# The Elephant in the Ground:
## Managing Oil and Sovereign Wealth

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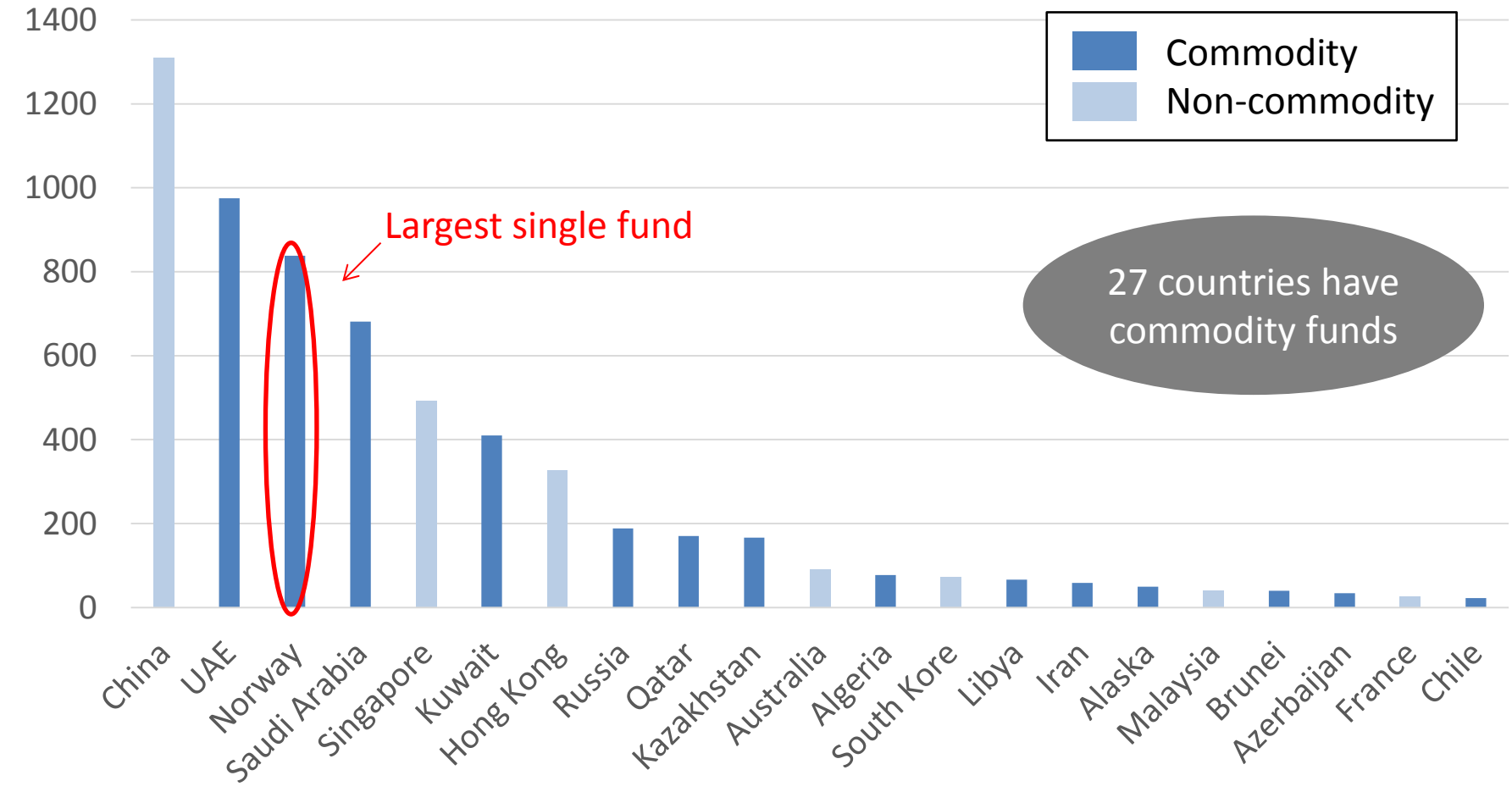
# Sovereign Wealth Funds account for US$ 6.4 trillion in assets. Norway is the largest single fund and has available data

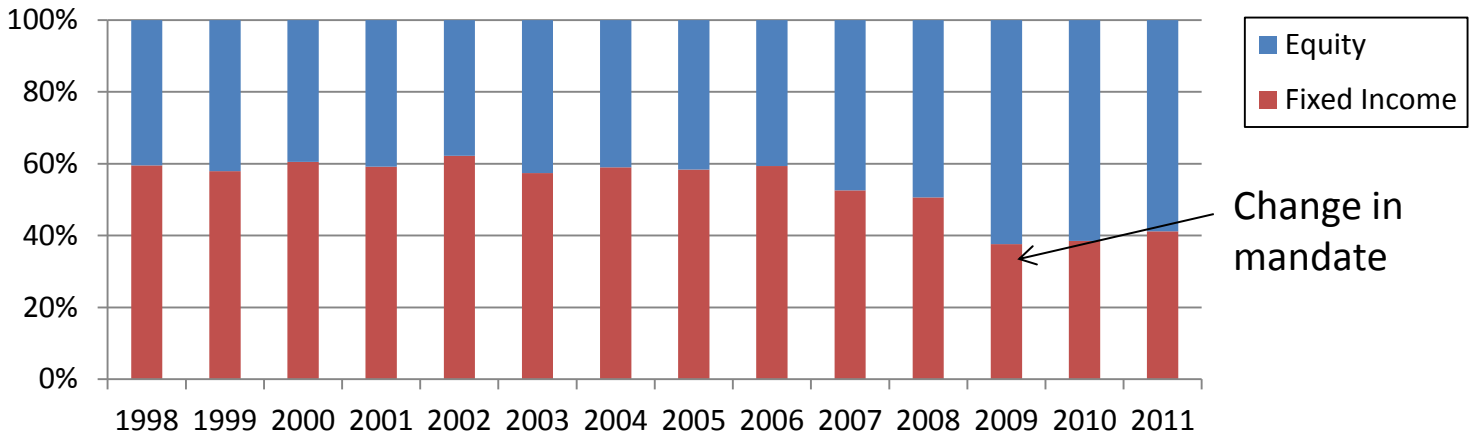
Largest SWFs by country, total SWF assets (US$ billion, 2014)




Source: Sovereign Wealth Fund Institute (2014)

