Estimating the Effect of Price on Oil Production: A Monte Carlo Experiment

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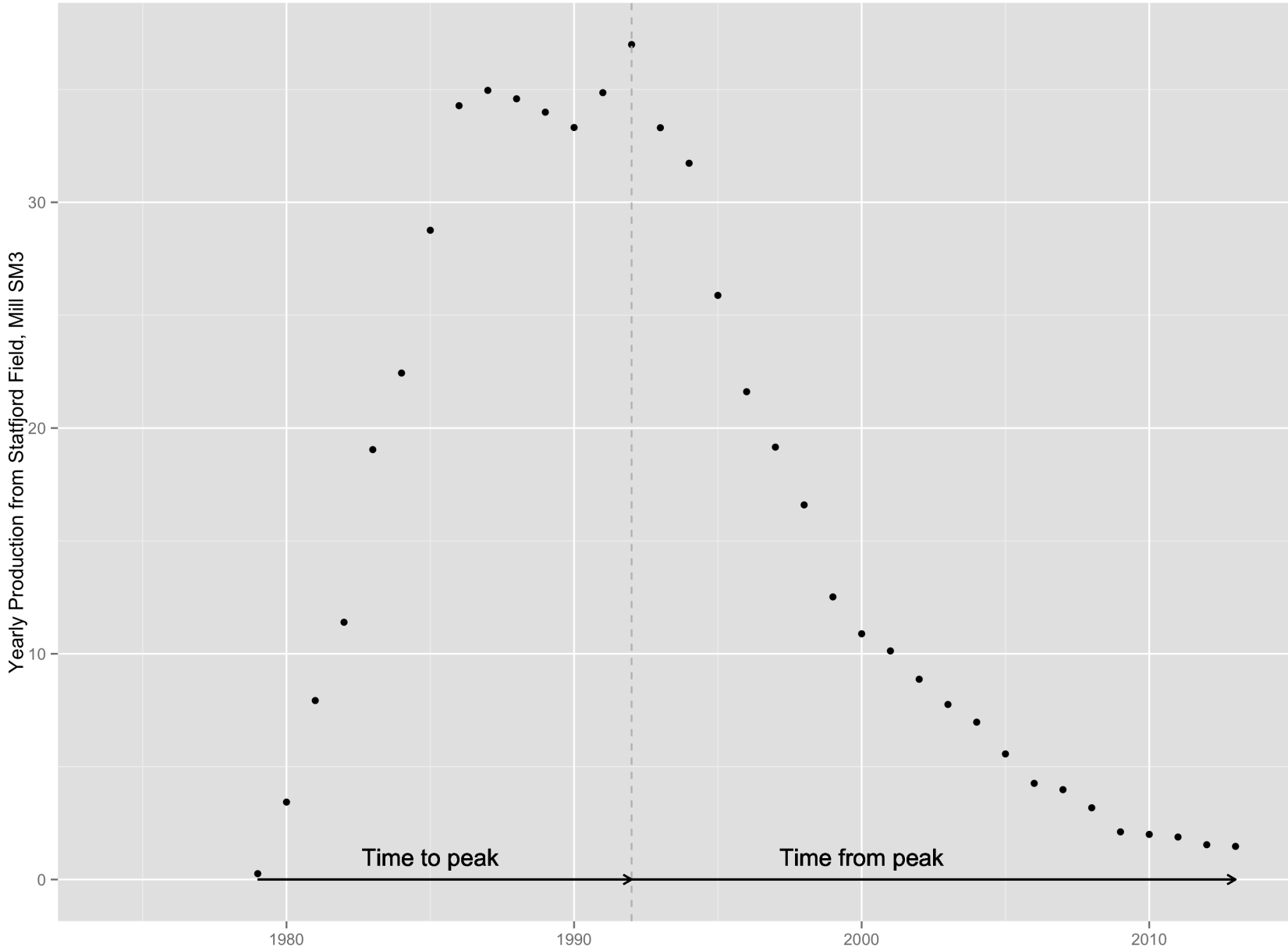
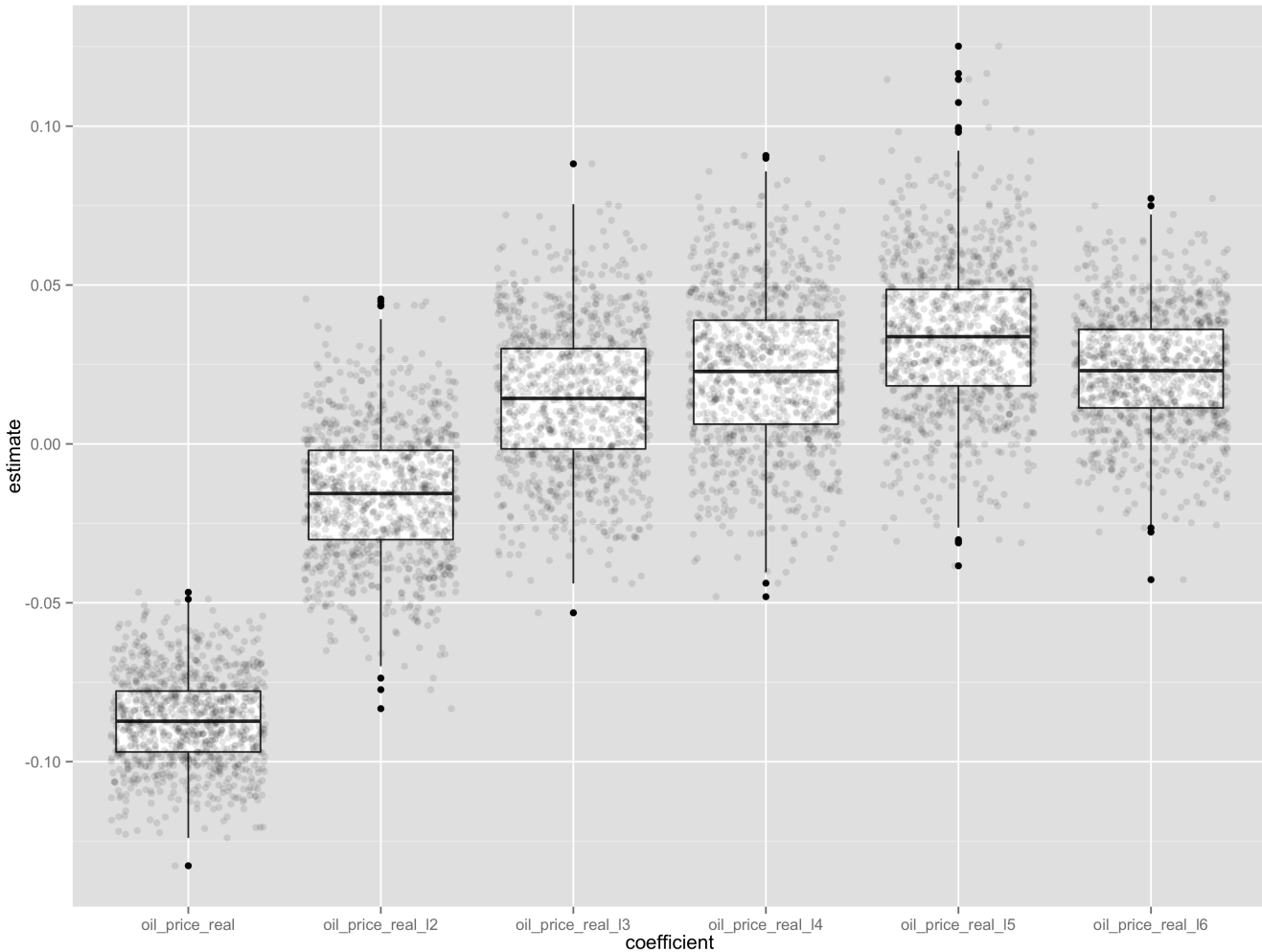
Main Results

