocation strategies	▪ Permanent Fund will **likely change investment strategies** in due course ▪ SWF proposal considers possibility of **bringing more investment in-house**	▪ Changes in investment strategy for a given asset class will alter **risk/return distributions** ▪ Investing in-house will **reduce fees**
Liquidity constraints	▪ **Clearer liability stream** will allow for more appropriate level of liquidity ▪ **Liability driven investing** may introduce greater leverage to portfolio	▪ Reduced levels of liquidity and/or higher leverage may **exacerbate risk on extremes of market return distribution**
New tax proposals	▪ Current proposal would amend the tax credit system and **directly impact O&G revenues going to the State**	▪ O&G revenues are a **relatively small percent of revenue** in SWF model ▪ Short-term impact, however, could be significant to ensure stability of fund