Panel data

For $t = 1, \ldots n$ and $i = 1, \ldots, N$

y_{it} : tth observation for ith individual

ε_{it} : tth error term for ith individual

x_{it} : regressor for ith individual at time t, x_{it} is $(k \times 1)$

N individuals, T observations, and k regressors.

PANEL DATA MODELS:

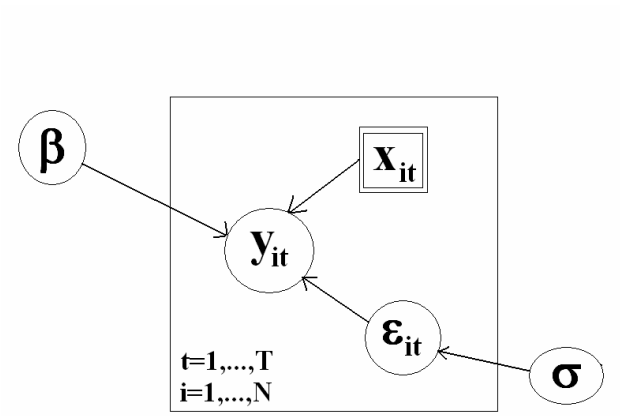
Pooled model: $y_i = X_i \beta + \varepsilon_i$

Individual effects model: $y_i = 1_T \alpha_i + \tilde{X}_i \tilde{\beta} + \varepsilon_i$

Random coefficients model: $y_i = X_i \beta_i + \varepsilon_i$

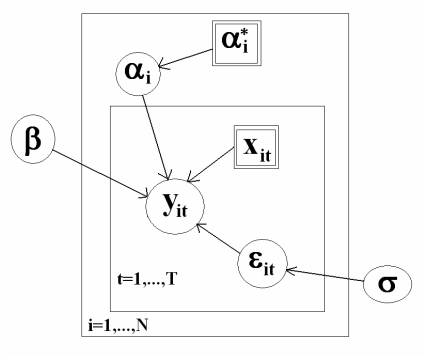
where $\beta = (\alpha, \tilde{\beta})', X = (1_T, \tilde{X})$, and $\varepsilon_i \sim NID(0, \sigma^2 I_T)$