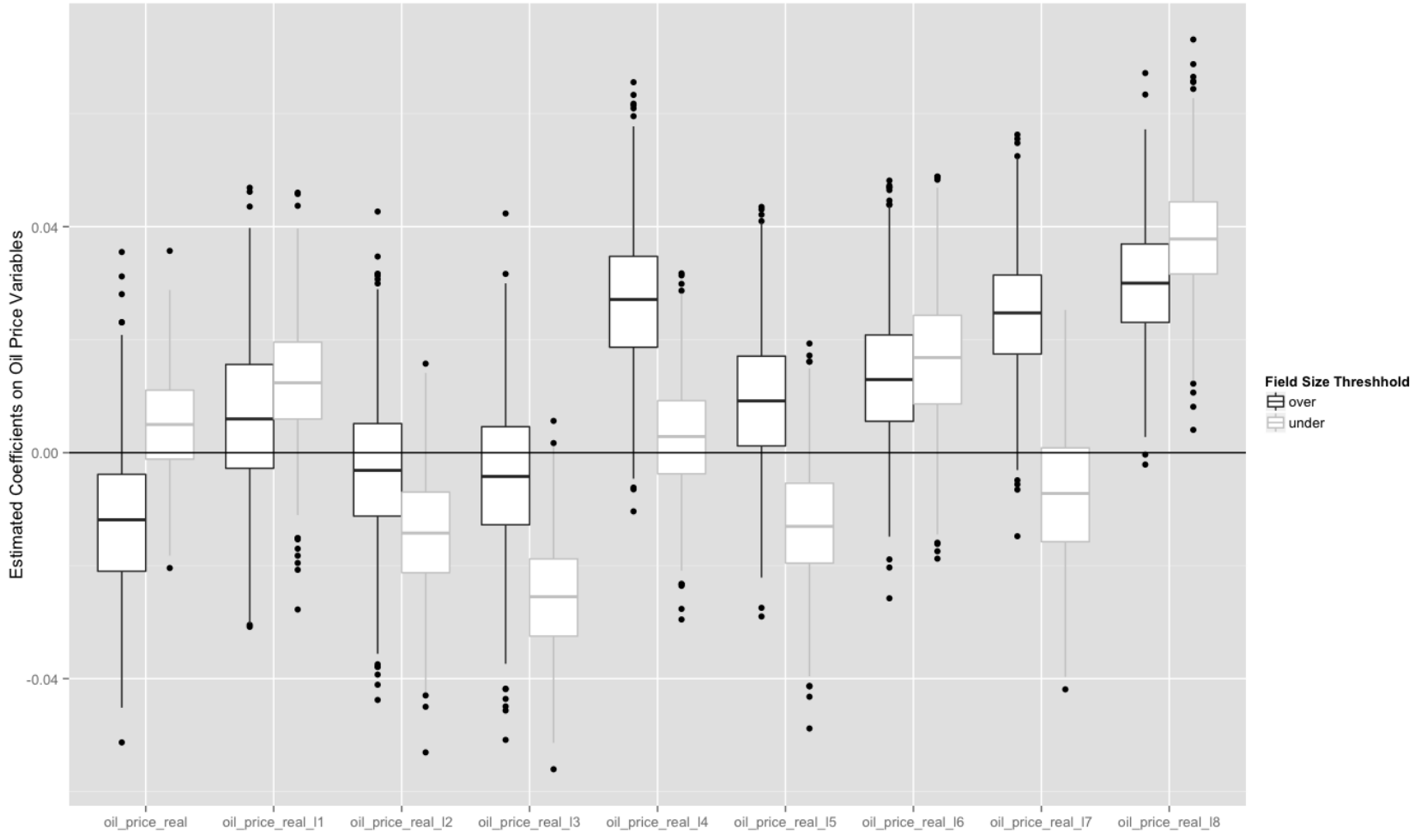
- No significant contemporary effect of oil price on field production (within 3 years)
- Slight lagged effect found after 4-8 years, magnitude of around 2%
- Most of this effect seems to come in the Planning stage of an oil field
- Little to no effect - contemporary or lagged - in depleting fields

