Appeared in: Applied Stochastic Models in Business and Industry, 2011, 27, 222-234.

Table 3. Cont'd

	$p = 0.0$			$p = 0.05$			$p = 0.1$		
	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 50, 0.6, 0.6, 1.0)$								
β_0	-0.0134	0.6142	0.9438	0.0569	0.6270	0.9423	0.0414	0.6486	0.9309
β_1	0.1067	0.3616	0.9436	0.2987	0.3770	0.9425	0.3071	0.3924	0.9328
β_2	0.1254	0.0781	0.9439	0.3105	0.0810	0.9434	0.3886	0.0853	0.9371
σ_v^2	0.4081	0.1527	0.9393	0.8606	0.1624	0.9337	0.9318	0.1702	0.9218
θ_1	14.8354	0.0229	0.9616	14.6790	0.0231	0.9603	15.8934	0.0235	0.9633
θ_2	4.5703	0.0279	0.9547	5.1709	0.0285	0.9520	4.7445	0.0280	0.9543
λ	-0.1059	0.0050	0.9442	0.0172	0.0052	0.9419	0.0015	0.0054	0.9318
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 50, 1.2, 1.2, 1.5)$								
β_0	-0.0115	0.8184	0.9486	0.0448	0.8516	0.9387	0.1505	0.8959	0.9336
β_1	0.2847	0.4630	0.9495	0.4167	0.4901	0.9351	0.6891	0.5189	0.9297
β_2	0.1781	0.1011	0.9483	0.3984	0.1072	0.9406	0.6231	0.1122	0.9315
σ_v^2	1.0174	0.4334	0.9408	1.4785	0.4664	0.9259	2.1340	0.4961	0.9212
θ_1	15.6651	0.0139	0.9563	15.2617	0.0134	0.9598	15.4448	0.0137	0.9579
θ_2	4.4971	0.0167	0.9504	5.0520	0.0170	0.9518	4.5319	0.0166	0.9508
λ	-0.1023	0.0064	0.9507	-0.0346	0.0067	0.9372	0.1172	0.0071	0.9273
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 50, 0.2, 0.2, .5)$								
β_0	-0.0028	0.1985	0.9512	0.0009	0.2008	0.9479	0.0235	0.2052	0.9445
β_1	0.0117	0.1200	0.9511	0.0192	0.1218	0.9459	0.0676	0.1234	0.9437
β_2	-0.0069	0.0255	0.9500	0.0140	0.0261	0.9468	0.0647	0.0260	0.9440
σ_v^2	0.0226	0.0140	0.9483	0.0430	0.0151	0.9296	0.1313	0.0155	0.9202
θ_1	5.2749	0.0254	0.9514	5.5840	0.0262	0.9504	5.6152	0.0260	0.9527
θ_2	5.2092	0.0255	0.9556	5.3008	0.0255	0.9527	5.4988	0.0254	0.9534
λ	-0.0126	0.0017	0.9506	-0.0062	0.0017	0.9469	0.0261	0.0017	0.9427
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 50, 0.6, 0.6, 1.0)$								
β_0	-0.0073	0.3755	0.9509	0.0213	0.3935	0.9436	0.0413	0.3915	0.9387
β_1	0.0425	0.2202	0.9489	0.1372	0.2331	0.9428	0.1646	0.2309	0.9382
β_2	0.0394	0.0477	0.9490	0.1001	0.0508	0.9418	0.1977	0.0499	0.9405
σ_v^2	0.1118	0.0928	0.9467	0.3985	0.0995	0.9374	0.4366	0.1002	0.9295
θ_1	5.0095	0.0120	0.9527	5.6816	0.0122	0.9526	5.2457	0.0122	0.9501
θ_2	5.0367	0.0121	0.9511	5.1018	0.0120	0.9555	4.7491	0.0120	0.9545
λ	-0.0351	0.0030	0.9495	0.0211	0.0032	0.9423	0.0407	0.0032	0.9376
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 50, 1.2, 1.2, 1.5)$								
β_0	-0.0193	0.5257	0.9511	0.0364	0.5536	0.9424	0.1483	0.5564	0.9372
β_1	0.0610	0.2869	0.9502	0.2051	0.3064	0.9368	0.4187	0.3169	0.9285
β_2	0.0243	0.0643	0.9506	0.1661	0.0690	0.9380	0.4209	0.0700	0.9334
σ_v^2	0.3188	0.2646	0.9478	0.6211	0.2856	0.9324	1.1417	0.3001	0.9230
θ_1	5.4190	0.0071	0.9491	5.0763	0.0069	0.9527	5.2458	0.0070	0.9501
θ_2	5.0622	0.0069	0.9515	5.2553	0.0070	0.9546	5.0317	0.0070	0.9484
λ	-0.0664	0.0040	0.9520	0.0157	0.0043	0.9368	0.1552	0.0044	0.9270

