The Decline of Norwegian Oil

The Effect of Price on Production in a Mature Petroleum Region

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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)
    - Ramcharran (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

figures/north_sea_reserves.png

Figure : *

figures/norwegian_sea_reserves.png

Figure : *

figures/oil_decline.png

Figure : *

figures/top10_production.png

Figure : *

$$
\begin{aligned}
Log(Production_{i,t}) = \alpha_0 &+ \alpha_1 time\_to\_peak_{i,t} + \alpha_2 time\_to\_peak_{i,t}^2 \\
&+ \alpha_3 time\_to\_peak_{i,t}^3 + \alpha_4 peak\_to\_end_{i,t} + \alpha_5 peak\_ \\
&+ \alpha_6 peak\_to\_end_{i,t}^3 + \gamma total\_recoverable\_oil_i \\
&+ \beta_1 oil\_price + \beta_2 oil\_price\_l1 + ... + \epsilon
\end{aligned} \tag{1}
$$

figures/statfjord_dem.png

Figure : *

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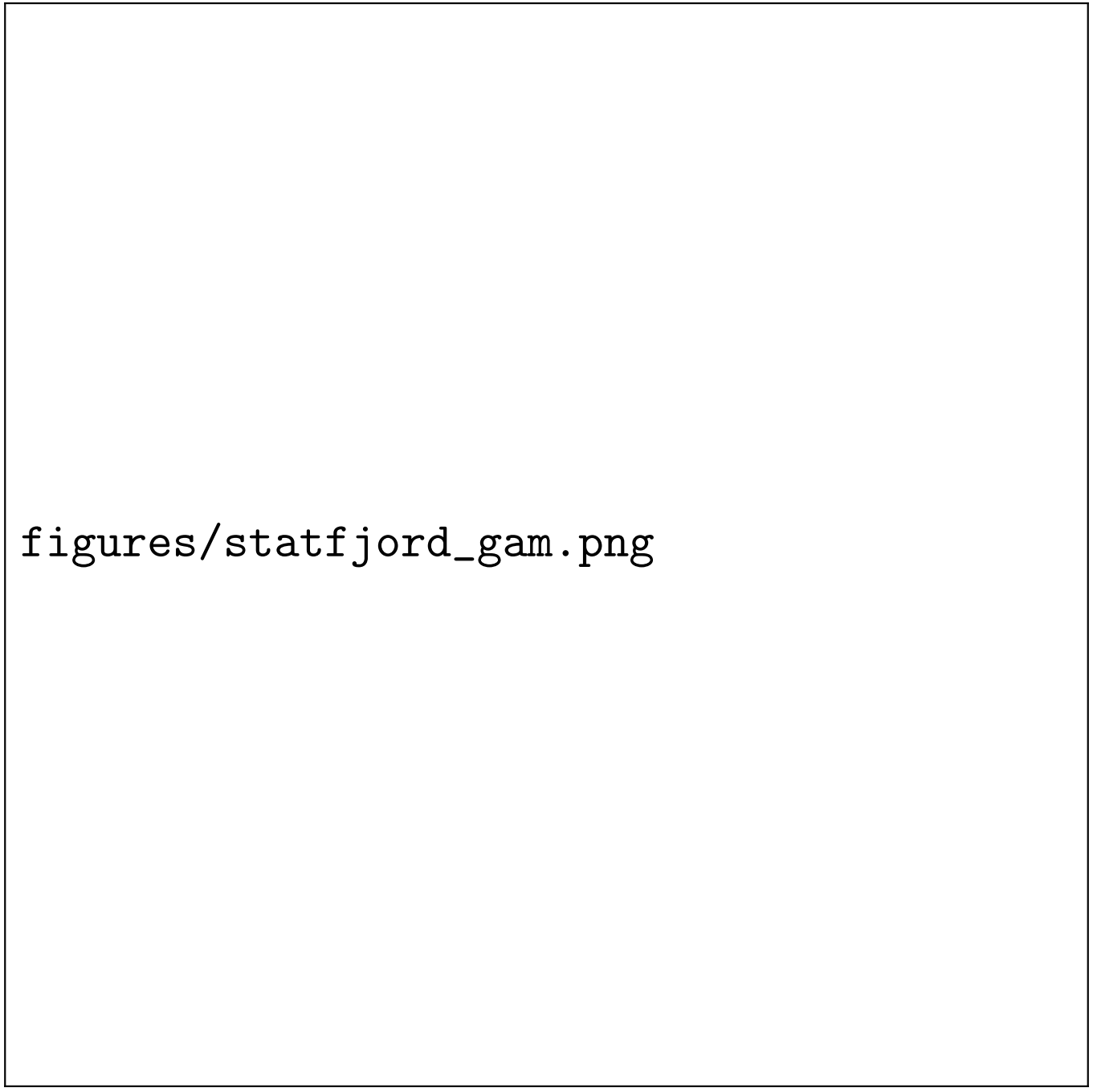
$$Production_t = f(time) + \epsilon \tag{2}$$