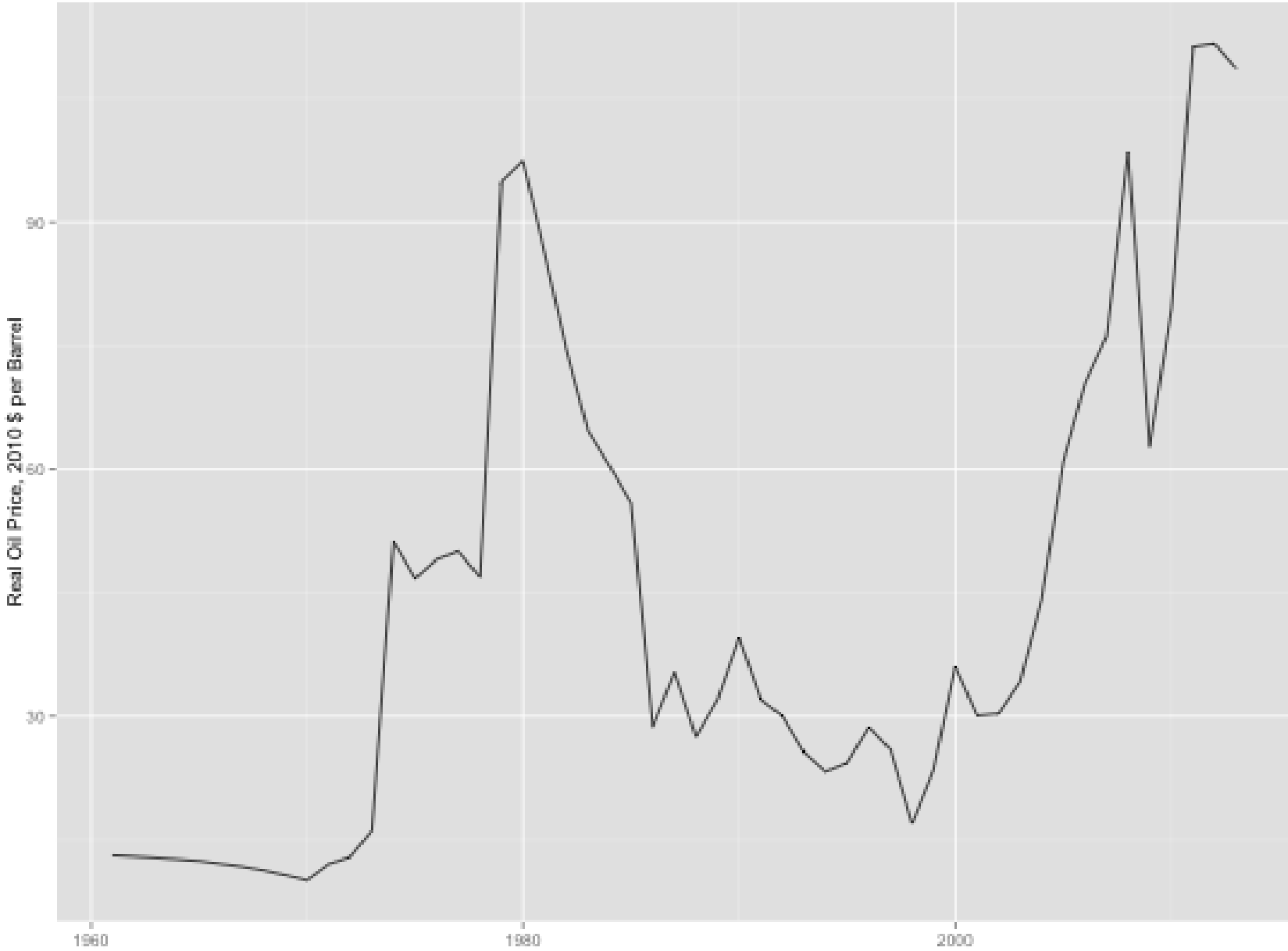

Yearly Production from Statfjord Field, Mill SM3
30
20
10
0
1980
1990
2000
2010
Time to peak
Time from peak

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


0.10
0.05
0.00
-0.05
-0.10
estimate
oil_price_real
oil_price_real_l2
oil_price_real_l3
oil_price_real_l4
oil_price_real_l5
oil_price_real_l6
coefficient

$$
\begin{aligned}
Log(Production_{i,t}) = & f(time\_to\_peak_{i,t}, total\_recoverable\_oil_i) \\
& + f(peak\_to\_end_{i,t}, total\_recoverable\_oil_i) \\
& + \beta_1 oil\_price + \beta_2 oil\_price\_l1 + ... + \epsilon
\end{aligned} \tag{2}
$$


Estimated Coefficients on Oil Price Variables
0.04
0.00
-0.04
oil_price_real
oil_price_real_l1
oil_price_real_l2
oil_price_real_l3
oil_price_real_l4
oil_price_real_l5
oil_price_real_l6
oil_price_real_l7
oil_price_real_l8
Field Size Threshhold
over
under