# Norway's fund is worth US$ 840 billion and is allocated between equity and bonds (some real estate) according to Gov't mandate

**The overall asset mix has been stable...**



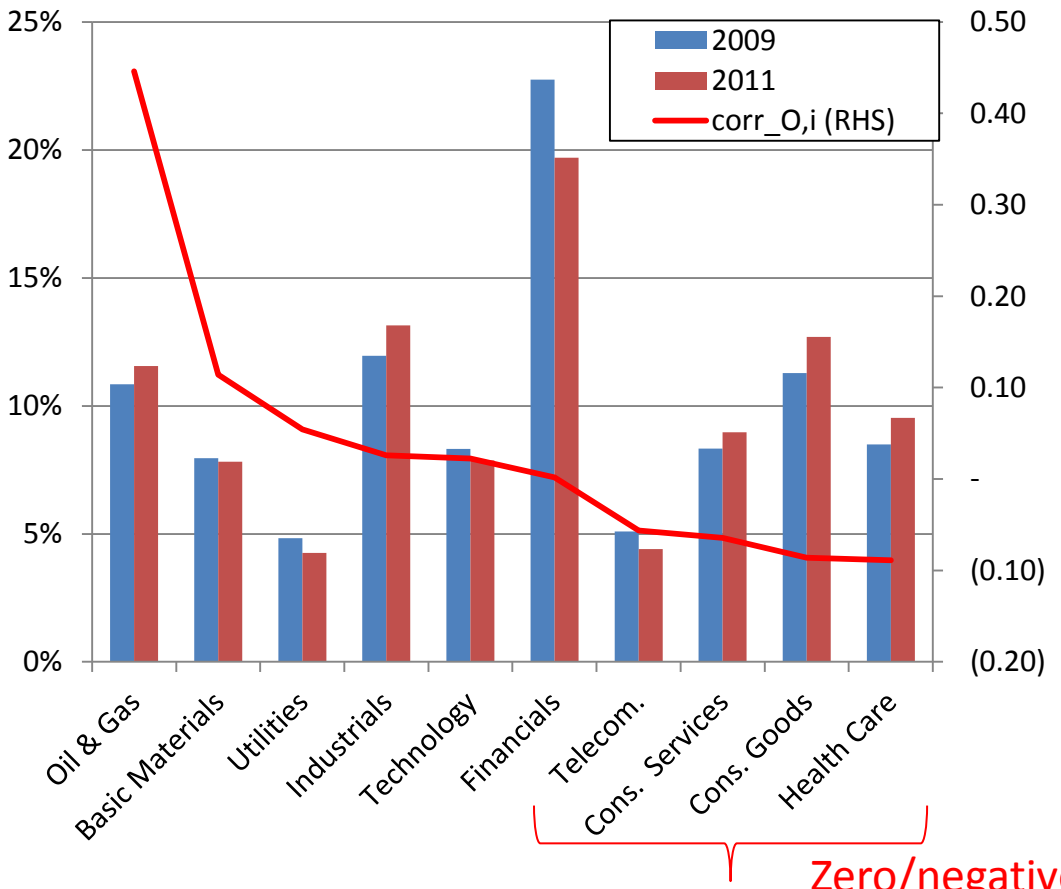

**...and is set by mandate from the Ministry of Finance**

**Ministry of Finance Mandate:**

| *Asset* | *Sub-asset* | *Benchmark* |
|---|---|---|
| Equity: 60% | | • FTSE Global All Cap index |
| Bonds: 40% | Government: 70% | • Barclays Global indices |
| | Corporate: 30% | |

# Norway's equity allocation across sectors has been stable, and seems independent of correlation with oil prices

**Norway GPFG equity allocation by sector and correlation with oil price (%)**




**Snapshot**

Diversified:
- Holds equity in 7427 companies (2012)

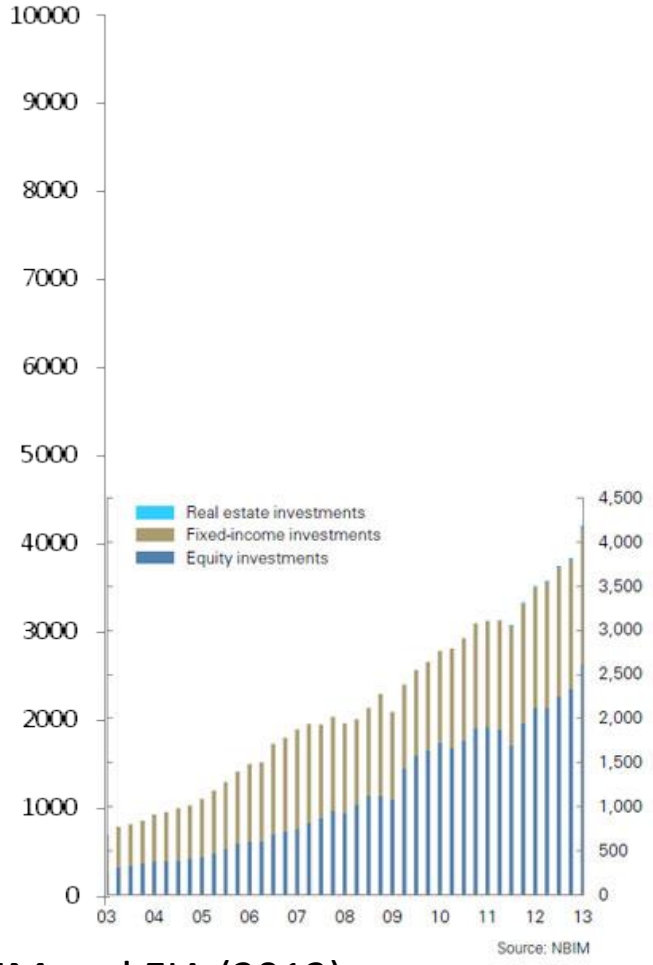
Well-performing:
- Net returns:
  - 2012: 11.2%
  - Since 1998: 3.0%

Well-managed:
- 10/10: Linaburg-Maduell Transparency Index (SWF Institute)
- 2nd : Governance and transparency index (Truman, 2008)