Pooled model

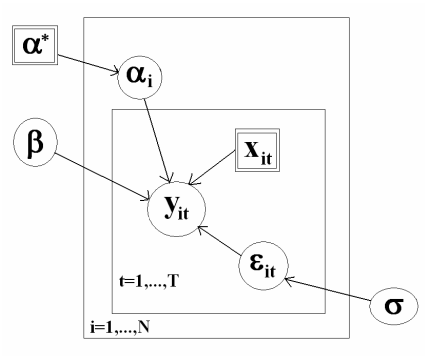


Individual effects model

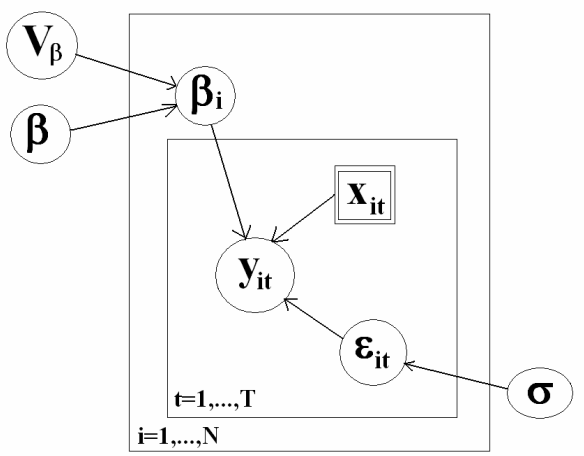
Nonhierarchical prior



Hierarchical prior



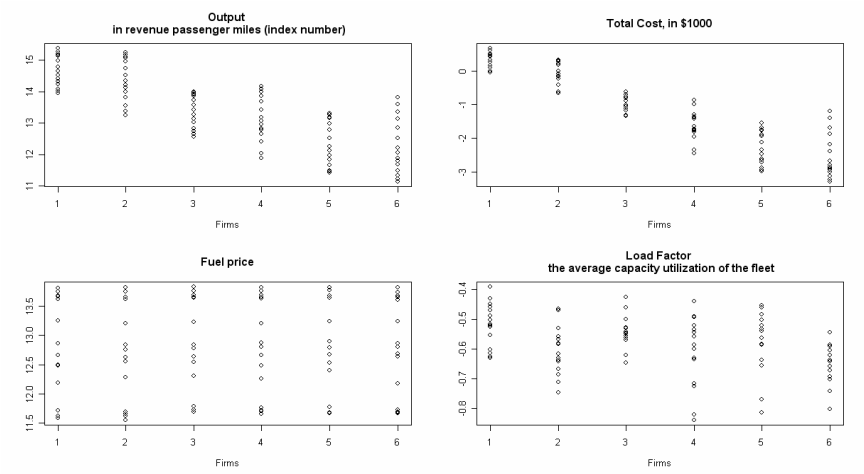
Random effects model



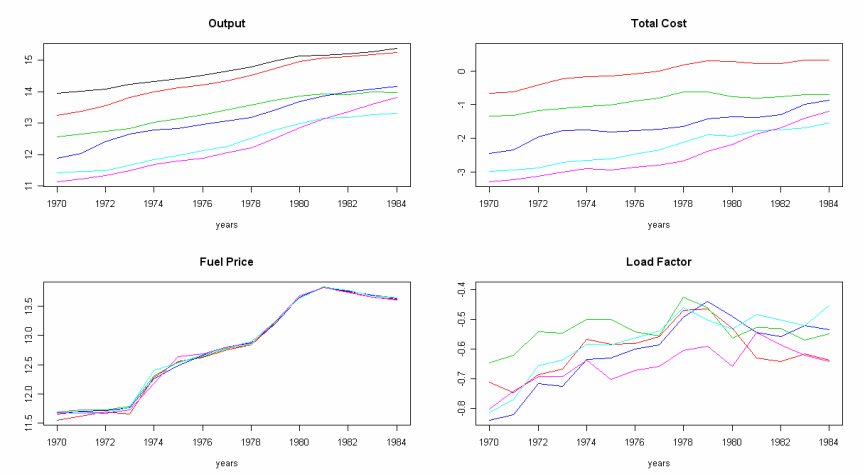
Panel data example

- Costs for 6 U.S. Airlines companies for 1970-1984.
- Dependent variable:
  - Output, in revenue passenger miles, index number
- Regressors:
  - Total cost, in $1000
  - Fuel price
  - Load factor, the average capacity utilization of the fleet
- T=15 years, N=6 companies and k=3 regressors

Airline data



Time series



6 individual regressions

	Intercept	Total Cost	Fuel Price	Load Factor
par	8.5591692	1.16640293	0.39169013	-1.46136744
se	0.2826514	0.10011437	0.01910501	0.25301802
par	9.5408439	1.46488720	0.31035028	-1.52160585
se	0.3246412	0.08210449	0.02801030	0.13702936
par	8.0011409	0.71963705	0.45343820	-0.42409611
se	0.5084815	0.15443287	0.03774771	0.35733772
par	8.5737604	0.93713881	0.45901400	-0.37646810
se	0.7317680	0.07859060	0.04497501	0.25935245
par	10.6531190	1.06183798	0.29591013	-0.61319870
se	0.7268076	0.07642568	0.04387228	0.17202497
par	10.9130393	0.96753868	0.30019366	0.08667271
se	0.5484628	0.03205107	0.03063012	0.24303809

Ignoring heterogeneity by fitting on linear regression model for all 90 observations

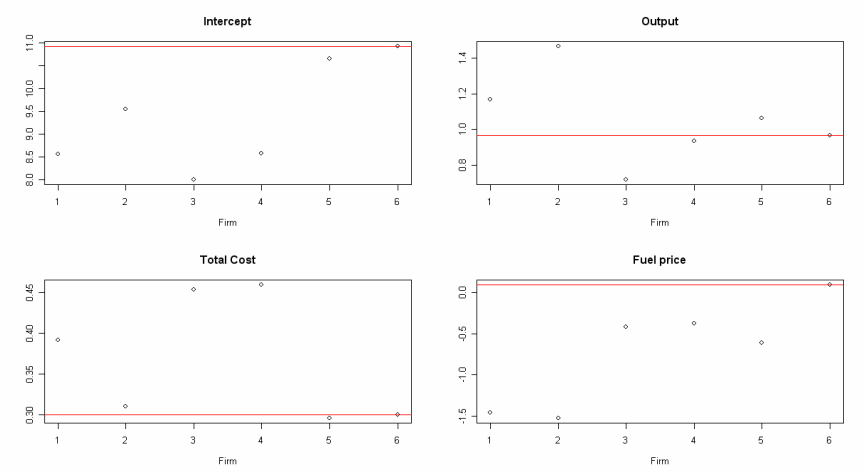
Parameter estimates

Firm	Intercept	Total Cost	Fuel Price	Load Factor
1	8.559169	1.1664029	0.3916901	-1.461367
2	9.540844	1.4648872	0.3103503	-1.521606
3	8.001141	0.7196371	0.4534382	-0.424096
4	8.573760	0.9371388	0.4590140	-0.376468
5	10.653119	1.0618380	0.2959101	-0.613199
6	10.913039	0.9675387	0.3001937	0.086673
Pooled	8.075649	0.8828541	0.4546868	-0.891464