Appeared in: Applied Stochastic Models in Business and Industry, 2011, 27, 222-234.

Table 4. Bias, RMSE and Empirical Coverage for 95% CI: Normal-Gamma Mix., $\lambda = .1$

	$p = 0.0$			$p = 0.05$			$p = 0.1$		
	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (10, 10, 0.2, 0.2, .5)$								
β_0	0.1387	1.0786	0.9407	0.0559	1.0833	0.9377	0.0954	1.0947	0.9341
β_1	0.9363	0.6838	0.9398	0.6970	0.6756	0.9369	0.7096	0.6680	0.9343
β_2	0.9712	0.1451	0.9366	0.5765	0.1407	0.9353	0.6100	0.1369	0.9363
σ_v^2	0.1975	0.0791	0.9038	-0.4202	0.0801	0.8946	-0.4909	0.0805	0.8955
θ_1	27.5955	0.2580	0.9510	27.9857	0.2599	0.9528	28.6888	0.2642	0.9544
θ_2	28.4713	0.2604	0.9546	28.2862	0.2616	0.9500	27.7482	0.2593	0.9538
λ	0.0155	0.0093	0.9401	-0.1364	0.0092	0.9395	-0.1082	0.0092	0.9358
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (10, 10, 0.6, 0.6, 1.0)$								
β_0	0.3914	2.2191	0.9368	0.3272	2.0506	0.9381	0.4917	2.2470	0.9355
β_1	3.3761	1.4619	0.9330	2.3040	1.2406	0.9323	3.4600	1.4611	0.9307
β_2	3.0534	0.3047	0.9288	1.8359	0.2581	0.9273	3.2947	0.3087	0.9267
σ_v^2	11.4578	0.7050	0.8805	7.0317	0.5770	0.8889	11.4402	0.7025	0.8778
θ_1	30.5338	0.1777	0.9506	31.5011	0.1836	0.9531	32.7323	0.1879	0.9492
θ_2	32.1446	0.1814	0.9525	33.2769	0.1881	0.9514	32.9169	0.1850	0.9551
λ	-0.3308	0.0190	0.9400	-0.3787	0.0168	0.9407	-0.2388	0.0190	0.9381
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (10, 10, 1.2, 1.2, 1.5)$								
β_0	0.6160	2.6908	0.9382	0.1624	2.6783	0.9324	-0.0561	2.7250	0.9313
β_1	4.2078	1.6677	0.9270	2.9737	1.6182	0.9216	2.9673	1.7171	0.9127
β_2	3.9903	0.3654	0.9254	3.3636	0.3745	0.9154	2.4886	0.3759	0.9117
σ_v^2	15.0132	1.8365	0.8757	12.4124	1.7937	0.8572	13.3607	1.8927	0.8519
θ_1	32.4313	0.1224	0.9466	31.8950	0.1219	0.9481	32.9125	0.1235	0.9499
θ_2	31.4464	0.1195	0.9515	33.6525	0.1244	0.9536	32.4661	0.1233	0.9515
λ	-0.4843	0.0218	0.9463	-1.2666	0.0218	0.9416	-1.6475	0.0229	0.9398
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 20, 0.2, 0.2, .5)$								
β_0	0.0242	0.5047	0.9496	-0.0276	0.5021	0.9474	0.0452	0.5150	0.9451
β_1	0.1708	0.3132	0.9486	0.0411	0.3137	0.9473	0.2153	0.3144	0.9441
β_2	0.1557	0.0664	0.9476	0.0013	0.0667	0.9454	0.2200	0.0684	0.9456
σ_v^2	-0.0763	0.0362	0.9380	-0.2168	0.0371	0.9337	0.0042	0.0375	0.9335
θ_1	14.3707	0.1075	0.9576	14.5538	0.1059	0.9581	13.8887	0.1058	0.9519
θ_2	13.9131	0.1044	0.9599	14.8473	0.1065	0.9571	15.4706	0.1082	0.9548
λ	-0.0154	0.0043	0.9511	-0.1050	0.0043	0.9476	0.0124	0.0044	0.9450
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 20, 0.6, 0.6, 1.0)$								
β_0	0.0841	0.9646	0.9472	-0.1501	0.9971	0.9419	-0.1839	0.9850	0.9448
β_1	0.5885	0.5802	0.9437	0.0402	0.5996	0.9387	-0.0517	0.5930	0.9430
β_2	0.7558	0.1287	0.9451	-0.0090	0.1318	0.9416	0.0058	0.1272	0.9402
σ_v^2	1.7311	0.2482	0.9305	0.5224	0.2541	0.9192	0.3674	0.2498	0.9256
θ_1	13.4402	0.0533	0.9591	14.6529	0.0550	0.9565	14.3654	0.0546	0.9599
θ_2	14.5459	0.0543	0.9622	14.1006	0.0545	0.9570	13.4086	0.0542	0.9524
λ	-0.0507	0.0080	0.9476	-0.4676	0.0084	0.9454	-0.5290	0.0083	0.9475