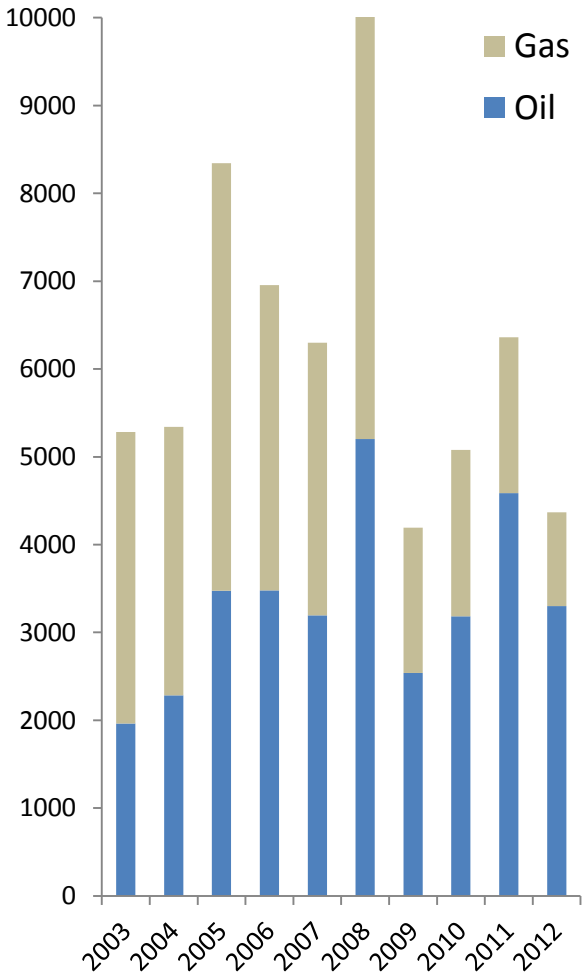
# However, Norway has a large and volatile exposure to oil and gas prices in its subsoil reserves

Value of Norway's GPFG and Proven subsoil reserves at market prices(NOK billion)

**Government Pension Fund Global**




**Proven subsoil reserves**




Source: NBIM and EIA (2013)

# Questions

1. How should assets above the ground be allocated if there are also assets below the ground?
   a. What if the assets below the ground can't be hedged?
   b. What if the fund can only invest in a limited set of assets?

2. When should assets below the ground be converted into assets above the ground?

3. How quickly should the proceeds be consumed?

# Norway's Ministry of Finance considered subsoil oil in 2008, when evaluating whether oil and gas stocks should be excluded from the SWF

- 2008: Considered removing Oil and Gas from SWF portfolio
  - Oil and gas stocks highly correlated with oil price
  - Rejected because: small benefit, lower returns/higher volatility, manage oil price risk through contracts/GPFG
  - Ignored coordinating extraction and investment, and spreading risk over many asset classes
- 2014: Reconsidering removing Oil and Gas from portfolio

# Punchlines

**Norway's sovereign wealth fund is well managed according to existing theory. However, it is not coordinated with subsoil oil. Incorporating oil would involve:**

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**Asset allocation**

**Portfolio Equation:**

- Leverage Effect: Hold more of all risky assets – wealth outside fund.
- Hedging Effect: Hold fewer assets positively correlated with oil (simplest case) – offset oil fluctuations.

**Consumption**

**Euler Equation:**

- Spend constant share of **total** wealth
- Precautionary savings: Save more to to manage residual volatility

**Extraction**

**Hotelling Equation:**

- Risk premium: Extract faster if oil price is pro-cyclical – increase rate of return on subsoil assets to compensate for extra risk

# Outline

1. Portfolio allocation without oil (recap)

2. Portfolio allocation for given oil extraction

   a. No investment restrictions

   b. Investment restriction

3. Portfolio allocation if oil extraction can be chosen

# Without oil the asset allocation problem can be separated into two steps: build the optimal portfolio, then choose how much to hold

**The optimal weight of each asset**

$$w_i = w\delta_i$$

**i. The size of the optimal risky portfolio**

- Does depend on preferences
- Does depend on the risk and return of the market as a whole

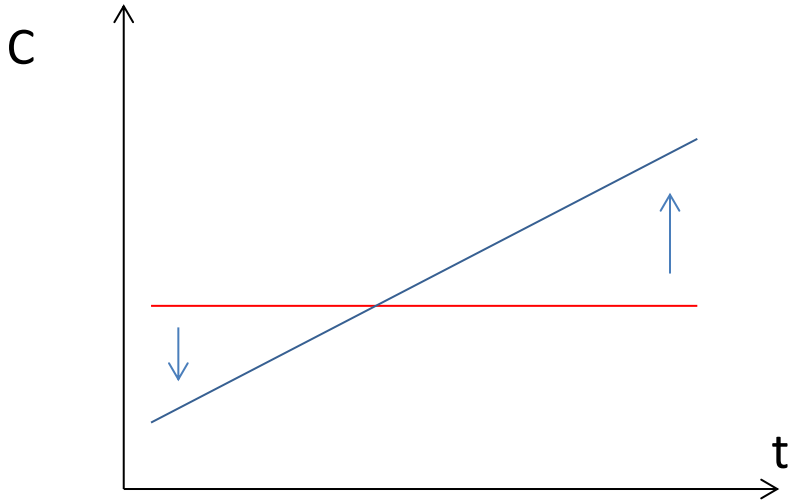
**ii. The mix of the optimal risky portfolio**

- Doesn't depend on preferences
- Does depend on the risk, return and correlation of each individual asset

# Consumption manages any left-over risk by building up a “buffer stock” of savings

## The consumption path

- Left over risk leads to “precautionary savings” in the early years




- Consumption is a fixed proportion of the sovereign wealth fund

$$C(t) = s \cdot F(t)$$

# Norway's current investments are consistent with standard finance theory

| Theory | Norway's GPFG |
| --- | --- |
| a. Asset allocation can be split into two steps | a. Assets are allocated in two stages, according to government mandate |
| i. Construct a diversified portfolio of all risky assets, independent of preferences (..ice cream and raincoats) | i. The FTSE All Cap index is the benchmark for asset shares in the Equity fund |
| ii. Find mix between the optimal risky portfolio and the risk free asset based on preferences | ii. The Equity/Bond mix is set by government, and can change with risk appetite (eg. 2009) |
| b. Consumption a linear function of wealth: $C(t) = s \cdot F(t)$ | b. Fixed drawdown rule: $C(t) = 0.04 * F(t)$ |
| Source: Merton (1990) | Source: www.nbim.no |

