

Table 1**Mean and Variance of $LM_T(p,0)$ in ADF(p) Regressions***

T	p=0		p=1		p=2		p=3		p=4		p=5		p=6		p=7		p=8	
	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.
Without Time Trend																		
5	2.019	1.718																
10	2.391	3.067	2.618	3.643	2.636	4.022	2.931	4.994	3.141	5.768								
15	2.576	3.931	2.752	4.444	2.734	4.646	2.928	5.361	2.978	5.859	3.228	6.950						
20	2.687	4.484	2.836	4.946	2.812	5.072	2.963	5.660	2.974	5.916	3.147	6.737	3.210	7.244				
25	2.740	4.768	2.862	5.206	2.838	5.290	2.961	5.769	2.957	5.980	3.093	6.596	3.129	6.997	3.275	7.771	3.330	8.313
30	2.794	5.111	2.895	5.477	2.871	5.530	2.980	5.975	2.967	6.084	3.076	6.576	3.090	6.846	3.210	7.471	3.238	7.810
40	2.845	5.507	2.931	5.840	2.911	5.888	2.993	6.235	2.980	6.298	3.065	6.653	3.064	6.806	3.148	7.229	3.149	7.428
50	2.893	5.804	2.959	6.061	2.947	6.070	3.014	6.353	3.002	6.397	3.073	6.712	3.068	6.818	3.139	7.190	3.129	7.265
60	2.894	5.907	2.957	6.170	2.944	6.190	2.995	6.390	2.982	6.405	3.040	6.695	3.036	6.768	3.096	6.990	3.089	7.049
70	2.919	6.019	2.968	6.213	2.956	6.215	3.004	6.439	2.993	6.488	3.043	6.702	3.040	6.771	3.093	7.006	3.088	7.077
100	2.981	6.376	3.014	6.524	3.005	6.526	3.037	6.660	3.028	6.662	3.065	6.844	3.058	6.874	3.095	7.024	3.087	7.035
With Time Trend																		
5	3.013	1.716																
10	3.803	3.586	4.106	4.430	3.970	5.206	4.315	6.519	4.506	7.511								
15	4.199	4.959	4.462	5.700	4.328	6.200	4.574	7.392	4.518	8.250	4.837	9.879						
20	4.428	5.909	4.657	6.672	4.538	6.954	4.747	7.941	4.665	8.540	4.879	9.860	4.857	10.653				
25	4.571	6.599	4.769	7.325	4.666	7.489	4.847	8.305	4.762	8.758	4.956	9.829	4.917	10.589	5.129	11.997	5.122	12.765
30	4.687	7.243	4.857	7.831	4.773	7.935	4.942	8.689	4.856	8.968	5.016	9.866	4.967	10.368	5.147	11.507	5.113	12.128
40	4.830	8.004	4.974	8.545	4.904	8.592	5.033	9.218	4.966	9.334	5.096	9.991	5.050	10.317	5.184	11.163	5.125	11.498
50	4.924	8.558	5.043	9.002	4.992	9.009	5.109	9.529	5.052	9.591	5.162	10.110	5.115	10.317	5.226	11.011	5.169	11.151
60	4.974	8.915	5.081	9.370	5.041	9.413	5.136	9.846	5.084	9.841	5.179	10.271	5.146	10.422	5.246	10.886	5.203	11.027
70	5.014	9.168	5.104	9.535	5.066	9.511	5.152	9.908	5.109	9.957	5.184	10.262	5.153	10.374	5.244	10.890	5.203	10.969
100	5.110	9.752	5.172	9.964	5.145	10.023	5.207	10.319	5.172	10.299	5.233	10.516	5.205	10.590	5.267	10.873	5.229	10.890

* The means and variances reported in this table are computed via stochastic simulations with 50,000 replications. $LM_T(p,0)$ is the Lagrangian multiplier statistic for testing $\beta=0$ in the ADF(p) regression without time trend, $\Delta y_t = \alpha + \beta y_{t-1} + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \text{error}$, and with time trend, $\Delta y_t = \alpha + \delta t + \beta y_{t-1} + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \text{error}$, $t=1,2,\dots,T$. The observations y_t are generated as $\Delta y_t = \varepsilon_t$, $\varepsilon_t \sim N(0,1)$, for $t=-p+1,-p+2,\dots,T$, with $y_{-p} = 0$.