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$$
\begin{aligned}
Log(Production_{i,t}) = & f(time\_to\_peak_{i,t}, total\_recoverable\_oil_i) \\
& + f(peak\_to\_end_{i,t}, total\_recoverable\_oil_i) \\
& + \beta_1 oil\_price + \beta_2 oil\_price\_l1 + ... + \epsilon
\end{aligned} \tag{3}
$$

Thin Plate (Regression) Splines (Duchon 1977)

$$y_i = g(x_1, x_2) \tag{4}$$

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

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

Figure : *

figures/bench_vs_split.png

Figure : *

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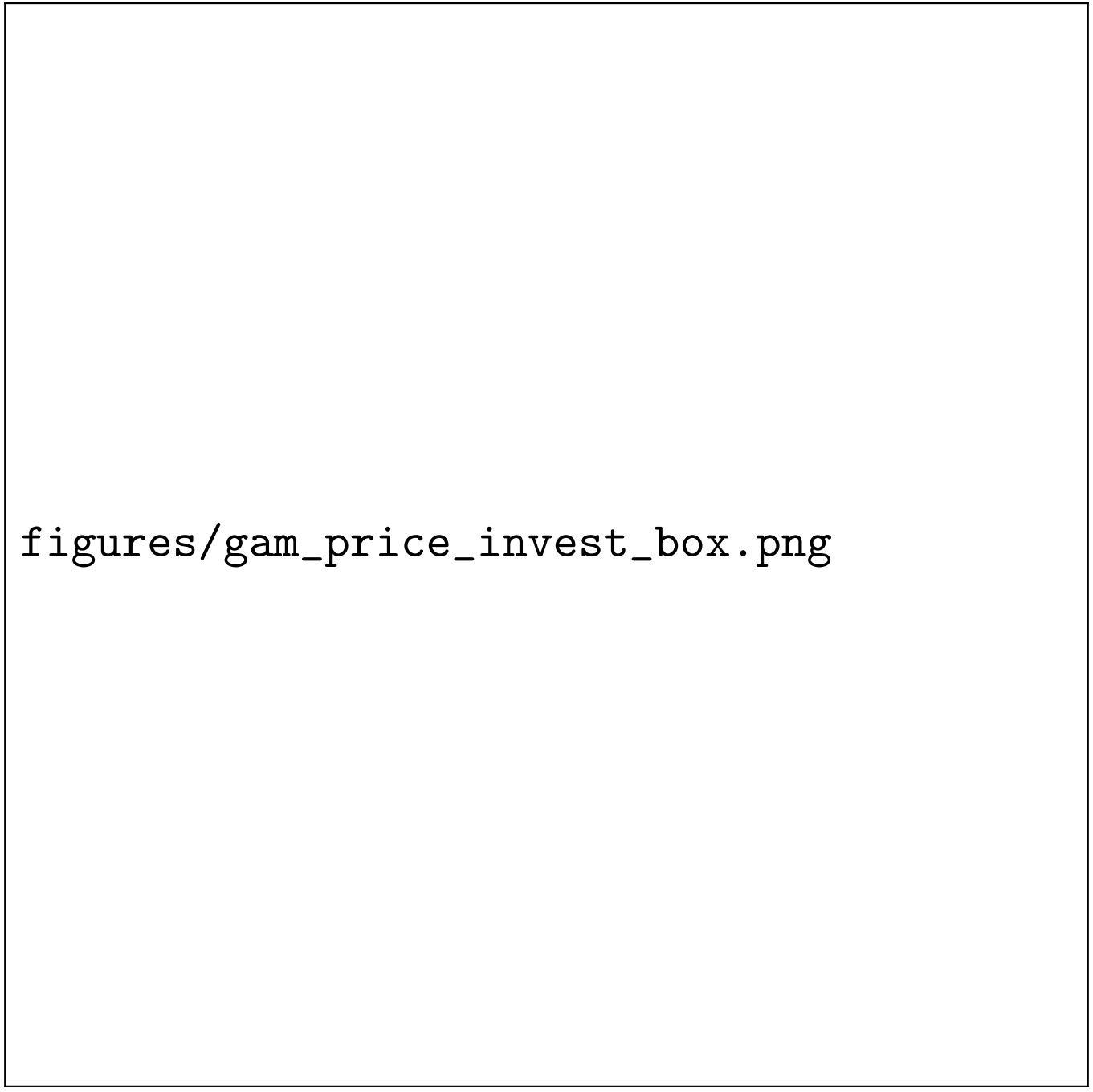
$$
\begin{aligned}
Log(Investment_{i,t}) = & f(time\_to\_peak_{i,t}, total\_recoverable\_oil_i) \\
& + f(peak\_to\_end_{i,t}, total\_recoverable\_oil_i) \\
& + \alpha oil_production_{i,t} \\
& + \beta_1 oil\_price + \beta_2 oil\_price\_l1 + ... + \epsilon
\end{aligned} \tag{7}
$$