**The mandates for Norway's GPFG seem consistent with standard portfolio theory**

# Outline

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# Oil can be valued by comparing its volatility and return with traded assets, and forecasting production

**Value of oil wealth**

$$V(t) = P_O(t)O(t) / \psi$$

Present value of oil wealth

Oil price today

Oil production today

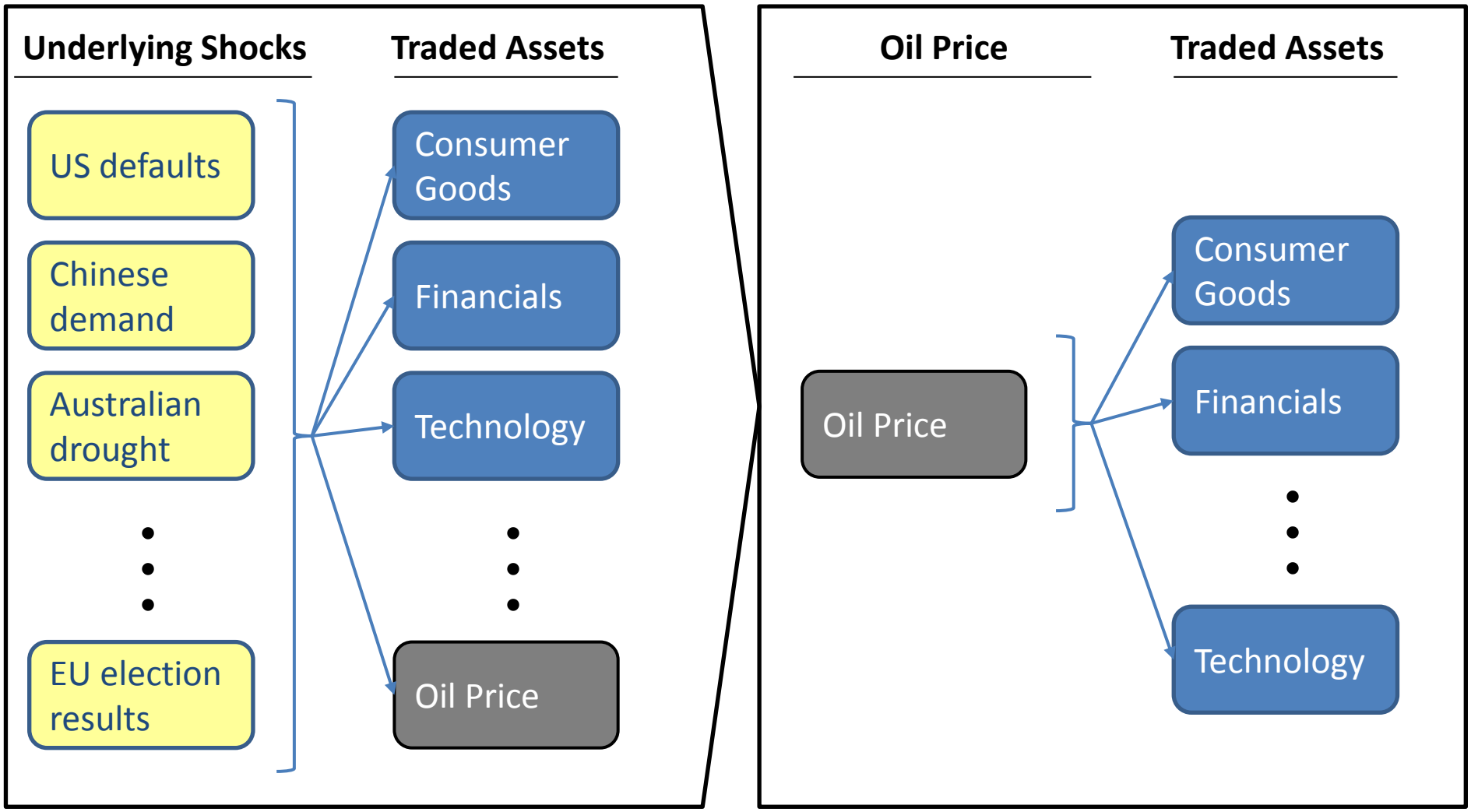
Risk-adjusted discount rate

- Valuing oil wealth requires
  - Oil price today
  - Estimated oil price drift, volatility, and correlation with other traded assets
  - Forecast oil production

- It doesn't require
  - Certain predictions about future oil prices

# The effect of oil on the portfolio can be found by "splitting up" oil's exposure to shocks amongst many traded assets

Spanning the market



# Oil adds (offsetting) leverage and hedging demands for each asset: which can be achieved with a simple change to the benchmark

## Portfolio Weights

- Oil should have a wealth and a substitution effect on portfolio weights.

$$w_i = \bar{w}_i + (\bar{w}_i - \beta_i)\frac{V}{F}$$

*Asset weight in SWF*

*Asset weight in total wealth*

*Leverage Effect*

*Hedging Effect:* depends on
- The asset's covariance with oil
- The asset's "uniqueness"

