

The Decline of Norwegian Oil

The Effect of Price on Production in a Mature Petroleum Region

Johannes Mauritzen

johannes.mauritzen@nhh.edu

February 2014

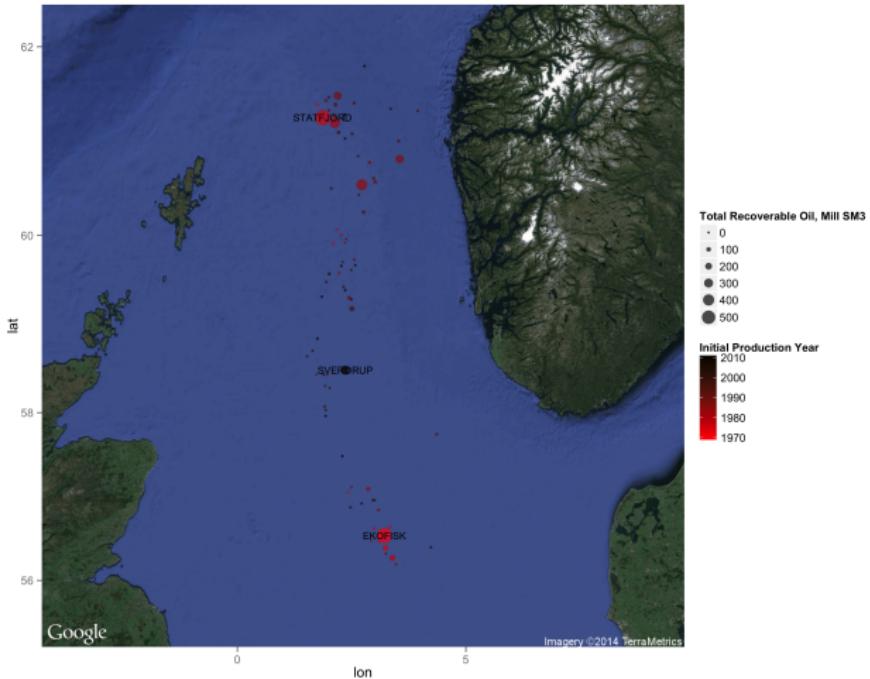
- ▶ Effect of Price on Drilling / Reserve Replacement
 - ▶ Mohn and Osmundsen (2008), Mohn (2008), Ringlund (2008)
- ▶ Production (Aggregate)
 - ▶ Curve-fitting/Simulation (geo-engineering)
 - ▶ Econometric
 - ▶ Kaufman (1990), Kaufman and Cleveland (2001)
 - ▶ Ramcharan (2002): Negative Price Elasticity (???)