Real Oil Price, 2010 $ per Barrel
90
60
30
1960
1980
2000

```
fieldSize <- exp(rnorm(77, mean=2.3, sd=1.5))
```

```
genyear<-function(size, maxsize){
#let small fields be distributed uniformly from 1975 to 2013
if(size<10){
year<-trunc(runif(1, 1975, 2008))
}
```

```
else{
range<-FALSE
while(range==FALSE){
year<-trunc(rnorm(1,mean=(1973+(maxsize+300)/(size+300)), sd=10)
ifelse(year>=1970 & year<=2013, range<-TRUE, range<-FALSE)
}
}
return(year)
}
```

$$cumProd = \frac{size}{1 + exp(\frac{-prodTime_t}{3})} \tag{3}$$

$$log(production) = f`(time) + beta * log(price) + epsilon \qquad (4)$$

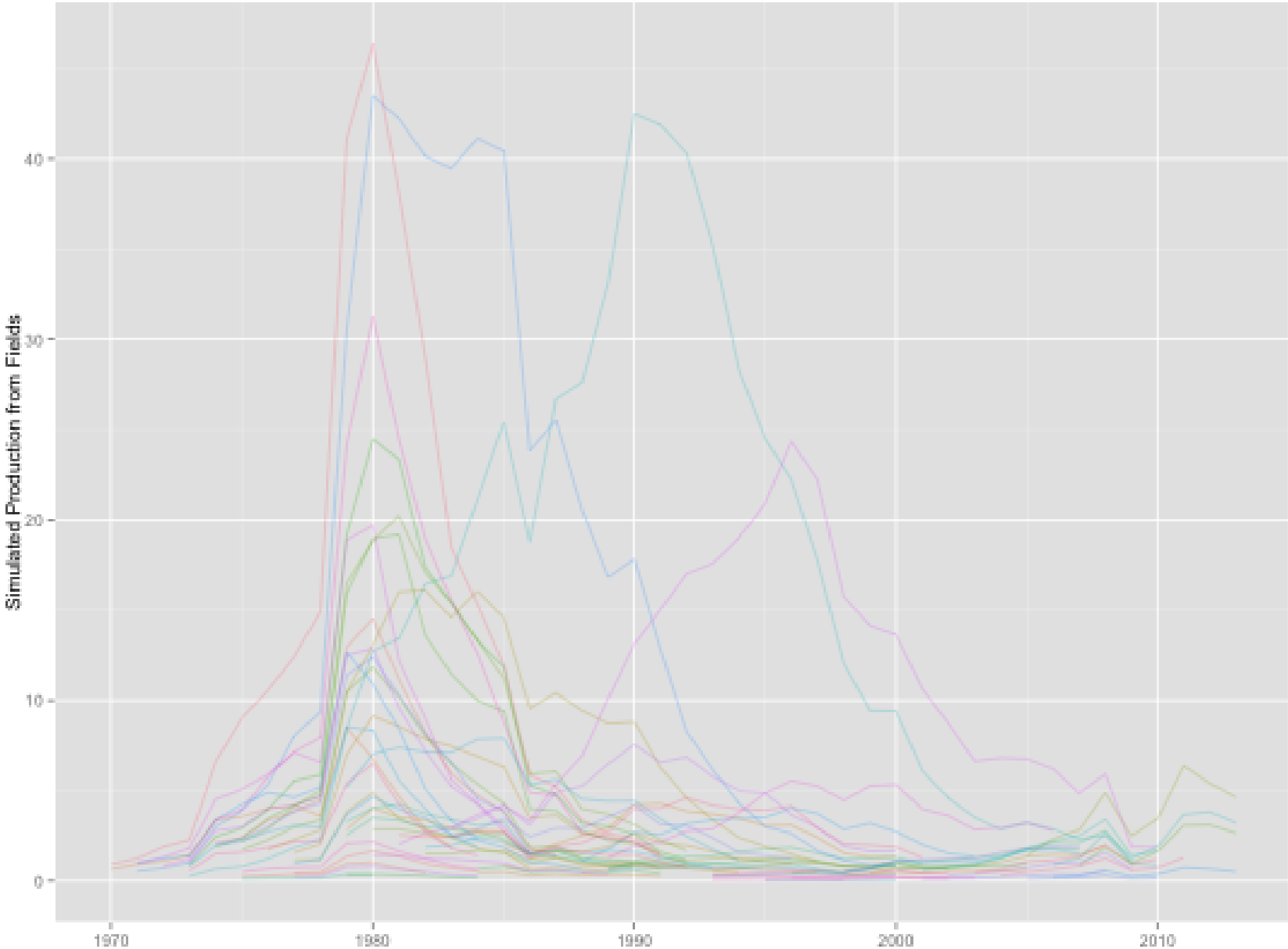


Figure : Simulated production of 77 oil fields

```
formula_0=formula(log(prod)~time_to_peak + time_to_peak_sq +
 time_to_peak_cu + peak_to_end + peak_to_end_sq +
 peak_to_end_cu + size + price)
```

```
gamm_mc_0<-replicate(1000, gam_mc(beta=0,
 formula=formula_0, use_true_prices=TRUE))
```