Table 2

Mean and Variance of $t_T(p,0)$ in ADF(p) Regressions*

T	p=0		p=1		p=2		p=3		p=4		p=5		p=6		p=7		p=8	
	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.
Without Time Trend																		
5	-1.558	2.648																
10	-1.504	1.069	-1.488	1.255	-1.319	1.421	-1.306	1.759	-1.171	2.080								
15	-1.514	0.923	-1.503	1.011	-1.387	1.078	-1.366	1.181	-1.260	1.279	-1.239	1.420						
20	-1.522	0.851	-1.516	0.915	-1.428	0.969	-1.413	1.037	-1.329	1.097	-1.313	1.171	-1.238	1.237				
25	-1.520	0.809	-1.514	0.861	-1.443	0.905	-1.433	0.952	-1.363	1.005	-1.351	1.055	-1.289	1.114	-1.273	1.164	-1.212	1.217
30	-1.526	0.789	-1.519	0.831	-1.460	0.865	-1.453	0.907	-1.394	0.946	-1.384	0.980	-1.331	1.023	-1.319	1.062	-1.266	1.105
40	-1.523	0.770	-1.520	0.803	-1.476	0.830	-1.471	0.858	-1.428	0.886	-1.421	0.912	-1.380	0.942	-1.371	0.968	-1.329	0.996
50	-1.527	0.760	-1.524	0.781	-1.493	0.798	-1.489	0.819	-1.454	0.842	-1.451	0.863	-1.418	0.886	-1.411	0.910	-1.377	0.929
60	-1.519	0.749	-1.519	0.770	-1.490	0.789	-1.486	0.802	-1.458	0.819	-1.454	0.839	-1.427	0.858	-1.423	0.875	-1.393	0.896
70	-1.524	0.736	-1.522	0.753	-1.498	0.766	-1.495	0.782	-1.470	0.801	-1.467	0.814	-1.444	0.834	-1.441	0.851	-1.415	0.871
100	-1.532	0.735	-1.530	0.745	-1.514	0.754	-1.512	0.761	-1.495	0.771	-1.494	0.781	-1.476	0.795	-1.474	0.806	-1.456	0.818
With Time Trend																		
5	-2.463	13.859																
10	-2.166	1.132	-2.173	1.453	-1.914	1.627	-1.922	2.482	-1.750	3.947								
15	-2.167	0.869	-2.169	0.975	-1.999	1.036	-1.977	1.214	-1.823	1.332	-1.804	1.590						
20	-2.168	0.763	-2.172	0.845	-2.047	0.882	-2.032	0.983	-1.911	1.052	-1.888	1.165	-1.778	1.243				
25	-2.167	0.713	-2.172	0.769	-2.074	0.796	-2.065	0.861	-1.968	0.913	-1.955	0.991	-1.868	1.055	-1.851	1.145	-1.761	1.208
30	-2.172	0.690	-2.173	0.734	-2.095	0.756	-2.091	0.808	-2.009	0.845	-1.998	0.899	-1.923	0.945	-1.912	1.009	-1.835	1.063
40	-2.173	0.655	-2.177	0.687	-2.120	0.702	-2.117	0.735	-2.057	0.759	-2.051	0.792	-1.995	0.828	-1.986	0.872	-1.925	0.902
50	-2.176	0.633	-2.180	0.654	-2.137	0.661	-2.137	0.688	-2.091	0.705	-2.087	0.730	-2.042	0.753	-2.036	0.786	-1.987	0.808
60	-2.174	0.621	-2.178	0.641	-2.143	0.653	-2.142	0.674	-2.103	0.685	-2.101	0.705	-2.065	0.725	-2.063	0.747	-2.024	0.766
70	-2.174	0.610	-2.176	0.627	-2.146	0.634	-2.146	0.650	-2.114	0.662	-2.111	0.673	-2.081	0.689	-2.079	0.713	-2.046	0.728
100	-2.177	0.597	-2.179	0.605	-2.158	0.613	-2.158	0.625	-2.135	0.629	-2.135	0.638	-2.113	0.650	-2.112	0.661	-2.088	0.670

* The means and variances reported in this table are computed via stochastic simulations with 50,000 replications. $t_T(p,0)$ is the t-statistic for testing $\beta=0$ in the ADF(p) regression without time trend, $\Delta y_t = \alpha + \beta y_{t-1} + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \text{error}$, and with time trend, $\Delta y_t = \alpha + \delta t + \beta y_{t-1} + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \text{error}$, $t=1,2,\dots,T$. The observations y_t are generated as $\Delta y_t = \varepsilon_t$, $\varepsilon_t \sim N(0,1)$, for $t=-p+1,-p+2,\dots,T$, with $y_{-p} = 0$.