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Table 4. Cont'd

	$p = 0.0$			$p = 0.05$			$p = 0.1$		
	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 20, 1.2, 1.2, 1.5)$								
β_0	0.1419	1.3197	0.9423	-0.1545	1.3293	0.9403	-0.6950	1.2960	0.9300
β_1	0.9224	0.7744	0.9433	0.2119	0.7785	0.9360	-0.9928	0.7484	0.9268
β_2	0.8876	0.1744	0.9431	0.2289	0.1758	0.9342	-1.0777	0.1710	0.9236
σ_v^2	3.3825	0.7427	0.9251	1.8803	0.7383	0.9185	-0.7022	0.7012	0.9047
θ_1	13.5800	0.0317	0.9594	14.1314	0.0327	0.9541	13.3984	0.0319	0.9559
θ_2	14.1420	0.0325	0.9549	13.6103	0.0324	0.9542	13.5376	0.0320	0.9580
λ	-0.1585	0.0106	0.9467	-0.6699	0.0108	0.9437	-1.4885	0.0106	0.9360
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 20, 0.2, 0.2, .5)$								
β_0	-0.0084	0.3335	0.9484	-0.0415	0.3234	0.9450	-0.0114	0.3264	0.9491
β_1	0.0321	0.2036	0.9468	-0.0592	0.1972	0.9470	0.0223	0.1995	0.9501
β_2	0.0333	0.0439	0.9475	-0.0902	0.0431	0.9444	0.0468	0.0425	0.9470
σ_v^2	-0.0976	0.0233	0.9471	-0.3297	0.0230	0.9410	-0.1212	0.0236	0.9379
θ_1	5.0909	0.0550	0.9512	5.0823	0.0554	0.9542	4.8888	0.0558	0.9526
θ_2	14.8764	0.0488	0.9644	15.7478	0.0497	0.9618	15.7914	0.0514	0.9587
λ	-0.0338	0.0028	0.9493	-0.0975	0.0027	0.9471	-0.0405	0.0028	0.9489
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 20, 0.6, 0.6, 1.0)$								
β_0	0.0214	0.6100	0.9469	-0.1485	0.6078	0.9426	-0.3103	0.6340	0.9395
β_1	0.1798	0.3634	0.9472	-0.1962	0.3616	0.9451	-0.6008	0.3715	0.9409
β_2	0.2115	0.0812	0.9474	-0.2107	0.0792	0.9456	-0.5686	0.0805	0.9425
σ_v^2	0.5588	0.1518	0.9443	-0.1682	0.1516	0.9357	-1.0510	0.1551	0.9304
θ_1	4.9682	0.0283	0.9577	4.5788	0.0281	0.9521	4.6142	0.0281	0.9516
θ_2	15.8645	0.0238	0.9614	16.0569	0.0239	0.9620	15.0444	0.0234	0.9631
λ	-0.0543	0.0050	0.9488	-0.3187	0.0050	0.9454	-0.6093	0.0052	0.9441
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 20, 1.2, 1.2, 1.5)$								
β_0	0.0448	0.8144	0.9485	-0.3091	0.8365	0.9444	-0.7377	0.8563	0.9306
β_1	0.3876	0.4598	0.9484	-0.4622	0.4680	0.9412	-1.5513	0.4748	0.9290
β_2	0.4060	0.1032	0.9491	-0.4251	0.1029	0.9426	-1.5859	0.1052	0.9327
σ_v^2	1.2218	0.4291	0.9428	-0.4216	0.4340	0.9339	-2.5331	0.4352	0.9126
θ_1	4.8254	0.0168	0.9522	4.2923	0.0167	0.9524	4.7270	0.0168	0.9531
θ_2	14.8253	0.0135	0.9627	15.4184	0.0136	0.9588	15.8453	0.0136	0.9583
λ	-0.0225	0.0063	0.9493	-0.6249	0.0066	0.9457	-1.4049	0.0068	0.9361
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 50, 0.2, 0.2, .5)$								
β_0	0.0112	0.3238	0.9516	-0.0009	0.3228	0.9485	-0.0210	0.3398	0.9468
β_1	0.0790	0.1975	0.9513	0.0372	0.1971	0.9469	-0.0111	0.2082	0.9455
β_2	0.0878	0.0423	0.9495	0.0231	0.0421	0.9505	-0.0216	0.0445	0.9455
σ_v^2	-0.0701	0.0229	0.9443	-0.1689	0.0231	0.9397	-0.2060	0.0247	0.9341
θ_1	15.8208	0.0503	0.9629	15.9845	0.0515	0.9593	15.8088	0.0499	0.9610
θ_2	4.5343	0.0543	0.9547	4.6887	0.0543	0.9545	4.8332	0.0550	0.9520
λ	0.0017	0.0027	0.9505	-0.0260	0.0027	0.9479	-0.0695	0.0029	0.9446