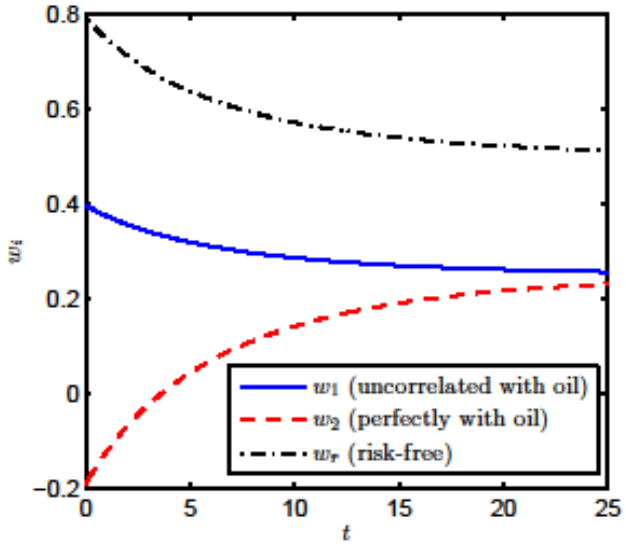
*Oil/SWF value*

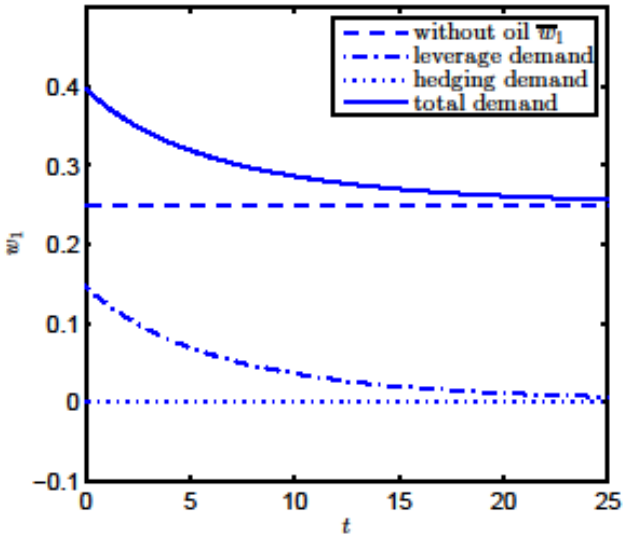
Use two indices as a benchmark:
1. Market index
2. Oil hedging index

# The leverage and hedging effects can be seen using a simple three-asset example

Asset Weights, no investment restrictions

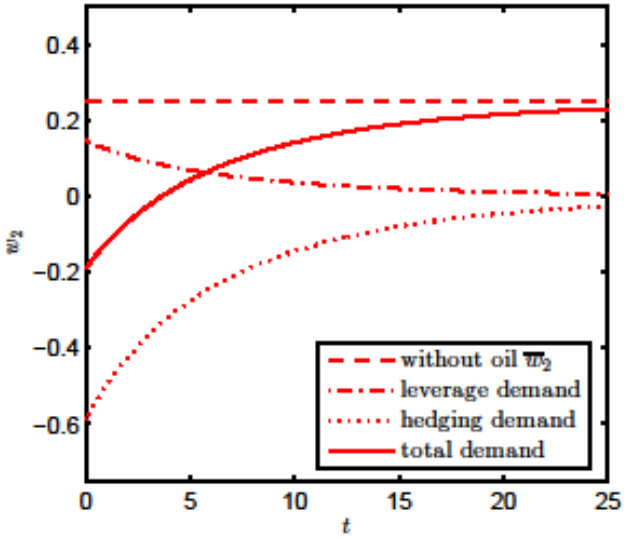
Overview

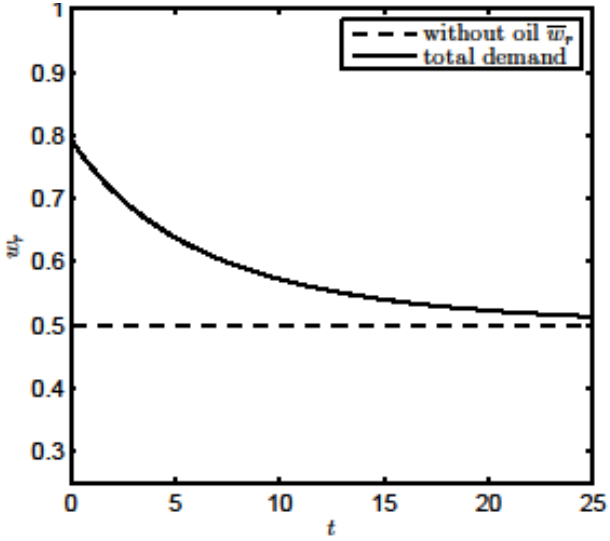



Asset 1: Uncorrelated with oil

Asset 2: Correlated with oil




Asset r: Risk-free

# Asset Allocation: The punchline

**Invest less in**

- Assets positively correlated with oil:
  - Oil and Gas stocks
  - Green Energy (in the short term)

**Invest more in**

- Assets negatively correlated with oil:
  - Businesses where oil is an input... eg:
    - Plastic manufacturing
    - Transport
    - Consumer goods (see slide 4)
  - Green Energy (in the long term)

# The consumption rule for resource-exporters should be a constant share of above and below ground wealth.

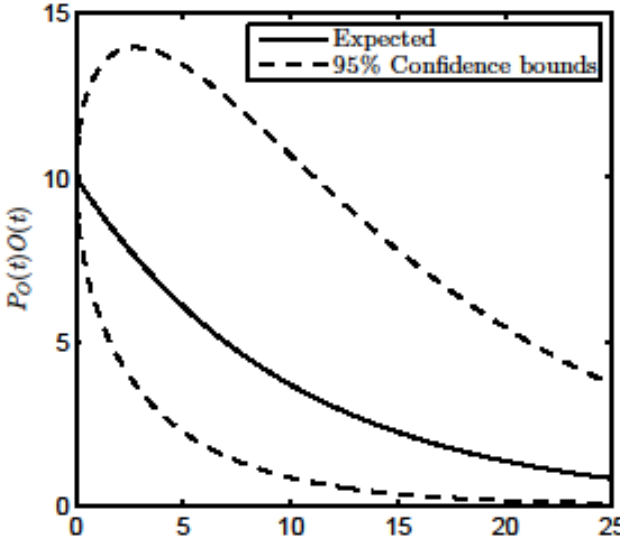
**Consumption**

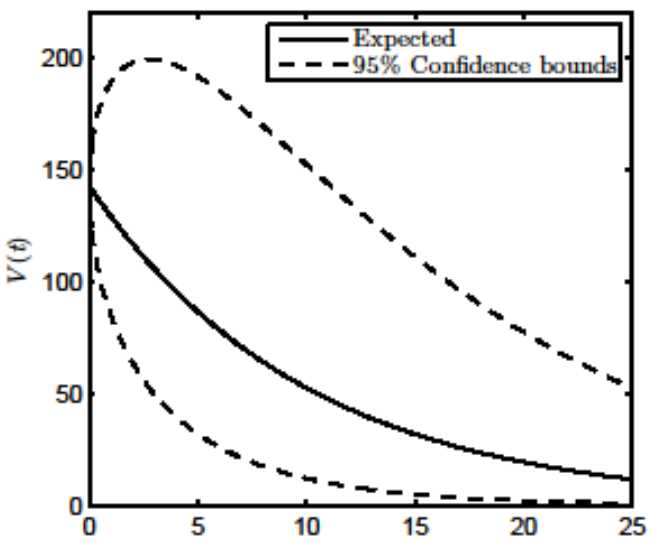
$$C(t) = s \cdot W(t)$$

- The government should consume a fixed proportion of **total wealth** (*W=F+V)*
- Consistent with the permanent income rule