Table 3**Exact Sample Critical Values of \overline{LM}_{NT} Statistic***

N/T	5	10	15	20	25	30	40	50	60	70	100	
Panel A: DF regressions containing only an intercept												
						<u>1 Percent</u>						
5	3.39	4.34	4.86	5.17	5.34	5.45	5.66	5.82	5.91	5.92	6.05	
7	3.18	4.04	4.47	4.70	4.90	5.03	5.20	5.32	5.36	5.46	5.49	
10	2.98	3.77	4.15	4.37	4.52	4.63	4.76	4.88	4.92	5.00	5.07	
15	2.81	3.49	3.85	4.03	4.19	4.26	4.38	4.49	4.54	4.56	4.63	
20	2.70	3.35	3.68	3.85	3.96	4.06	4.17	4.25	4.30	4.33	4.40	
25	2.63	3.25	3.54	3.71	3.84	3.92	4.03	4.10	4.14	4.19	4.23	
50	2.46	2.98	3.25	3.41	3.50	3.58	3.66	3.72	3.77	3.79	3.84	
100	2.33	2.81	3.05	3.18	3.28	3.34	3.41	3.47	3.51	3.53	3.59	
						<u>5 Percent</u>						
5	3.01	3.76	4.11	4.34	4.49	4.56	4.71	4.79	4.88	4.92	4.99	
7	2.84	3.53	3.87	4.06	4.19	4.30	4.43	4.51	4.55	4.59	4.65	
10	2.71	3.34	3.65	3.83	3.96	4.04	4.15	4.22	4.27	4.31	4.37	
15	2.58	3.16	3.45	3.63	3.73	3.80	3.90	3.96	4.02	4.04	4.10	
20	2.51	3.05	3.34	3.48	3.58	3.66	3.76	3.83	3.87	3.89	3.94	
25	2.46	2.98	3.24	3.39	3.49	3.57	3.66	3.72	3.76	3.79	3.84	
50	2.33	2.81	3.05	3.18	3.27	3.34	3.42	3.46	3.50	3.53	3.58	
100	2.24	2.69	2.91	3.03	3.11	3.17	3.25	3.30	3.33	3.35	3.40	
						<u>10 Percent</u>						
5	2.79	3.44	3.74	3.94	4.06	4.12	4.24	4.30	4.37	4.41	4.47	
7	2.66	3.27	3.56	3.73	3.84	3.92	4.03	4.10	4.13	4.19	4.23	
10	2.56	3.12	3.40	3.55	3.66	3.74	3.85	3.89	3.93	3.97	4.03	
15	2.46	2.99	3.24	3.40	3.49	3.56	3.65	3.70	3.75	3.78	3.84	
20	2.40	2.90	3.16	3.30	3.39	3.45	3.55	3.60	3.64	3.66	3.71	
25	2.36	2.85	3.09	3.30	3.32	3.39	3.47	3.52	3.56	3.59	3.63	
50	2.26	2.72	2.94	3.01	3.15	3.21	3.28	3.33	3.37	3.39	3.44	
100	2.19	2.62	2.84	2.95	3.03	3.09	3.16	3.20	3.23	3.25	3.30	
Panel B: DF regressions containing an intercept and a linear time trend												
						<u>1 Percent</u>						
5	4.20	5.76	6.61	7.11	7.47	7.68	8.07	8.30	8.44	8.59	8.78	
7	4.05	5.46	6.21	6.68	7.00	7.25	7.54	7.73	7.88	7.98	8.15	
10	3.88	5.20	5.88	6.31	6.60	6.78	7.07	7.26	7.37	7.43	7.63	
15	3.74	4.94	5.56	5.94	6.20	6.37	6.65	6.76	6.92	7.00	7.14	
20	3.65	4.78	5.39	5.72	5.97	6.14	6.37	6.53	6.64	6.71	6.85	
25	3.58	4.68	5.26	5.60	5.84	5.99	6.19	6.36	6.45	6.53	6.66	
50	3.43	4.42	4.95	5.25	5.46	5.69	5.79	5.92	6.00	6.09	6.19	
100	3.31	4.24	4.72	5.01	5.19	5.33	5.59	5.63	5.70	5.76	5.87	
						<u>5 Percent</u>						
5	3.92	5.19	5.89	6.28	6.54	6.75	7.02	7.19	7.28	7.40	7.55	
7	3.78	4.98	5.61	5.98	6.23	6.42	6.68	6.84	6.95	7.02	7.18	
10	3.66	4.78	5.38	5.73	5.96	6.13	6.37	6.50	6.61	6.67	6.82	
15	3.54	4.61	5.16	5.49	5.71	5.86	6.08	6.21	6.31	6.37	6.52	
20	3.48	4.50	5.03	5.34	5.55	5.69	5.91	6.03	6.13	6.19	6.31	
25	3.42	4.42	4.94	5.24	5.45	5.60	5.79	5.92	5.99	6.06	6.17	
50	3.31	4.24	4.72	5.01	5.19	5.33	5.51	5.62	5.70	5.76	5.85	
100	3.22	4.11	4.56	4.84	5.01	5.14	5.31	5.41	5.48	5.54	5.64	
						<u>10 Percent</u>						
5	3.75	4.89	5.49	5.85	6.08	6.25	6.49	6.63	6.73	6.83	6.96	
7	3.63	4.72	5.29	5.63	5.85	6.01	6.24	6.38	6.47	6.53	6.68	
10	3.53	4.57	5.10	5.43	5.63	5.78	6.01	6.12	6.22	6.28	6.41	
15	3.43	4.43	4.93	5.26	5.45	5.59	5.78	5.91	6.00	6.05	6.18	
20	3.38	4.34	4.84	5.14	5.33	5.46	5.66	5.76	5.86	5.92	6.03	
25	3.34	4.28	4.77	5.06	5.26	5.38	5.57	5.68	5.76	5.83	5.92	
50	3.24	4.14	4.60	4.88	5.06	5.19	5.35	5.46	5.53	5.59	5.69	
100	3.17	4.04	4.48	4.75	4.91	5.04	5.20	5.30	5.37	5.42	5.51	