Standard error of estimates

	Intercept	Total Cost	Fuel Price	Load Factor
se	0.2826514	0.10011437	0.01910501	0.25301802
se	0.3246412	0.08210449	0.02801030	0.13702936
se	0.5084815	0.15443287	0.03774771	0.35733772
se	0.7317680	0.07859060	0.04497501	0.25935245
se	0.7268076	0.07642568	0.04387228	0.17202497
se	0.5484628	0.03205107	0.03063012	0.24303809
Pooled	0.3342027	0.01330213	0.02046025	0.19065474

Estimates



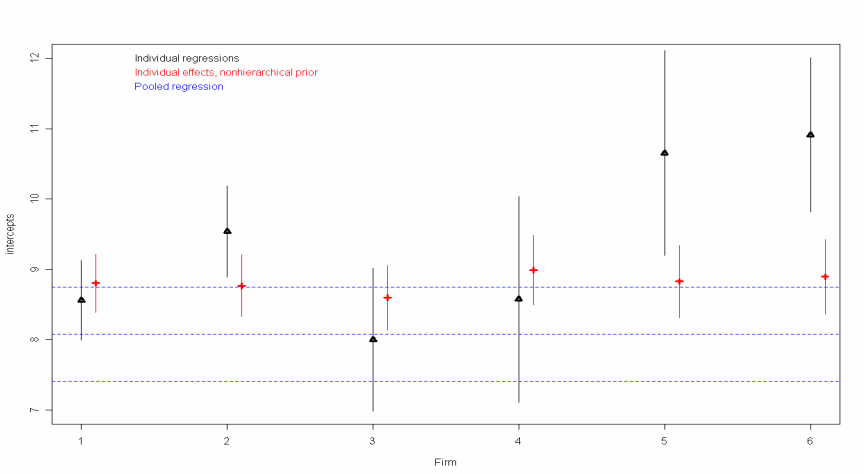
Individual effects with nonhierarchical prior

	parameter estimates	standard error
alpha1	8.8019549	0.20826802
alpha2	8.7654389	0.21888229
alpha3	8.5947641	0.23069662
alpha4	8.9884205	0.24725654
alpha5	8.8268837	0.25908670
alpha6	8.8939219	0.26647114
COST	0.9187036	0.02976197
FUEL	0.4158084	0.01503234
FACTOR	-0.5527304	0.10992766

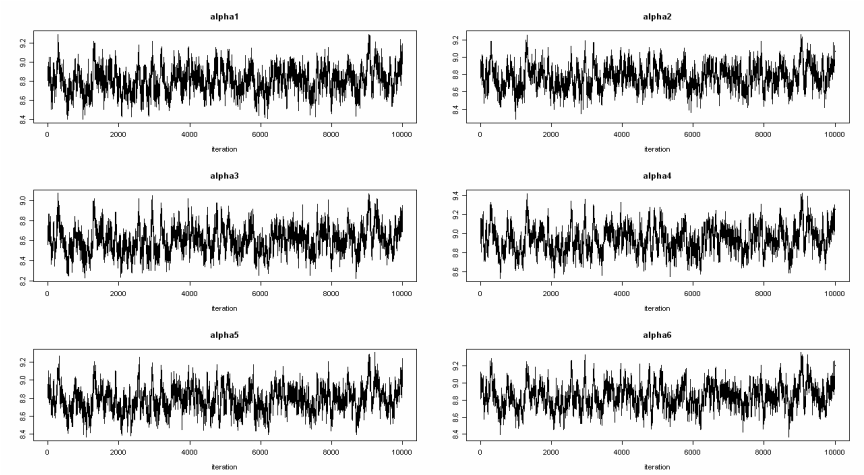
Comparing other regressors

	Total Cost	Fuel Price	Load Factor	sigma2
Airline 1	1.1664029	0.3916901	-1.46136744	0.001413859
Airline 2	1.4648872	0.3103503	-1.52160585	0.015579075
Airline 3	0.7196370	0.4534382	-0.42409611	0.003543916
Airline 4	0.9371388	0.4590140	-0.37646810	0.145444336
Airline 5	1.0618380	0.2959101	-0.61319870	0.147826639
Airline 6	0.9675387	0.3001937	0.08667271	0.144791589
Pooled	0.8828541	0.4546868	-0.89146395	0.150715274
Nonhierarchical	0.9187036	0.4158084	-0.55273039	0.155929392
Hierarchical	0.9010860	0.4160487	-0.52612046	0.160115255