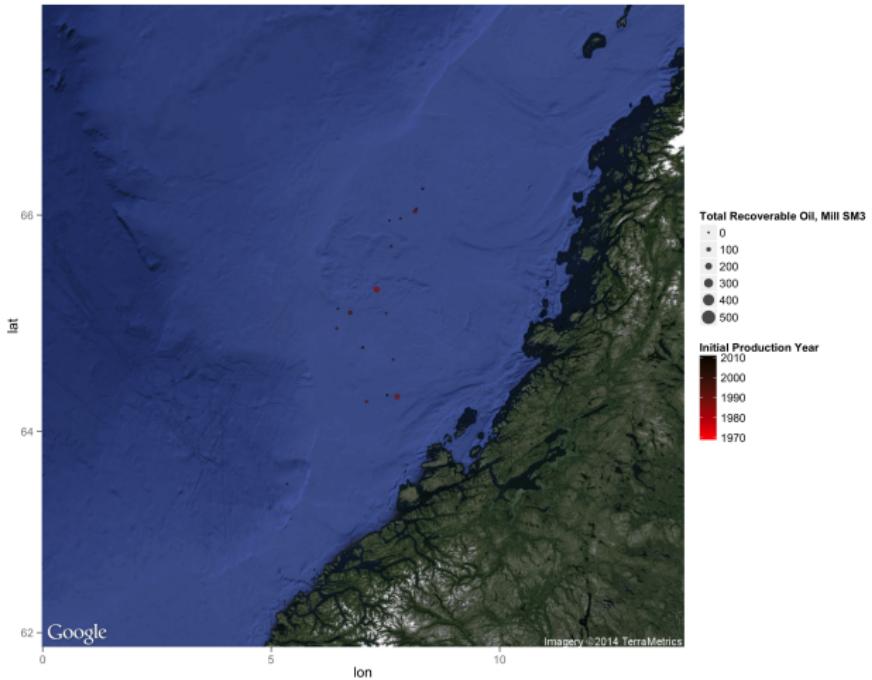
Generalized Additive Models

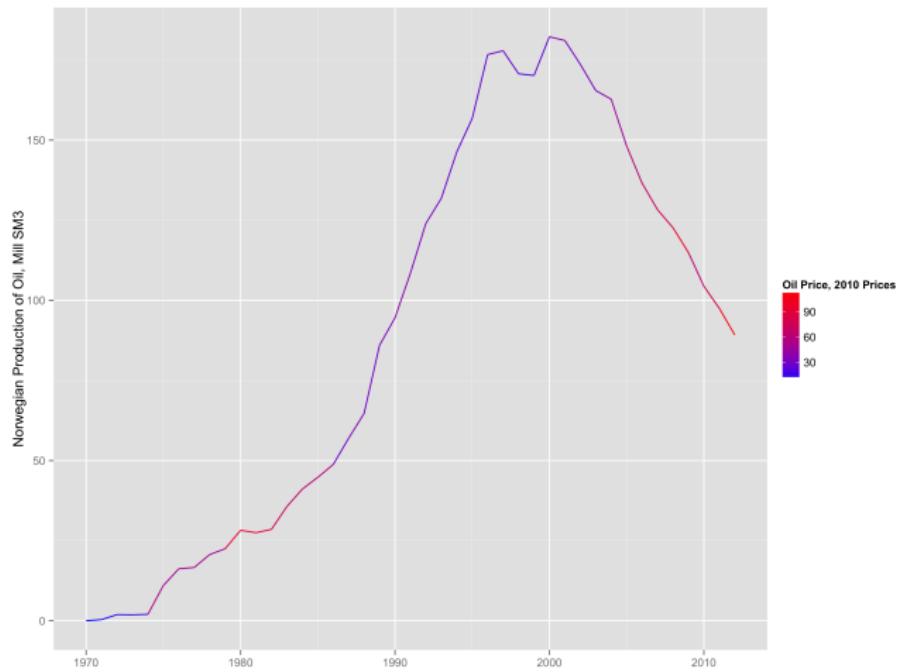
- ▶ Hastie and Tibshirani (1990)
- ▶ Wood (2006)

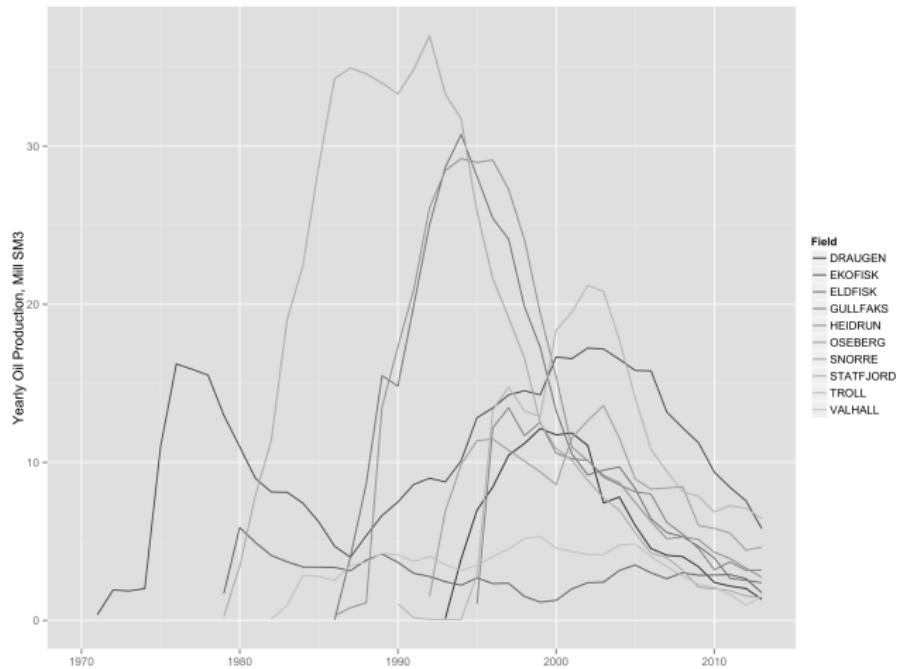
Main Results

- ▶ No significant contemporary effect of oil price on field production (within 3 years)
- ▶ Slight lagged effect found after 4-8 years, magnitude of around 2%
- ▶ Most of this effect seems to come in the Planning stage of an oil field
- ▶ Little to no effect - contemporary or lagged - in depleting fields