* The critical values reported in this table are computed via numerical integration with 50,000 replications. The \overline{LM}_{NT} statistic, defined by (3.3), is the sample average of the Lagrange multiplier statistics obtained from DF regressions of individual groups. The underlying DGP is $y_{it} = y_{i,t-1} + \varepsilon_{it}$, $\varepsilon_{it} \sim N(0,1)$, $t=1,2,\dots,T$; $i=1,2,\dots,N$, with $y_{i0} = 0$.

Table 4

Exact Sample Critical Values of \bar{t}_{NT} Statistic*

N/T	5	10	15	20	25	30	40	50	60	70	100	
Panel A: DF regressions containing only an intercept												
						<u>1 Percent</u>						
5	-3.79	-2.66	-2.54	-2.50	-2.46	-2.44	-2.43	-2.42	-2.42	-2.40	-2.40	
7	-3.45	-2.47	-2.38	-2.33	-2.32	-2.31	-2.29	-2.28	-2.28	-2.28	-2.27	
10	-3.06	-2.32	-2.24	-2.21	-2.19	-2.18	-2.16	-2.16	-2.16	-2.16	-2.15	
15	-2.79	-2.14	-2.10	-2.08	-2.07	-2.05	-2.04	-2.05	-2.04	-2.04	-2.04	
20	-2.61	-2.06	-2.02	-2.00	-1.99	-1.99	-1.98	-1.98	-1.98	-1.97	-1.97	
25	-2.51	-2.01	-1.97	-1.95	-1.94	-1.94	-1.93	-1.93	-1.93	-1.93	-1.92	
50	-2.20	-1.85	-1.83	-1.82	-1.82	-1.82	-1.81	-1.81	-1.81	-1.81	-1.81	
100	-2.00	-1.75	-1.74	-1.73	-1.73	-1.73	-1.73	-1.73	-1.73	-1.73	-1.73	
						<u>5 Percent</u>						
5	-2.76	-2.28	-2.21	-2.19	-2.18	-2.16	-2.16	-2.15	-2.16	-2.15	-2.15	
7	-2.57	-2.17	-2.11	-2.09	-2.08	-2.07	-2.07	-2.06	-2.06	-2.06	-2.05	
10	-2.42	-2.06	-2.02	-1.99	-1.99	-1.99	-1.98	-1.98	-1.97	-1.98	-1.97	
15	-2.28	-1.95	-1.92	-1.91	-1.90	-1.90	-1.90	-1.89	-1.89	-1.89	-1.89	
20	-2.18	-1.89	-1.87	-1.86	-1.85	-1.85	-1.85	-1.85	-1.84	-1.84	-1.84	
25	-2.11	-1.85	-1.83	-1.82	-1.82	-1.82	-1.81	-1.81	-1.81	-1.81	-1.81	
50	-1.95	-1.75	-1.74	-1.73	-1.73	-1.73	-1.73	-1.73	-1.73	-1.73	-1.73	
100	-1.84	-1.68	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67	
						<u>10 Percent</u>						
5	-2.38	-2.10	-2.06	-2.04	-2.04	-2.02	-2.02	-2.02	-2.02	-2.02	-2.01	
7	-2.27	-2.01	-1.98	-1.96	-1.95	-1.95	-1.95	-1.95	-1.94	-1.95	-1.94	
10	-2.17	-1.93	-1.90	-1.89	-1.88	-1.88	-1.88	-1.88	-1.87	-1.88	-1.88	
15	-2.06	-1.85	-1.83	-1.82	-1.82	-1.82	-1.81	-1.81	-1.81	-1.81	-1.81	
20	-2.00	-1.80	-1.79	-1.78	-1.78	-1.78	-1.78	-1.78	-1.78	-1.77	-1.77	
25	-1.96	-1.77	-1.76	-1.75	-1.75	-1.75	-1.75	-1.75	-1.75	-1.75	-1.75	
50	-1.85	-1.70	-1.69	-1.69	-1.69	-1.69	-1.68	-1.68	-1.68	-1.68	-1.69	