# Consuming a constant share of total wealth leads to smoother spending, like Friedman's Permanent Income Hypothesis.

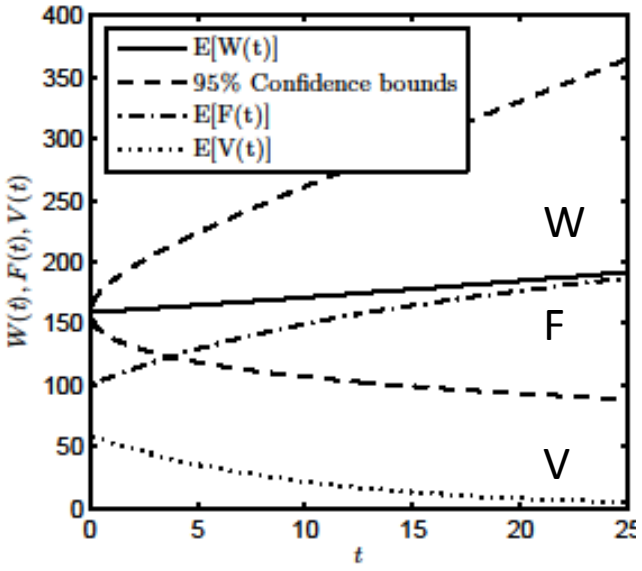
Oil Extraction

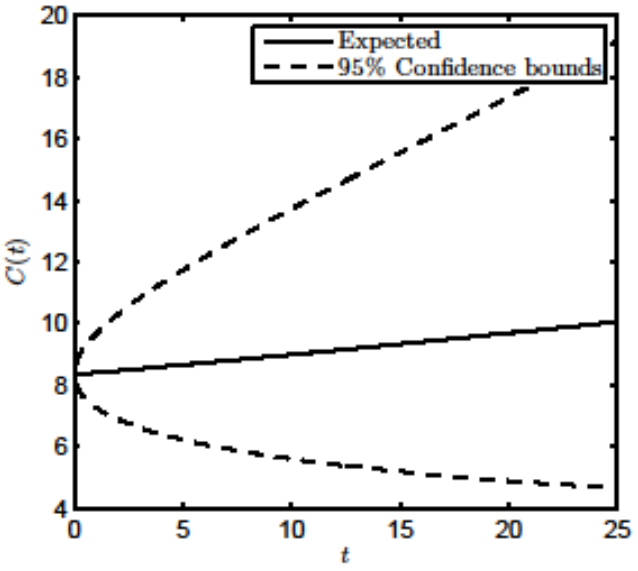



Oil Value (V)

Wealth




Consumption

# Hedging Norway's oil exposure would increase welfare equal to a permanent 3-9% increase in the oil dividend

## Data

Norway's benchmarks:

- FTSE All Cap index: Monthly, 2009-2014
  - Disaggregated by sector
- Barclays Global Aggregate Index: Monthly, 2009-2014
- Brent Crude Oil Price: Monthly, 2009-2014

## Assumptions

- Exponentially declining oil production

## Method

- With hedging:
  - Closed form for value function
  - Monte Carlo simulations
- Without hedging:
  - Monte Carlo simulation

# Outline

1. Portfolio allocation without oil (recap)

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# Norway is currently considering divesting oil and gas stocks from its portfolio, and we consider the implications in the paper…

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## Norway's oil fund to debate ending fossil fuel investments

By Richard Milne in Oslo


Norway is to debate whether the world's largest sovereign wealth fund – funded by petroleum revenues – should stop investing in oil, gas and coal companies.

The two governing centre-right parties and two of their allies have agreed to set up an expert group to look into the $840bn oil fund's investments in fossil fuels and report back in a year's time.

Any decision to stop investing in fossil fuel-related companies would send shockwaves through markets where the oil fund's actions are closely followed.

Oil and gas companies represent 8.4 per cent of the fund's equity investments, or about $44bn, according to its annual report. Three of its top 10 holdings are in oil companies: Royal Dutch Shell, BG Group, and BP.

The debate over fossil fuel investments started when

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## Norway's oil fund faces key strategy decisions

By Richard Milne in Oslo


Norway's $815bn oil fund faces a crucial year with several big decisions expected on its strategy as a debate rages over whether the world's largest sovereign wealth fund has become too big.

The oil fund will provide its new strategy for the next three years in the coming weeks. Then the new centre-right government in Norway will have its first chance to put its own stamp on the fund's operation while the finance ministry will decide whether the fund should manage its money in a more active manner.

"This year will be one of the most important for the fund. There is always some excitement around a new government and there are some large strategic issues that need answers," said one person with detailed knowledge of the fund.

Norway's oil fund has quintupled in size in the past eight years – the time of the last change of government

