

Table 5: Production Function Model Estimates

Coefficient	(1)		(2)		(3)		(4)		(5)		(6)	
	Gaussian Process		Gaussian Process		Cobb-Douglas		Cobb-Douglas		Cobb-Douglas		Cobb-Douglas	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
γ_0	-0.3923	0.0519	-0.4552	0.0558								
γ_S	6.1910	0.1073	6.2347	0.1294								
γ_W	6.0067	0.1175	6.0079	0.1268								
γ_{lat}	-2.3848	0.0458	-2.4227	0.0509								
γ_{lon}	-2.2974	0.0489	-2.3485	0.0560								
α	-2.5177	0.2361	-2.1914	0.8241	0.3877	0.2955	-3.9305	0.3585	1.7730	0.7489	-2.8046	0.6635
β	-0.5592	0.0012	-0.5592	0.0012	-0.5592	0.0012	-0.5593	0.0012	-0.5592	0.0012	-0.5594	0.0012
δ	1.1663	0.0025	1.1663	0.0025	1.1662	0.0025	1.1663	0.0025	1.1664	0.0025	1.1663	0.0025
η	0.8525	0.0251	0.8466	0.0251	0.4335	0.0311	0.7966	0.0257	0.4770	0.0308	0.8041	0.0257
ω_{TOC}			-0.9552	0.4460					-0.8794	0.3961	0.0062	0.3202
ω_{THICK}			-0.2531	0.8717					-0.5705	0.5853	-2.3859	0.5017
ω_{MATURE}			1.1767	0.3846					-0.5281	0.3774	-0.2376	0.2814
ω_S			-0.1951	0.1515	0.2087	0.0165	0.1457	0.0122	-0.3054	0.1632	-0.0528	0.1226
$\omega_{TOC,S}$			0.2093	0.0855					0.0933	0.0900	0.0197	0.0697
$\omega_{THICK,S}$			0.0180	0.1526					0.7271	0.1328	0.4945	0.1022
$\omega_{MATURE,S}$			-0.0886	0.0764					0.0790	0.0863	-0.0587	0.0634
ω_W			0.1718	0.1665	0.0437	0.0168	0.1334	0.0125	0.1856	0.1655	0.1941	0.1292
$\omega_{TOC,W}$			-0.0599	0.0914					0.0499	0.0891	-0.0483	0.0695
$\omega_{THICK,W}$			0.0517	0.1622					-0.4550	0.1394	-0.1389	0.1089
$\omega_{MATURE,W}$			-0.1075	0.0809					0.0136	0.0846	0.0946	0.0646
$\log \sigma_\epsilon$	-1.1807	0.0135	-1.1829	0.0138	-0.5601	0.0109	-1.0264	0.0111	-0.5940	0.0109	-1.0316	0.0111
$\log \sigma_\nu$	-0.7885	0.0016	-0.7885	0.0016	-0.7884	0.0016	-0.7885	0.0016	-0.7884	0.0016	-0.7885	0.0016
Township FE	No		No		No		Yes		No		Yes	
Overall R^2	0.7385		0.7389		0.5046		0.6900		0.5213		0.6915	
Between R^2	0.8093		0.8100		0.2668		0.7056		0.3130		0.7087	

Wells = 4,408, # Well-months = 193,846. "Between" R^2 is the R^2 for the average predicted log baseline production. The R^2 for the predicted time series of production is .6717 for all specifications. Maximum likelihood estimates of Cobb-Douglas production function models:

$$\log Y_{it} = \alpha + \beta \log t + \delta \log D_{it} + \eta \log H_i + m(Z_i, R_i | \omega) + \tau_i + \epsilon_i + \nu_{it}$$

and Gaussian process production function models:

$$\log Y_{it} = \alpha + \beta \log t + \delta \log D_{it} + \eta \log H_i + f(Z_i, R_i | \gamma, \omega) + \epsilon_i + \nu_{it}$$

Y_{it} is oil production for well i when it is t months old, D_{it} is the number of days producing, H_i is the horizontal length, R_i is the vector of organic content, thickness and maturity, and Z_i is the vector of sand use S_i , water use W_i , latitude lat_i and longitude lon_i . τ_i is a set of township fixed effects.