100	-1.77	-1.64	-1.64	-1.64	-1.64	-1.64	-1.64	-1.64	-1.64	-1.64	-1.64	
Panel B: DF regressions containing an intercept and a linear time trend												
						<u>1 Percent</u>						
5	-8.12	-3.42	-3.21	-3.13	-3.09	-3.05	-3.03	-3.02	-3.00	-3.00	-2.99	
7	-7.36	-3.20	-3.03	-2.97	-2.94	-2.93	-2.90	-2.88	-2.88	-2.87	-2.86	
10	-6.44	-3.03	-2.88	-2.84	-2.82	-2.79	-2.78	-2.77	-2.76	-2.75	-2.75	
15	-5.72	-2.86	-2.74	-2.71	-2.69	-2.68	-2.67	-2.65	-2.66	-2.65	-2.64	
20	-5.54	-2.75	-2.67	-2.63	-2.62	-2.61	-2.59	-2.60	-2.59	-2.58	-2.58	
25	-5.16	-2.69	-2.61	-2.58	-2.58	-2.56	-2.55	-2.55	-2.55	-2.54	-2.54	
50	-4.50	-2.53	-2.48	-2.46	-2.45	-2.45	-2.44	-2.44	-2.44	-2.44	-2.43	
100	-4.00	-2.42	-2.39	-2.38	-2.37	-2.37	-2.36	-2.36	-2.36	-2.36	-2.36	
						<u>5 Percent</u>						
5	-4.66	-2.98	-2.87	-2.82	-2.80	-2.79	-2.77	-2.76	-2.75	-2.75	-2.75	
7	-4.38	-2.85	-2.76	-2.72	-2.70	-2.69	-2.68	-2.67	-2.67	-2.66	-2.66	
10	-4.11	-2.74	-2.66	-2.63	-2.62	-2.60	-2.60	-2.59	-2.59	-2.58	-2.58	
15	-3.88	-2.63	-2.57	-2.55	-2.53	-2.53	-2.52	-2.52	-2.52	-2.51	-2.51	
20	-3.73	-2.56	-2.52	-2.49	-2.48	-2.48	-2.48	-2.47	-2.47	-2.46	-2.46	
25	-3.62	-2.52	-2.48	-2.46	-2.45	-2.45	-2.44	-2.44	-2.44	-2.44	-2.43	
50	-3.35	-2.42	-2.38	-2.38	-2.37	-2.37	-2.36	-2.36	-2.36	-2.36	-2.36	
100	-3.13	-2.34	-2.32	-2.32	-2.31	-2.31	-2.31	-2.31	-2.31	-2.31	-2.31	
						<u>10 Percent</u>						
5	-3.73	-2.77	-2.70	-2.67	-2.65	-2.64	-2.63	-2.63	-2.62	-2.63	-2.62	
7	-3.60	-2.68	-2.62	-2.59	-2.58	-2.57	-2.57	-2.56	-2.56	-2.55	-2.55	
10	-3.45	-2.59	-2.54	-2.52	-2.51	-2.51	-2.50	-2.50	-2.50	-2.49	-2.49	
15	-3.33	-2.52	-2.47	-2.46	-2.45	-2.45	-2.44	-2.44	-2.44	-2.44	-2.44	
20	-3.26	-2.47	-2.44	-2.42	-2.41	-2.41	-2.41	-2.40	-2.40	-2.40	-2.40	
25	-3.18	-2.44	-2.40	-2.39	-2.39	-2.38	-2.38	-2.38	-2.38	-2.38	-2.38	
50	-3.02	-2.36	-2.33	-2.33	-2.33	-2.32	-2.32	-2.32	-2.32	-2.32	-2.32	
100	-2.90	-2.30	-2.29	-2.28	-2.28	-2.28	-2.28	-2.28	-2.28	-2.28	-2.28	

* The critical values reported in this table are computed via numerical integration with 50,000 replications. The t-bar (\bar{t}_{NT}) statistic, defined by (5.1), is the sample average of the t-statistics obtained from DF regressions of individual groups. The underlying DGP is $y_{it} = y_{i,t-1} + \epsilon_{it}$, $\epsilon_{it} \sim N(0,1)$, $t=1,2,\dots,T$; $i=1,2,\dots,N$, with $y_{i0} = 0$.