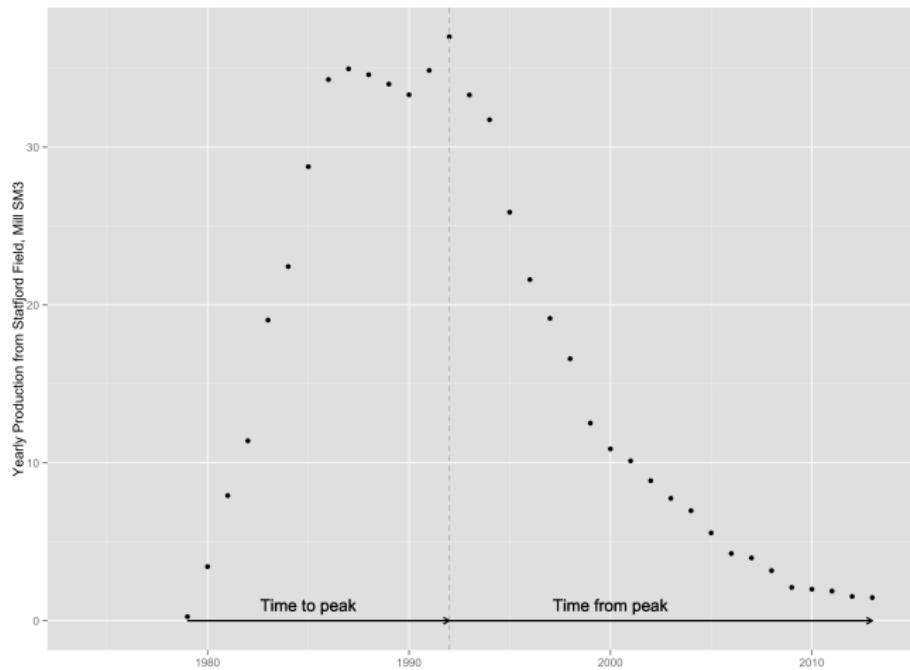


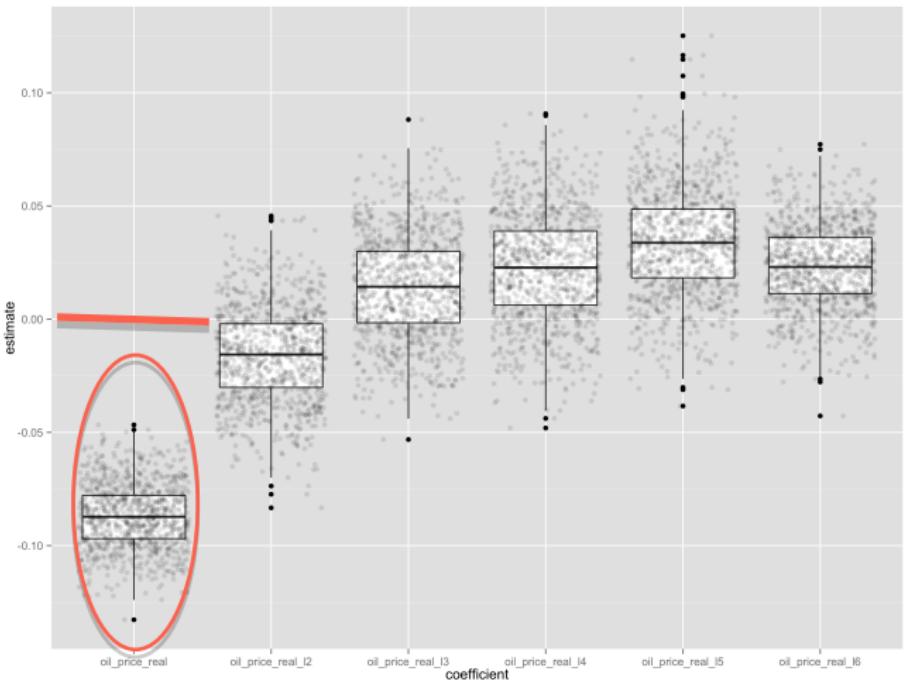




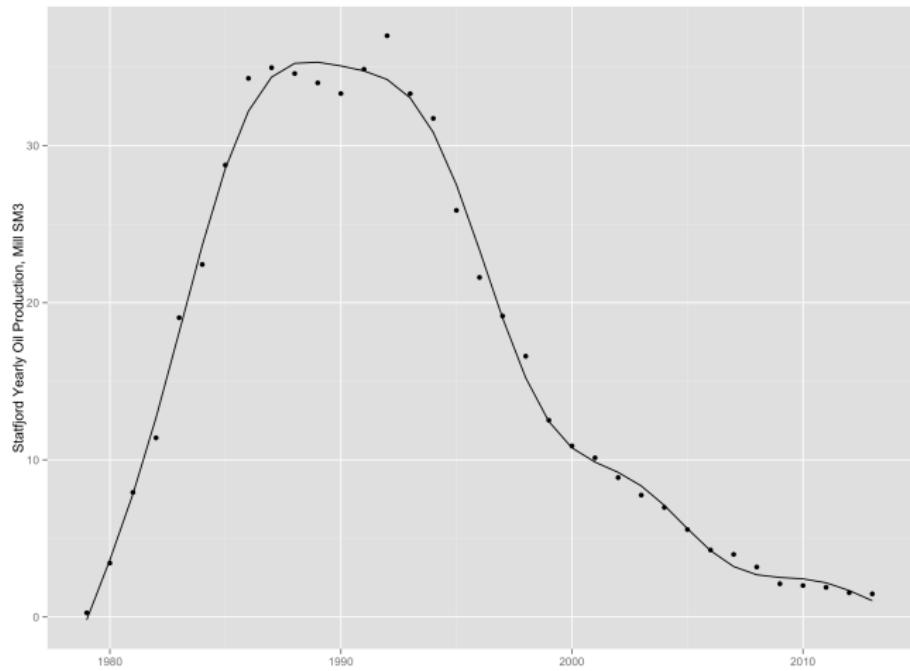


$$\begin{aligned} \text{Log}(Production_{i,t}) = & \alpha_0 + \alpha_1 time_to_peak_{i,t} + \alpha_2 time_to_peak_{i,t}^2 \\ & + \alpha_3 time_to_peak_{i,t}^3 + \alpha_4 peak_to_end_{i,t} + \alpha_5 peak_ \\ & + \alpha_6 peak_to_end_{i,t}^3 + \gamma total_recoverable_oil_i \\ & + \beta_1 oil_price + \beta_2 oil_price_l1 + \dots + \epsilon \end{aligned} \tag{1}$$