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figures/NPD_oil_forecast.png

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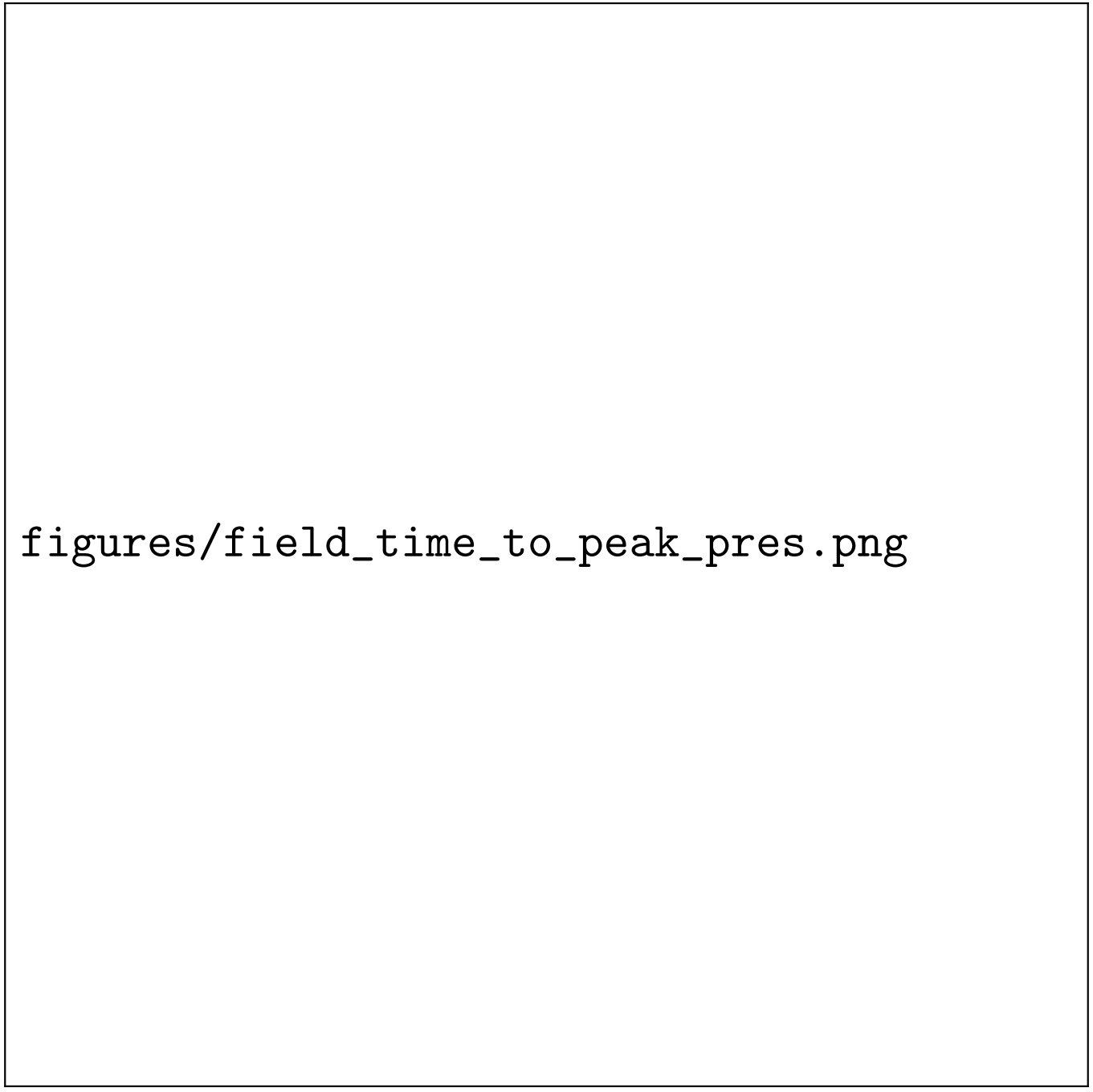

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