Table 5**Size and Power of Unit Root Tests in Heterogenous Panels*
(Experiments 1: No Serial Correlations $\rho_i = 0$, No Time Trend)**

		<u>$T = 5^2$</u>		<u>$T = 10^2$</u>		<u>$T = 25$</u>		<u>$T = 50$</u>	
		Size	Power	Size	Power	Size	Power	Size	Power
<u>$N = 1^1$</u>	DF	-	-	0.089	0.095	0.069	0.091	0.058	0.151
<u>$N = 5$</u>	$\Gamma_{\overline{LM}}$	0.078	0.089	0.078	0.108	0.089	0.209	0.077	0.478
	$\Gamma_{\overline{t}}$	0.053	0.058	0.052	0.071	0.050	0.153	0.050	0.441
<u>$N = 10$</u>	LL	-	-	-	-	0.061	0.260	0.057	0.555
	$\Gamma_{\overline{LM}}$	0.058	0.069	0.068	0.113	0.069	0.279	0.072	0.711
	$\Gamma_{\overline{t}}$	0.041	0.051	0.050	0.090	0.049	0.261	0.054	0.752
<u>$N = 25$</u>	LL	-	-	-	-	0.064	0.532	0.054	0.925
	$\Gamma_{\overline{LM}}$	0.057	0.088	0.059	0.153	0.059	0.479	0.063	0.975
	$\Gamma_{\overline{t}}$	0.053	0.070	0.052	0.141	0.048	0.549	0.050	0.992
<u>$N = 50$</u>	LL	-	-	-	-	0.070	0.809	0.065	0.998
	$\Gamma_{\overline{LM}}$	0.058	0.106	0.057	0.221	0.057	0.737	0.057	1.000
	$\Gamma_{\overline{t}}$	0.051	0.085	0.050	0.229	0.044	0.838	0.051	1.000
<u>$N = 100$</u>	LL	-	-	-	-	0.084	0.983	0.068	1.000
	$\Gamma_{\overline{LM}}$	0.053	0.141	0.057	0.343	0.065	0.947	0.056	1.000
	$\Gamma_{\overline{t}}$	0.044	0.103	0.046	0.384	0.053	0.990	0.051	1.000

* This table reports the size and power of the Levin and Lin (LL) test, and the LM-bar ($\Gamma_{\overline{LM}}$) and the t-bar ($\Gamma_{\overline{t}}$) test statistics defined by (3.8) and (5.2), respectively. The underlying data generation process is $y_{it} = \mu_i(1-\phi) + \phi y_{i,t-1} + \varepsilon_{it}$, $t=-51, -50, \dots, T$; $i=1, 2, \dots, N$, $\mu_i \sim N(0, 1)$, $\varepsilon_{it} \sim N(0, \sigma_i^2)$, and σ_i^2 are from $U[0.5, 1.5]$. μ_i and σ_i^2 are generated once and then fixed in all replications. The LM-bar and the t-bar statistics are based on the simple DF regressions: $\Delta y_{it} = \hat{\alpha}_i + \hat{\beta}_i y_{i,t-1} + \text{error}$, $t=1, 2, \dots, T$; $i=1, 2, \dots, N$. The size ($\phi = 1.0$) and power ($\phi = 0.9$) of the tests are computed at the five percent nominal level. Number of replications is 2,000.

¹ The result for $N = 1$ is reported for comparison, and refers to the standard Dicky-Fuller test.

² The LL test for $T = 5$ and $T = 10$ is not included, since the adjustment factors that are necessary to compute the LL statistic are not reported in Levin and Lin (1993).

Table 6**Size and Power of Unit Root Tests in Heterogenous Panels*
(Experiments 2: $\rho_i \sim U[0.2,0.4]$, No Time Trend)**