$$Production_t = f(\text{time}) + \epsilon \quad (2)$$



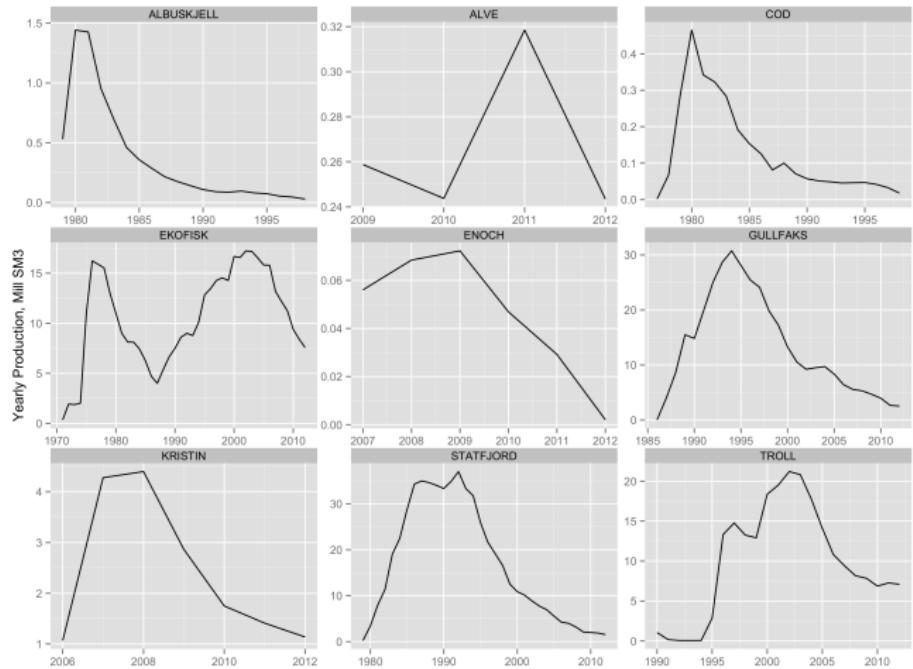
$$\begin{aligned} \text{Log}(Production_{i,t}) = & f(\text{time_to_peak}_{i,t}, \text{total_recoverable_oil}_i) \\ & + f(\text{peak_to_end}_{i,t}, \text{total_recoverable_oil}_i) \\ & + \beta_1 \text{oil_price} + \beta_2 \text{oil_price_l1} + \dots + \epsilon \end{aligned} \tag{3}$$

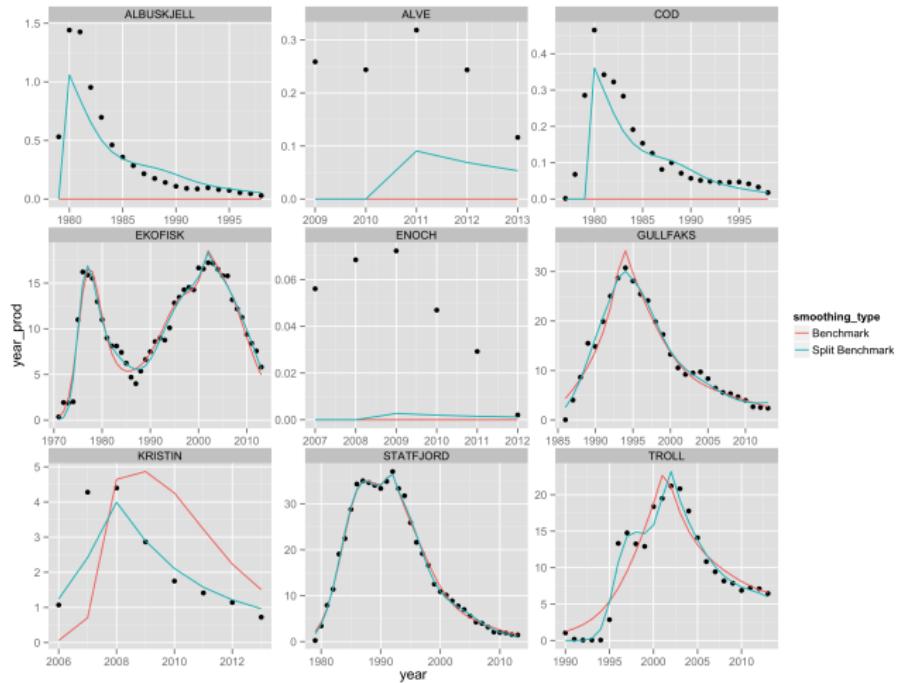
Thin Plate (Regression) Splines (Duchon 1977)