Table 4. Cont'd

	$p = 0.0$			$p = 0.05$			$p = 0.1$		
	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI	% Bias	RMSE	95% CI
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 50, 0.6, 0.6, 1.0)$								
β_0	-0.0134	0.6142	0.9438	-0.1277	0.6176	0.9458	-0.3243	0.6333	0.9383
β_1	0.1067	0.3616	0.9436	-0.1674	0.3675	0.9445	-0.6227	0.3767	0.9364
β_2	0.1254	0.0781	0.9439	-0.1876	0.0793	0.9449	-0.5389	0.0823	0.9390
σ_v^2	0.4081	0.1527	0.9393	-0.0376	0.1547	0.9361	-0.9950	0.1582	0.9254
θ_1	14.8354	0.0229	0.9616	14.7925	0.0231	0.9606	15.7662	0.0233	0.9647
θ_2	4.5703	0.0279	0.9547	5.1820	0.0284	0.9499	4.6815	0.0278	0.9558
λ	-0.1059	0.0050	0.9442	-0.2997	0.0051	0.9467	-0.6302	0.0053	0.9401
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (20, 50, 1.2, 1.2, 1.5)$								
β_0	-0.0115	0.8184	0.9486	-0.3627	0.8216	0.9426	-0.7198	0.8681	0.9343
β_1	0.2847	0.4630	0.9495	-0.6191	0.4612	0.9405	-1.4844	0.4850	0.9290
β_2	0.1781	0.1011	0.9483	-0.5931	0.1016	0.9462	-1.5009	0.1066	0.9296
σ_v^2	1.0174	0.4334	0.9408	-0.7036	0.4277	0.9296	-2.3781	0.4429	0.9161
θ_1	15.6651	0.0139	0.9563	15.3102	0.0133	0.9615	15.4852	0.0136	0.9576
θ_2	4.4971	0.0167	0.9504	4.9993	0.0169	0.9526	4.5576	0.0166	0.9522
λ	-0.1023	0.0064	0.9507	-0.7247	0.0065	0.9482	-1.3650	0.0069	0.9381
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 50, 0.2, 0.2, .5)$								
β_0	-0.0028	0.1985	0.9512	-0.0207	0.2005	0.9475	-0.0387	0.2030	0.9481
β_1	0.0117	0.1200	0.9511	-0.0359	0.1212	0.9469	-0.0851	0.1219	0.9482
β_2	-0.0069	0.0255	0.9500	-0.0432	0.0260	0.9483	-0.0774	0.0257	0.9473
σ_v^2	0.0226	0.0140	0.9483	-0.0643	0.0144	0.9377	-0.2095	0.0145	0.9397
θ_1	5.2749	0.0254	0.9514	5.6266	0.0261	0.9500	5.6490	0.0260	0.9518
θ_2	5.2092	0.0255	0.9556	5.4026	0.0255	0.9562	5.4178	0.0254	0.9552
λ	-0.0126	0.0017	0.9506	-0.0439	0.0017	0.9471	-0.0804	0.0017	0.9472
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 50, 0.6, 0.6, 1.0)$								
β_0	-0.0073	0.3755	0.9509	-0.1349	0.3879	0.9458	-0.2528	0.3866	0.9399
β_1	0.0425	0.2202	0.9489	-0.2558	0.2272	0.9476	-0.5692	0.2236	0.9407