T	N		ADF(0)		ADF(1)		ADF(2)		ADF(3)		ADF(4)		
			Size	Power	Size	Power	Size	Power	Size	Power	Size	Power	
10	10	Ψ_{LM}	0.015	0.013	0.069	0.117	0.078	0.106	0.080	0.103	0.085	0.105	
		Ψ_{τ}	0.010	0.009	0.060	0.110	0.067	0.108	0.073	0.110	0.065	0.095	
	25	Ψ_{LM}	0.007	0.004	0.069	0.166	0.085	0.143	0.092	0.166	0.109	0.142	
		Ψ_{τ}	0.002	0.003	0.046	0.133	0.066	0.136	0.067	0.163	0.075	0.151	
	50	Ψ_{LM}	0.003	0.001	0.074	0.241	0.095	0.203	0.095	0.225	0.135	0.199	
		Ψ_{τ}	0.000	0.001	0.046	0.213	0.061	0.211	0.066	0.238	0.074	0.217	
	100	Ψ_{LM}	0.000	0.000	0.100	0.400	0.114	0.316	0.122	0.331	0.158	0.276	
		Ψ_{τ}	0.000	0.000	0.044	0.343	0.055	0.333	0.062	0.372	0.069	0.337	
	25	10	LL	0.015	0.004	0.067	0.224	0.043	0.088	0.038	0.061	0.029	0.021
			Ψ_{LM}	0.007	0.004	0.057	0.237	0.056	0.203	0.059	0.194	0.070	0.172
			Ψ_{τ}	0.005	0.004	0.046	0.241	0.043	0.207	0.042	0.185	0.053	0.175
		25	LL	0.006	0.001	0.081	0.464	0.043	0.155	0.035	0.081	0.017	0.008
Ψ_{LM}			0.001	0.000	0.069	0.410	0.075	0.340	0.071	0.307	0.075	0.261	
Ψ_{τ}			0.000	0.000	0.056	0.483	0.058	0.431	0.051	0.384	0.054	0.339	
50		LL	0.002	0.001	0.093	0.722	0.030	0.258	0.021	0.101	0.008	0.006	
		Ψ_{LM}	0.001	0.000	0.061	0.661	0.064	0.560	0.066	0.530	0.068	0.424	
		Ψ_{τ}	0.000	0.000	0.050	0.758	0.049	0.691	0.045	0.633	0.042	0.559	
100		LL	0.000	0.000	0.113	0.930	0.019	0.398	0.008	0.129	0.002	0.002	
		Ψ_{LM}	0.000	0.000	0.073	0.886	0.077	0.794	0.082	0.771	0.092	0.670	
		Ψ_{τ}	0.000	0.000	0.052	0.959	0.054	0.922	0.046	0.892	0.057	0.845	
50	10	LL	0.011	0.002	0.062	0.379	0.046	0.174	0.037	0.087	0.029	0.017	
		Ψ_{LM}	0.008	0.016	0.050	0.569	0.057	0.524	0.057	0.494	0.059	0.431	
		Ψ_{τ}	0.003	0.018	0.051	0.672	0.045	0.579	0.044	0.545	0.046	0.486	
	25	LL	0.002	0.001	0.084	0.778	0.052	0.451	0.043	0.203	0.026	0.026	
		Ψ_{LM}	0.001	0.005	0.057	0.912	0.059	0.868	0.058	0.827	0.052	0.758	
		Ψ_{τ}	0.000	0.015	0.064	0.972	0.055	0.941	0.046	0.917	0.048	0.878	
	50	LL	0.000	0.000	0.085	0.977	0.047	0.740	0.039	0.397	0.020	0.035	
		Ψ_{LM}	0.000	0.002	0.059	0.997	0.064	0.992	0.065	0.982	0.071	0.960	
		Ψ_{τ}	0.000	0.021	0.060	1.000	0.049	0.999	0.054	0.998	0.057	0.993	
	100	LL	0.000	0.000	0.095	1.000	0.042	0.963	0.033	0.685	0.012	0.058	
		Ψ_{LM}	0.000	0.000	0.057	1.000	0.067	1.000	0.064	1.000	0.069	0.999	
		Ψ_{τ}	0.000	0.015	0.063	1.000	0.051	1.000	0.048	1.000	0.051	1.000	

* The results in this table are computed using the same data generation process as in Table 5; except that the disturbances follow AR(1) process, $\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + e_{it}$, where $e_{it} \sim N(0, \sigma_i^2)$, and $\rho_i \sim U[0.2, 0.4]$. ρ_i 's are generated once and then fixed in all replications. The reported size and power are based on the individual ADF regressions: $\Delta y_{it} = \hat{\alpha} + \hat{\beta} y_{i,t-1} + \sum_{j=1}^p \hat{\gamma}_{ij} \Delta y_{i,t-j} + \text{error}$, $t=1, 2, \dots, T$; $i=1, 2, \dots, N$. The test statistics Ψ_{LM} and Ψ_{τ} are defined by (4.6) and (5.3), respectively. See the notes to Table 5.