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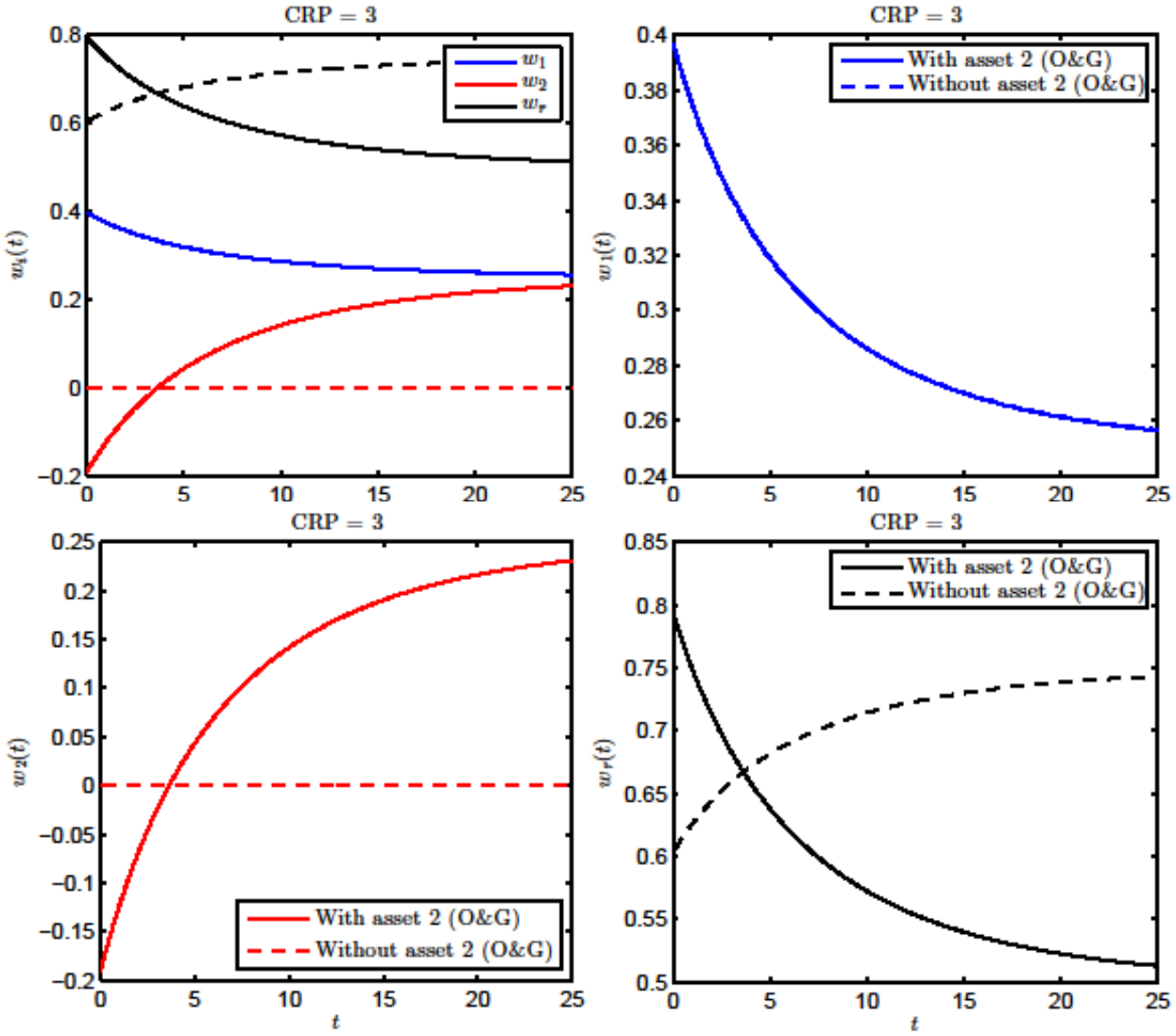
Norway oil fund ramps up property assets

# Consciously excluding an asset class will limit the ability to hedge oil by going short…

Asset Weights, excluding asset 2 from the portfolio

Overview




Asset 1: Uncorrelated with oil

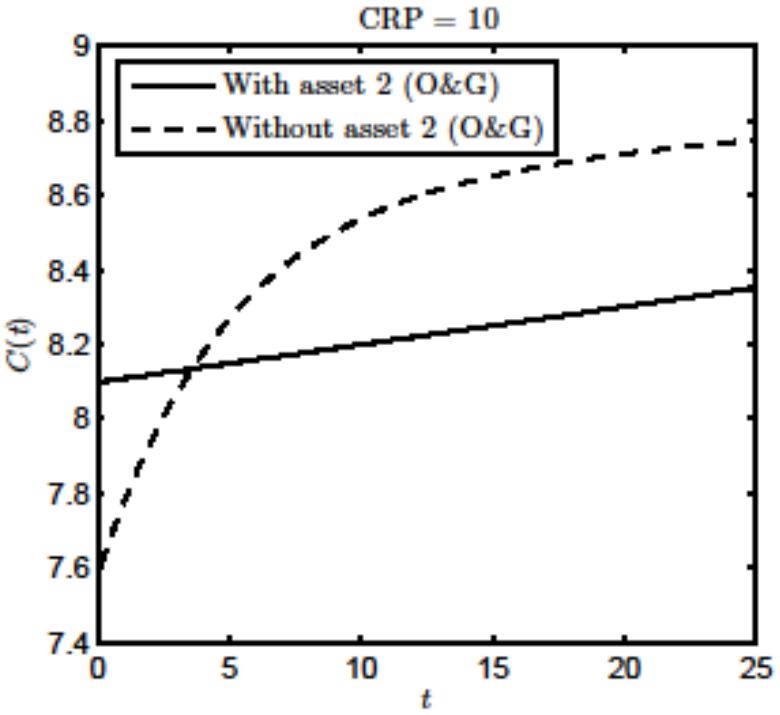
Asset 2: Correlated with oil

Asset r: Risk-free

# Consciously excluding an asset class will limit the ability to hedge oil by going short… requiring more precautionary savings

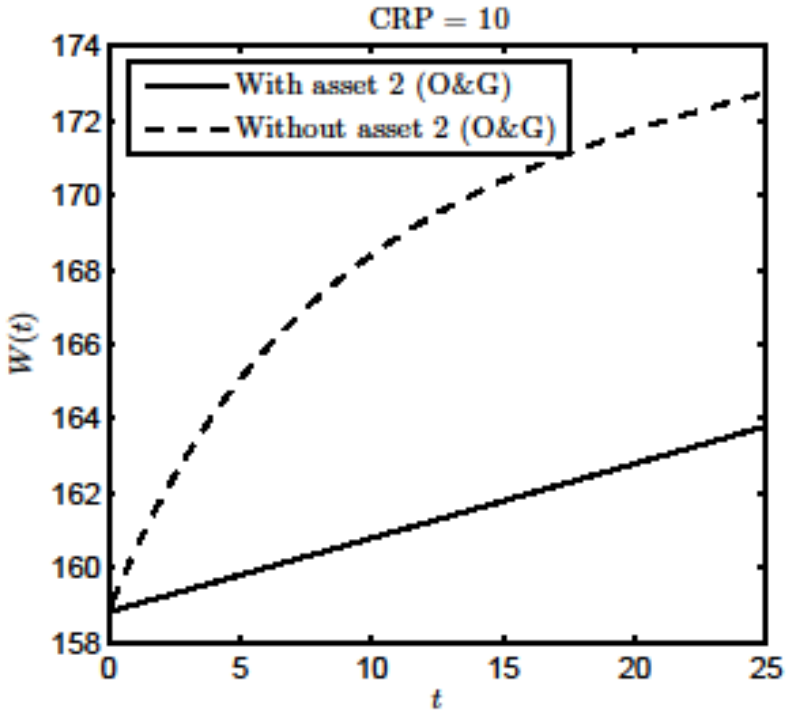
## Spending path

### Consumption




*More precautionary savings…*

### Assets




*Builds up a buffer stock of assets.*

# If the fund is restricted from investing in certain asset classes then they will need a different hedging portfolio, and build up a large buffer stock

## Asset Allocation

- Construct the closest hedging portfolio

## Total Wealth

- The risk/return tradeoff will depend on the asset that is being removed, and how important it is for hedging oil shocks

## Consumption

- More precautionary savings to manage the risk from less diversification
- Lower spending rate.