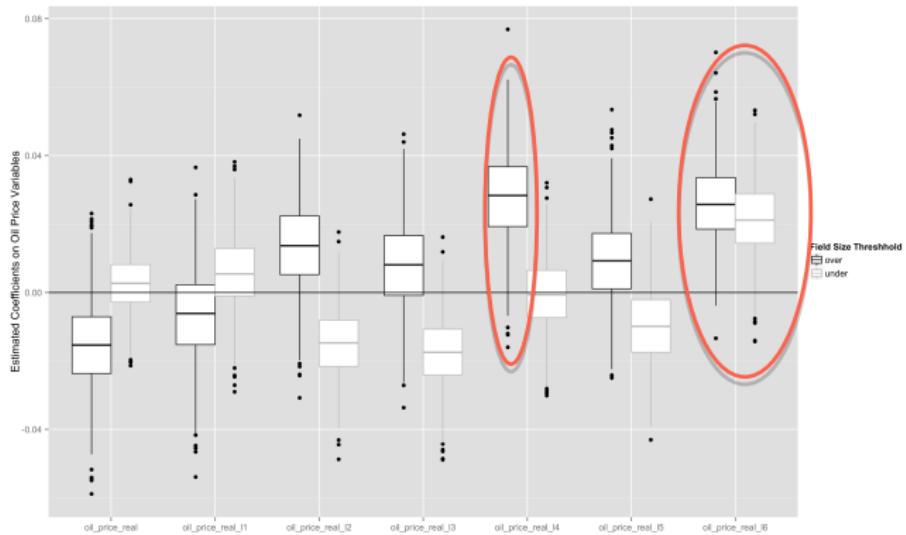
$$y_i = g(x_1, x_2) \quad (4)$$

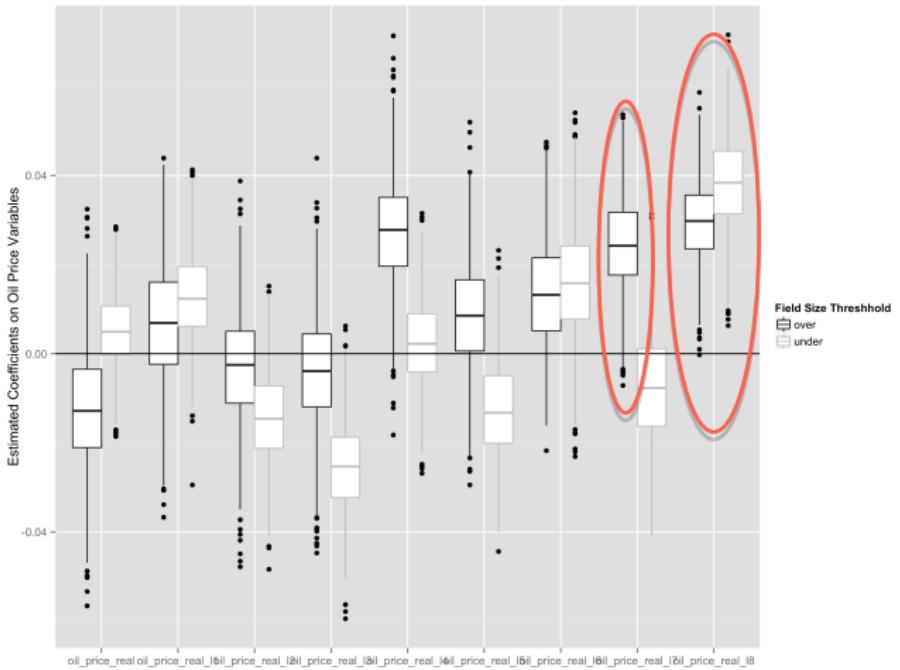
$$\min \| \mathbf{y} - \mathbf{f} \|^2 + \lambda J_{md}(f) \quad (5)$$

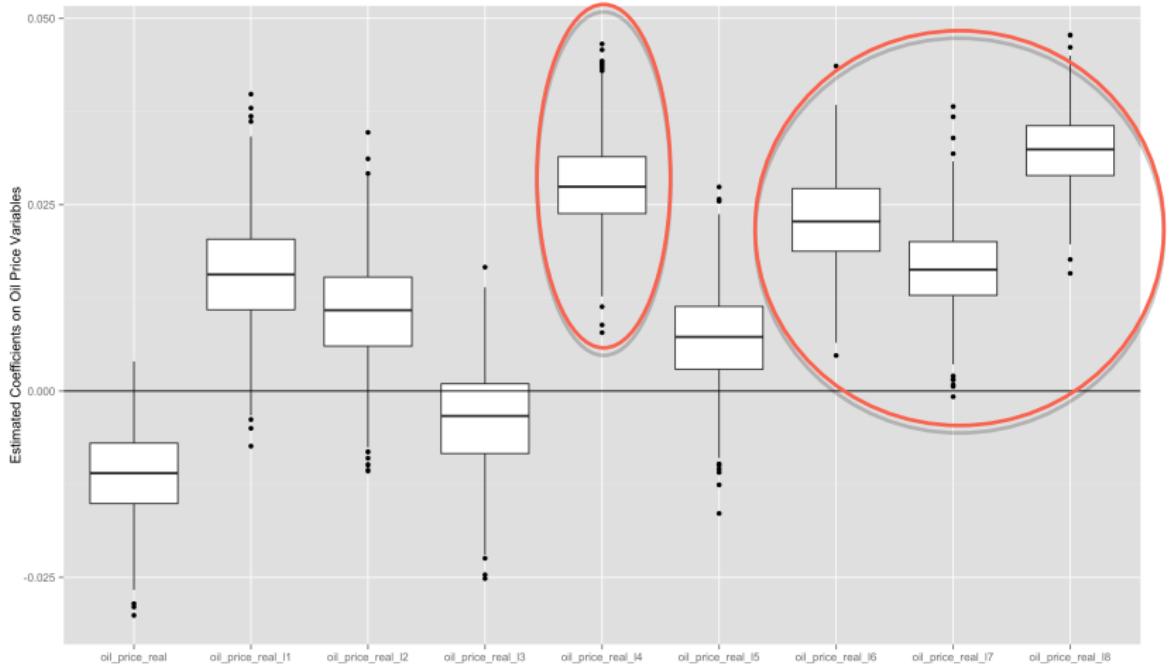
$$J_{22}f = \frac{\partial^2 f}{\partial x_1^2} + \frac{\partial^2 f}{\partial x_1 x_2^2} + \frac{\partial^2 f}{\partial x_2^2} dx_1 dx_2 \quad (6)$$