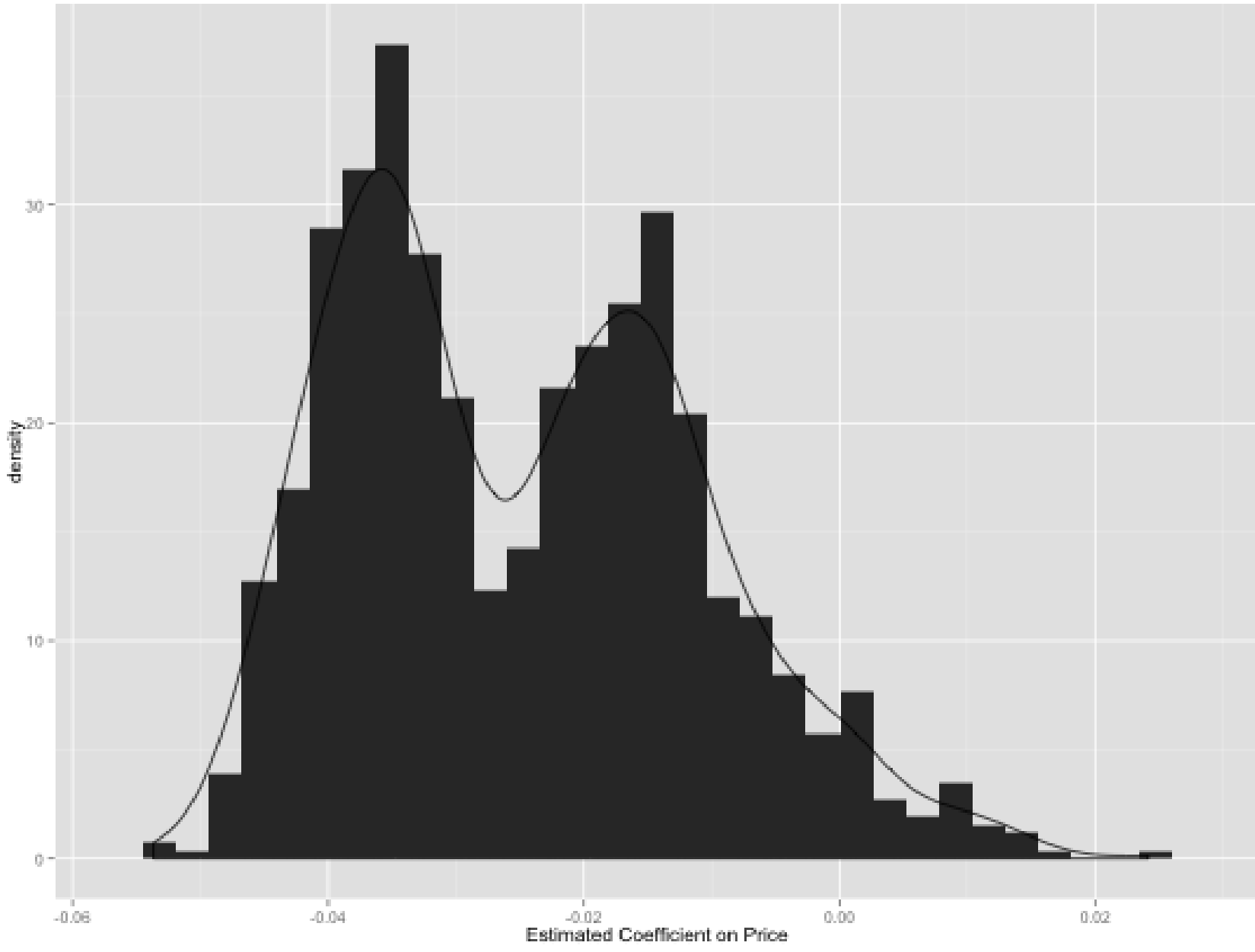


Figure : Estimated coefficients on price from linear model from Monte Carlo Experiment

```
formula_1= formula(prod~s(prod_time,size) + price)
```