β_2	0.0394	0.0477	0.9490	-0.2838	0.0498	0.9430	-0.5486	0.0485	0.9422
σ_v^2	0.1118	0.0928	0.9467	-0.4334	0.0945	0.9436	-1.0840	0.0935	0.9333
θ_1	5.0095	0.0120	0.9527	5.6869	0.0121	0.9532	5.2776	0.0122	0.9521
θ_2	5.0367	0.0121	0.9511	5.1328	0.0121	0.9541	4.7199	0.0120	0.9543
λ	-0.0351	0.0030	0.9495	-0.2486	0.0032	0.9480	-0.4651	0.0031	0.9430
	$(N, T, \sigma_\mu, \sigma_\eta, \sigma_v) = (50, 50, 1.2, 1.2, 1.5)$								
β_0	-0.0193	0.5257	0.9511	-0.3972	0.5366	0.9436	-0.7238	0.5484	0.9311
β_1	0.0610	0.2869	0.9502	-0.8712	0.2912	0.9417	-1.7549	0.3040	0.9226
β_2	0.0243	0.0643	0.9506	-0.9005	0.0659	0.9420	-1.7896	0.0672	0.9263
σ_v^2	0.3188	0.2646	0.9478	-1.5364	0.2650	0.9347	-3.2674	0.2758	0.9070
θ_1	5.4190	0.0071	0.9491	5.1391	0.0069	0.9546	5.1740	0.0070	0.9498
θ_2	5.0622	0.0069	0.9515	5.2646	0.0070	0.9558	4.9899	0.0070	0.9497
λ	-0.0664	0.0040	0.9520	-0.7234	0.0041	0.9471	-1.3479	0.0043	0.9275

Appeared in: Applied Stochastic Models in Business and Industry, 2011, 27, 222-234.

6. Conclusions

A flexible random effects model is developed that is shown to be more suitable in modeling the private production and workers' wage than the traditional models with linear of loglinear functional form. Clearly, this model can also be applied to model other economic activities such as firm size, health expenditure, consumption, demand, etc. A simple computational device is given, which makes the handling of large panel data feasible using a personal computer. More appropriate one-sided LM tests are given for testing the random effects and functional form jointly or individually.

Further extensions of the model in specification and estimation are both possible and interesting, such as the inclusion of serial correlation and/or spatial correlation, use of quasi-maximum likelihood estimation (QMLE) method, etc. The QMLE should be useful in the context that exact normality cannot be achieved by transformation, which is typical when using the Box-Cox transformation.

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