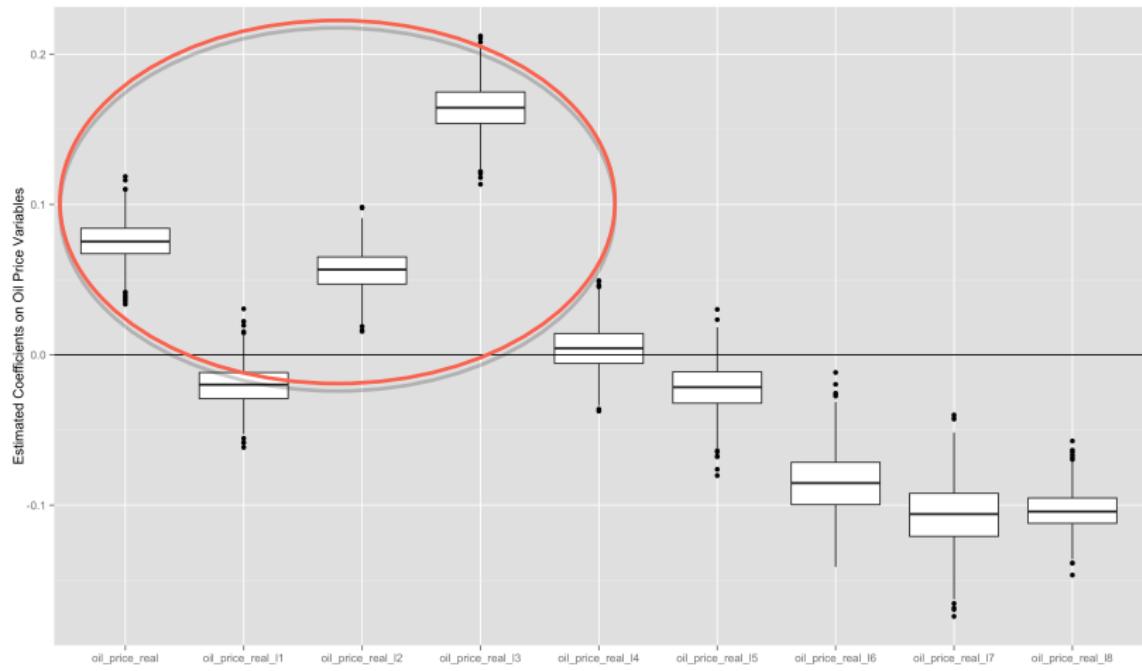


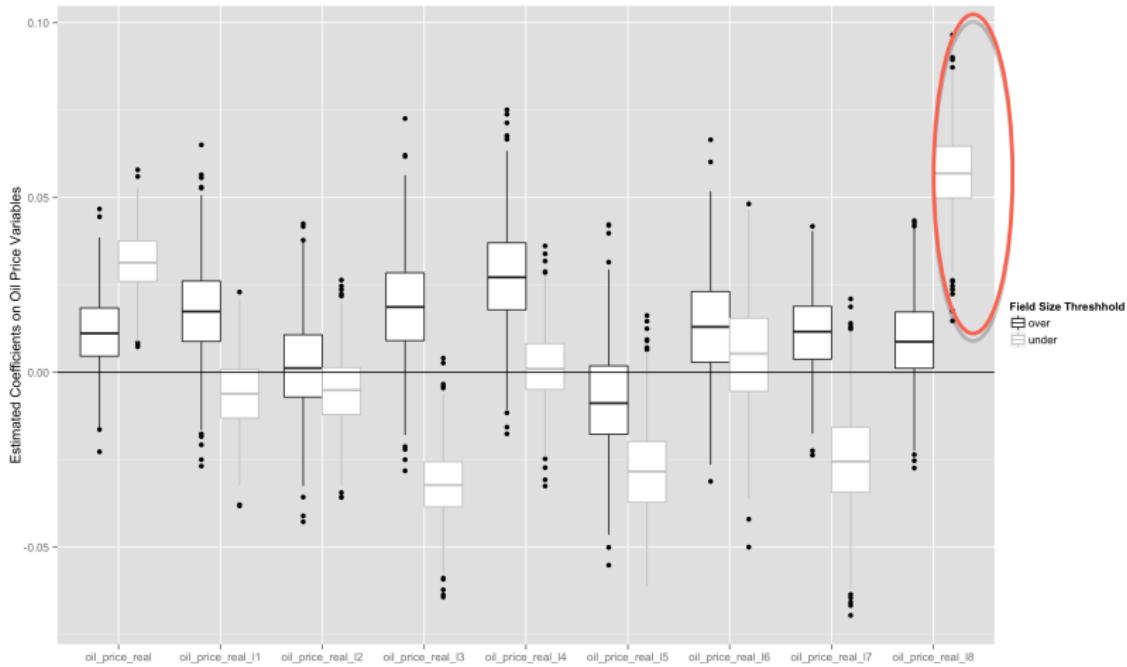


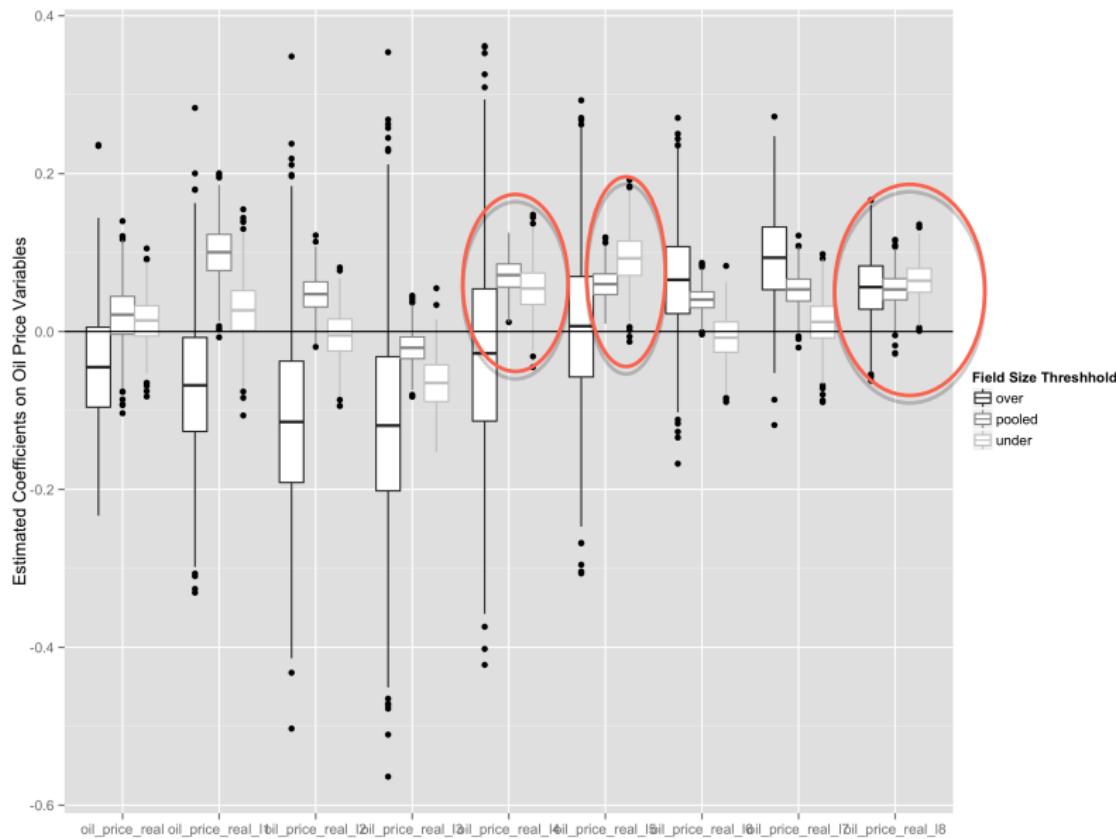


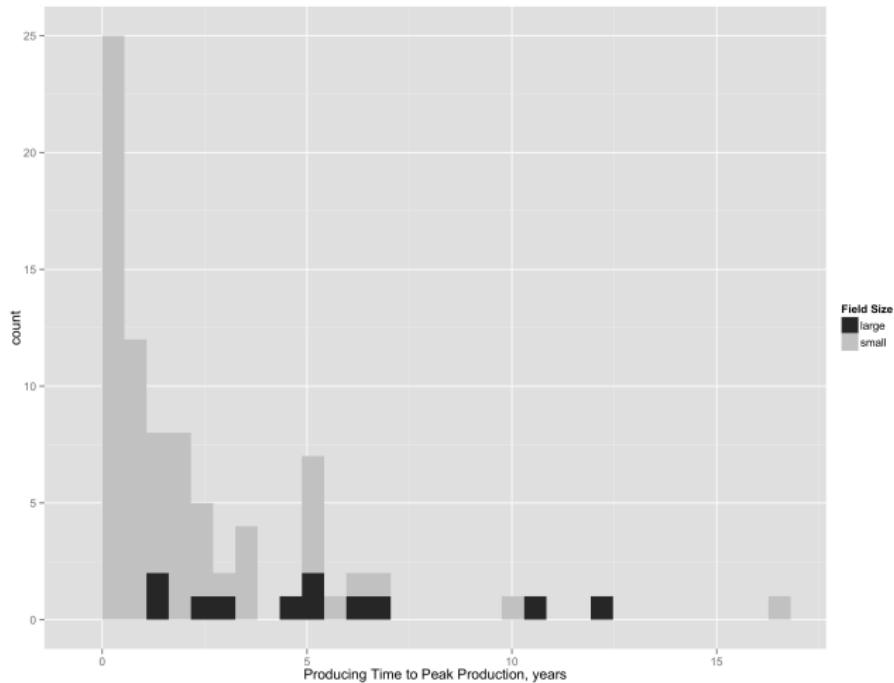


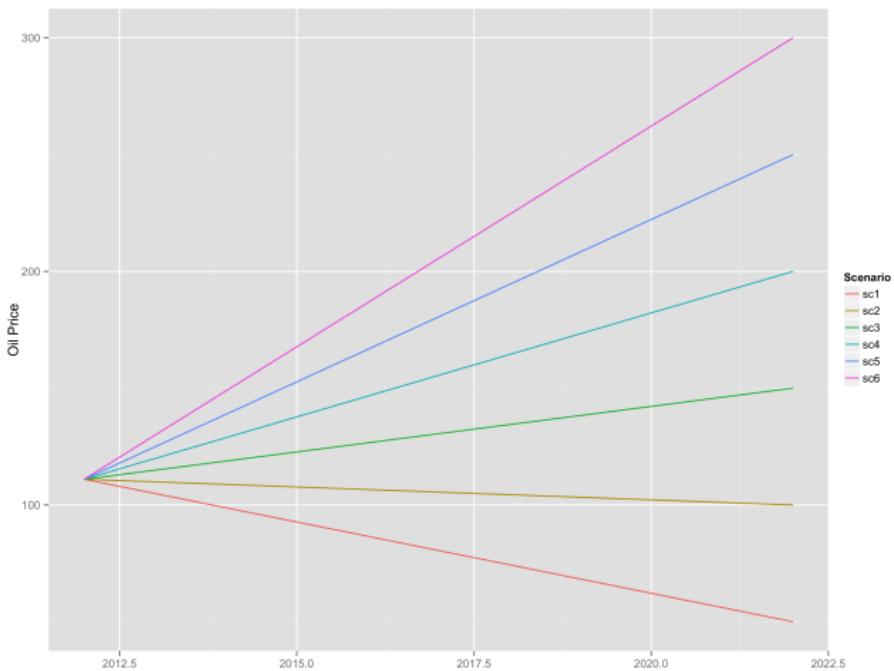
$$\begin{aligned} \text{Log}(Investment}_{i,t}) = & f(\text{time_to_peak}_{i,t}, \text{total_recoverable_oil}_i) \\ & + f(\text{peak_to_end}_{i,t}, \text{total_recoverable_oil}_i) \\ & + \alpha \text{oil_production}_{i,t} \\ & + \beta_1 \text{oil_price} + \beta_2 \text{oil_price_l1} + \dots + \epsilon \end{aligned} \tag{7}$$