Table 7

**Size and Power of Unit Root Tests in Heterogenous Panels*
(Experiments 3: $\rho_i \sim U[0.2,0.4]$, with Time Trend)**

<i>T</i>	<i>N</i>		ADF(0)		ADF(1)		ADF(2)		ADF(3)		ADF(4)		
			Size	Power	Size	Power	Size	Power	Size	Power	Size	Power	
10	10	Ψ_{LM}	0.003	0.002	0.057	0.060	0.058	0.066	0.058	0.074	0.061	0.059	
		Ψ_{τ}	0.000	0.000	0.055	0.069	0.058	0.057	0.065	0.065	0.054	0.058	
	25	Ψ_{LM}	0.000	0.000	0.041	0.050	0.058	0.066	0.067	0.082	0.076	0.090	
		Ψ_{τ}	0.000	0.000	0.044	0.065	0.053	0.065	0.056	0.076	0.066	0.077	
	50	Ψ_{LM}	0.000	0.000	0.049	0.066	0.064	0.077	0.080	0.093	0.097	0.114	
		Ψ_{τ}	0.000	0.000	0.054	0.067	0.064	0.083	0.086	0.096	0.075	0.096	
	100	Ψ_{LM}	0.000	0.000	0.046	0.068	0.056	0.078	0.084	0.109	0.111	0.135	
		Ψ_{τ}	0.000	0.000	0.058	0.077	0.050	0.077	0.080	0.103	0.092	0.103	
	25	10	LL	0.095	0.111	0.045	0.088	0.011	0.015	0.005	0.007	0.000	0.000
			Ψ_{LM}	0.000	0.000	0.057	0.098	0.060	0.097	0.069	0.097	0.066	0.096
			Ψ_{τ}	0.000	0.000	0.051	0.093	0.052	0.085	0.056	0.084	0.057	0.084
		25	LL	0.095	0.205	0.030	0.104	0.003	0.007	0.000	0.000	0.000	0.000
Ψ_{LM}			0.000	0.000	0.051	0.133	0.065	0.123	0.070	0.120	0.064	0.105	
Ψ_{τ}			0.000	0.000	0.051	0.123	0.053	0.106	0.057	0.098	0.055	0.093	
50		LL	0.071	0.229	0.024	0.158	0.000	0.004	0.000	0.000	0.000	0.000	
		Ψ_{LM}	0.000	0.000	0.063	0.209	0.070	0.180	0.076	0.169	0.067	0.146	
		Ψ_{τ}	0.000	0.000	0.057	0.203	0.056	0.165	0.053	0.136	0.058	0.139	
100		LL	0.046	0.200	0.017	0.212	0.000	0.000	0.000	0.000	0.000	0.000	
		Ψ_{LM}	0.000	0.000	0.059	0.322	0.066	0.258	0.064	0.240	0.077	0.239	
		Ψ_{τ}	0.000	0.000	0.053	0.315	0.049	0.246	0.038	0.209	0.058	0.225	
50	10	LL	0.129	0.129	0.043	0.239	0.011	0.075	0.006	0.030	0.002	0.004	
		Ψ_{LM}	0.000	0.001	0.058	0.258	0.060	0.229	0.062	0.198	0.060	0.190	
		Ψ_{τ}	0.000	0.000	0.052	0.257	0.054	0.234	0.054	0.205	0.052	0.181	
	25	LL	0.119	0.316	0.040	0.420	0.007	0.102	0.002	0.018	0.000	0.000	
		Ψ_{LM}	0.000	0.000	0.056	0.457	0.065	0.394	0.058	0.345	0.057	0.292	
		Ψ_{τ}	0.000	0.000	0.052	0.488	0.064	0.442	0.058	0.379	0.049	0.312	
	50	LL	0.114	0.430	0.036	0.685	0.003	0.138	0.000	0.008	0.000	0.000	
		Ψ_{LM}	0.000	0.000	0.062	0.752	0.059	0.648	0.059	0.578	0.059	0.500	
		Ψ_{τ}	0.000	0.000	0.055	0.786	0.055	0.716	0.054	0.648	0.049	0.550	
	100	LL	0.087	0.435	0.015	0.925	0.000	0.204	0.000	0.007	0.000	0.000	
		Ψ_{LM}	0.000	0.000	0.052	0.948	0.054	0.895	0.054	0.827	0.053	0.754	
		Ψ_{τ}	0.000	0.000	0.048	0.964	0.063	0.937	0.054	0.888	0.043	0.806	

* The underlying data generation process for this table is as follows: $y_{it} = \mu_i + (1-\phi)\mu_i + \phi y_{i,t-1} + \varepsilon_{it}$, where the parameter values and the disturbances are identical to those in Table 6. The reported size and power are based on the ADF(p) regressions: $\Delta y_{it} = \hat{\alpha}_i + \hat{\delta}_i t + \hat{\beta}_i y_{i,t-1} + \sum_{j=1}^p \hat{\gamma}_{ij} \Delta y_{it-j} + \text{error}$, $t=1,2,\dots,T$; $i=1,2,\dots,N$. See also the notes to Tables 5 and 6.