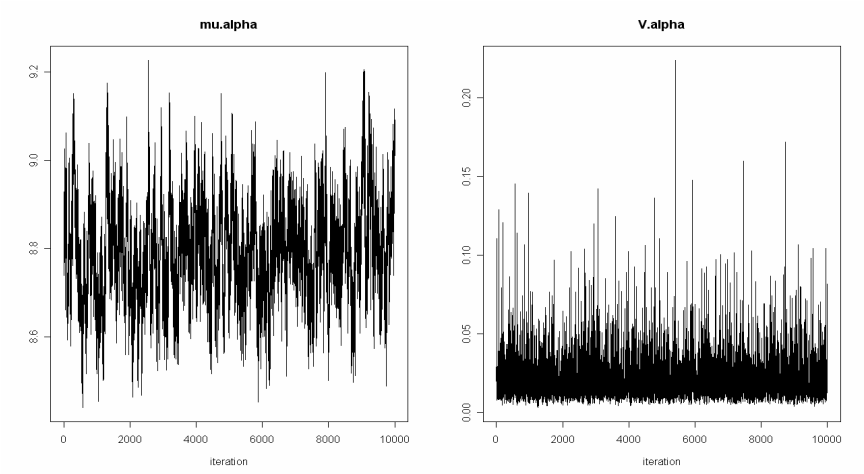
Comparison



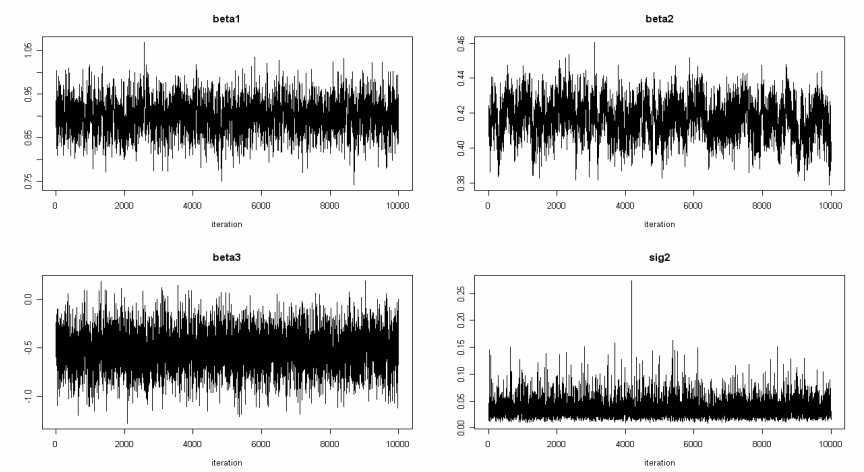
Individual effects with hierarchical prior