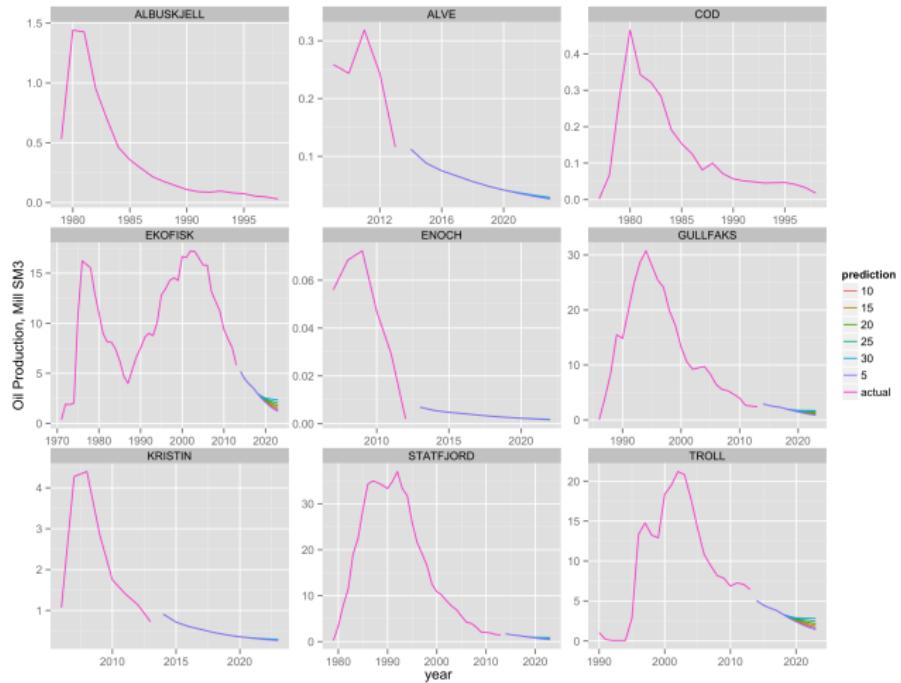


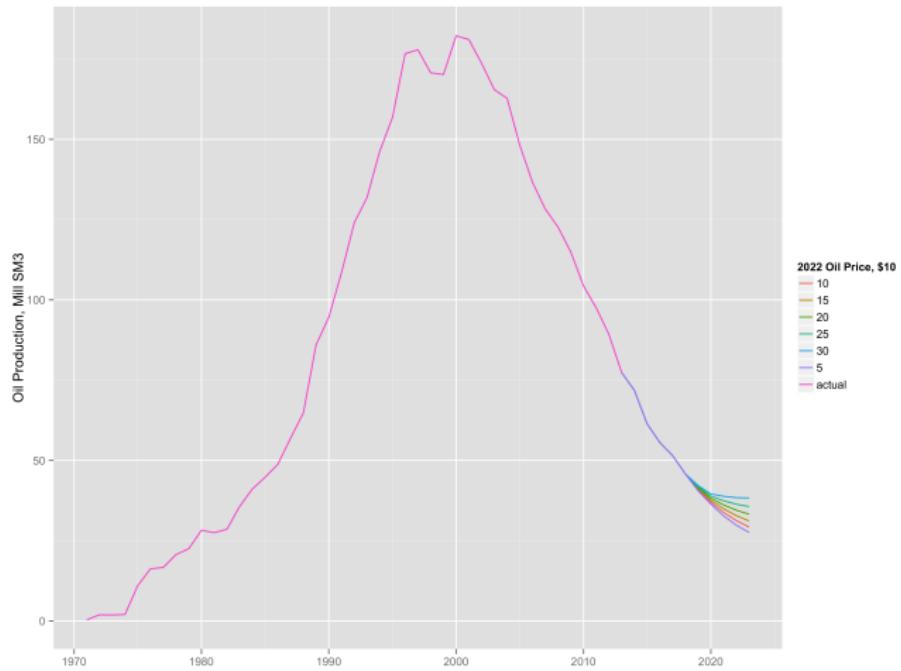












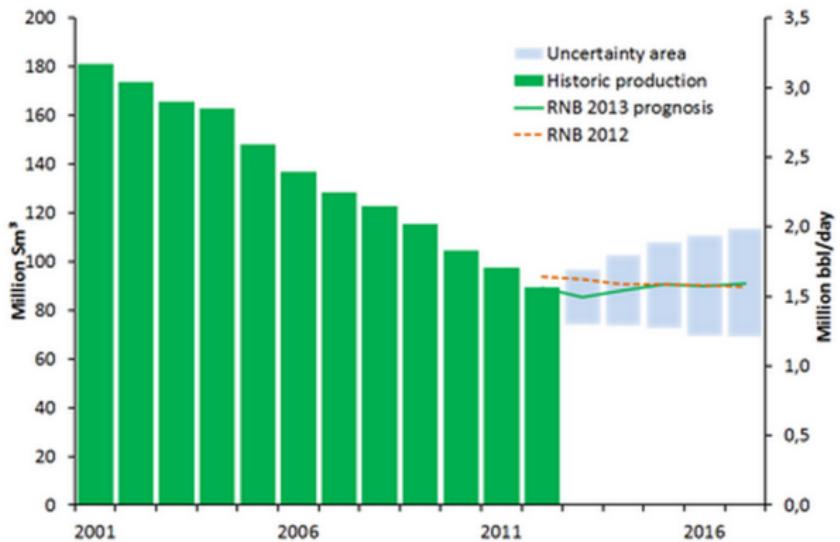


Figure 3. Uncertainty in future oil production.