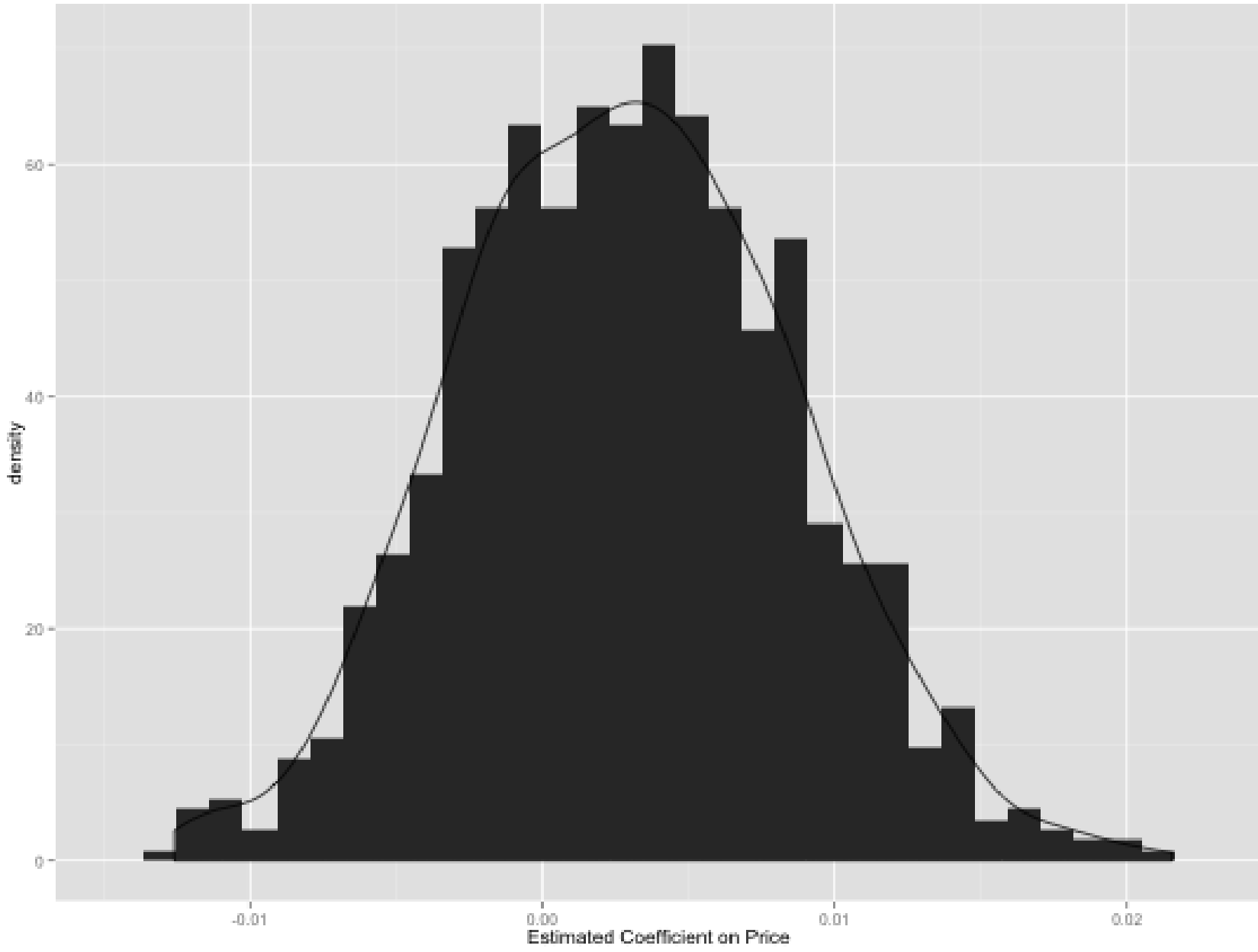


Figure : Estimated coefficients on price from GAM model from Monte Carlo Experiment

Extensions

- Computation and estimation of efficiency, power of estimators
- Comparison of stationary and non stationary simulated price series
- Using monte carlo to generate uncertainty of oil production forecasts