hyperparameters

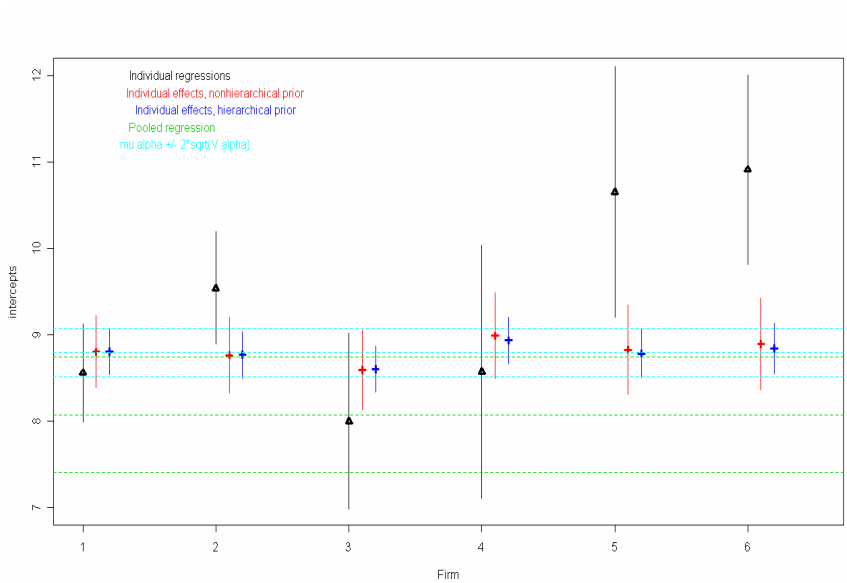


Other parameters



	PRIOR			
	NON-HIERARCHICAL		HIERARCHICAL	
	parameter estimates	standard error	parameter estimates	standard error
alpha1	8.801955	0.2082680	8.803550	0.1316991
alpha2	8.765439	0.2188823	8.768506	0.1347153
alpha3	8.594764	0.2306966	8.603203	0.1316831
alpha4	8.988420	0.2472565	8.935631	0.1353796
alpha5	8.826884	0.2590867	8.782959	0.1394919
alpha6	8.893922	0.2664711	8.841829	0.1447149
m.alpha			8.792618	0.1157588
V.alpha			0.137541	0.0120244

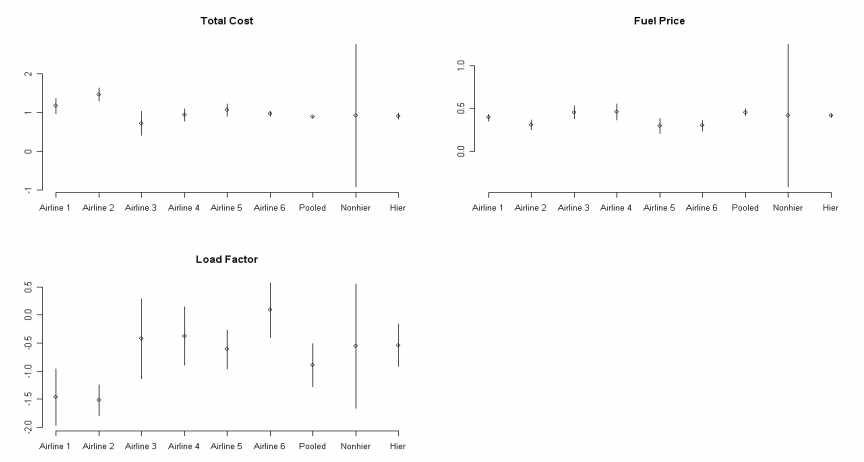
Comparison



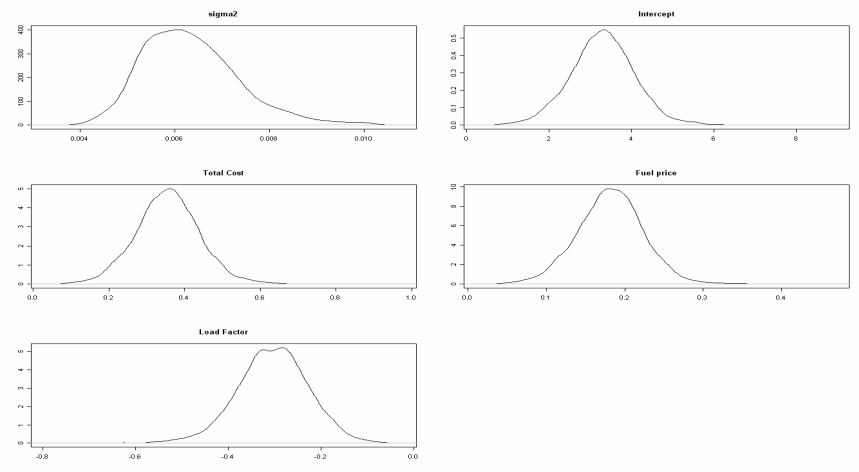
Other parameters

	Total Cost	Fuel Price	Load Factor	sigma2
Airline 1	1.1664029	0.3916901	-1.46136744	0.001413859
Airline 2	1.4648872	0.3103503	-1.52160585	0.015579075
Airline 3	0.7196370	0.4534382	-0.42409611	0.003543916
Airline 4	0.9371388	0.4590140	-0.37646810	0.131699070
Airline 5	1.0618380	0.2959101	-0.61319870	0.134715261
Airline 6	0.9675387	0.3001937	0.08667271	0.131683146
Pooled	0.8828541	0.4546868	-0.89146395	0.135379576
Nonhierarchical	0.9187036	0.4158084	-0.55273039	0.139491879
Hierarchical	0.8993396	0.4164568	-0.53900453	0.144714911

Other parameters



Random coefficients model



Random coefficients