# Outline

1. Portfolio allocation without oil (recap)

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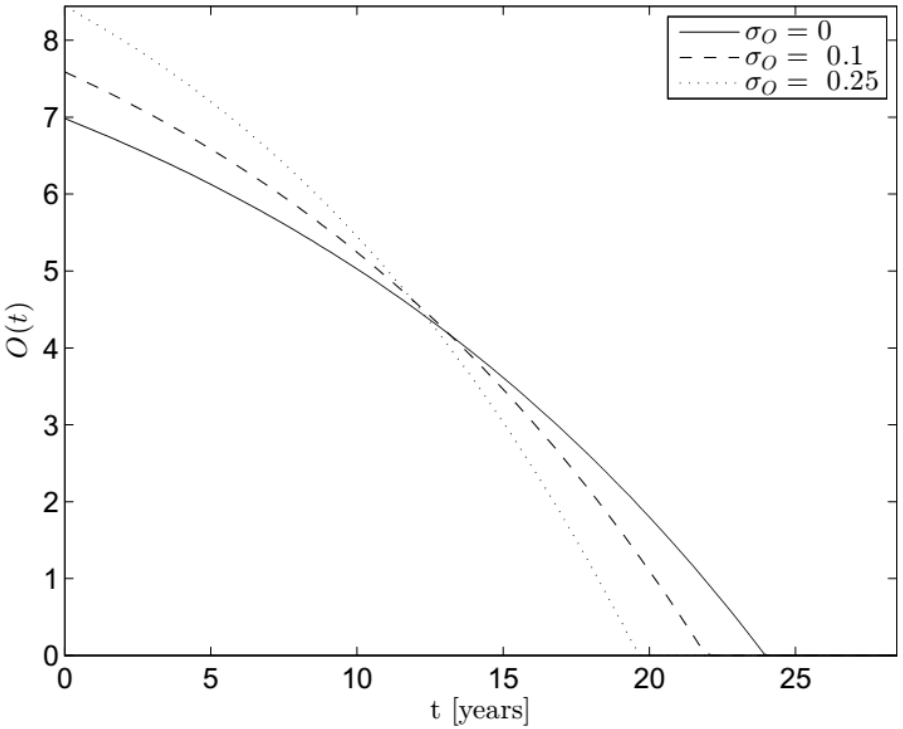
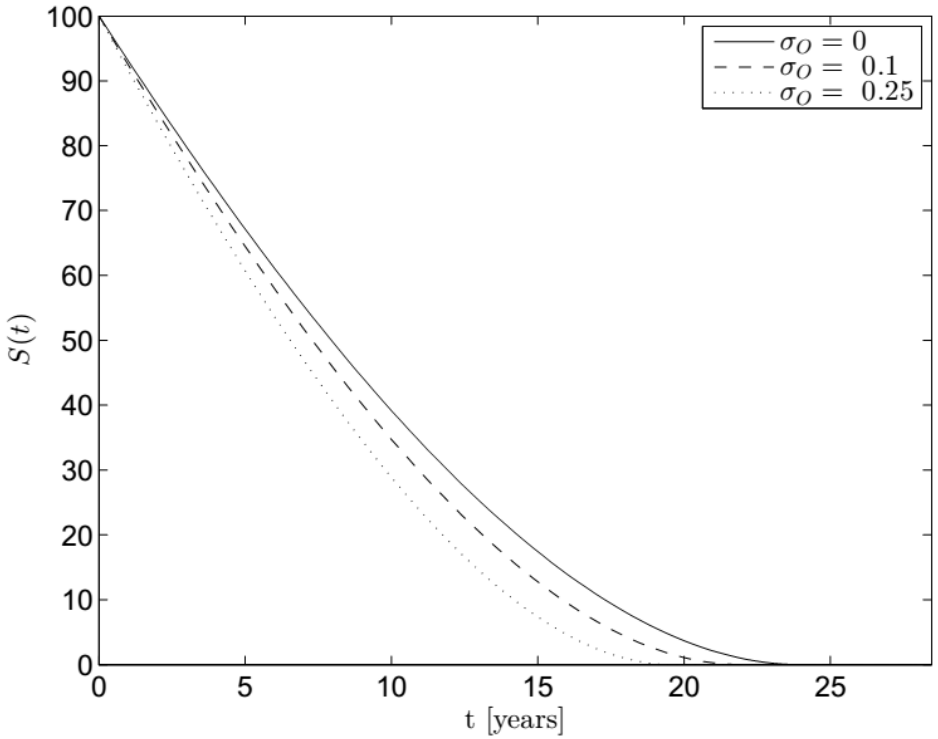
# Extraction: extract oil faster to generate a premium for bearing exposure to oil prices

Stylised illustration, see previous calibration

**Optimal Extraction**




**Reserve Depletion**




- Supports and extends previous results (Pindyck, 1981; van der Ploeg, 2010)
  - Volatility only works through unlikely extraction costs (extractive prudence)
  - Ignore size of fund

# Policy Implications

- Norway's fund was initially designed using guidelines from economic theory

- This paper provides a theoretical foundation for updating these guidelines
  - Current political appetite for altering investments
    - Divest oil and gas – different reason but consistent with our findings, (not permanently).

- Presented to:
  - Norwegian Ministry of Finance (Asset Management Dept)
  - Saudi Arabian Monetary Authority
  - Abu Dhabi Investment Authority`

# Next steps

- Currently implementing theory for Norwegian case
  - Short/Long positions done
  - Long-only positions in progress
- Next will incorporate:
  - Pension liabilities
  - Tax revenues that depend on the country's particular industries
- Seeking other cases to implement
- Seeking better understanding of fund manager concerns in practice

# Questions