Appendix A

SUPPLEMENTARY TABLES OF CHAPTER 3

Note: '–' indicates data unavailable in all the tables.

Table A1 Area Sown Variability Measured by APC1

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.07	0.06	0.22	0.09	0.19	0.21	0.20	0.18	0.04
Hubei	0.06	0.05	0.05	0.08	0.10	0.25	0.20	0.12	0.03
Hunan	0.04	0.16	0.11	0.11	0.13	0.23	–	–	0.04
Guangdong	0.02	0.29	–	0.07	0.09	–	–	–	0.03
Gansu	0.12	0.03	0.12	0.06	0.11	0.10	0.06	0.07	0.02
Guangxi	0.04	0.38	0.08	0.17	0.17	–	–	–	0.03
Guizhou	0.03	0.19	0.03	0.13	0.06	–	–	–	0.03
Heilongjiang	0.16	0.13	0.11	0.10	0.07	0.11	0.06	0.09	0.03
Henan	0.11	0.03	0.08	0.08	0.12	0.18	0.11	0.09	0.03
Jiangsu	0.05	0.07	0.08	0.10	0.12	0.27	0.25	0.08	0.03
Liaoning	0.18	0.27	0.15	0.27	0.06	0.13	0.10	0.23	0.03
Ningxia	0.08	0.07	–	0.18	0.15	–	–	–	0.04
Qinghai	0.00	0.06	–	0.10	–	–	–	–	0.04
Shaanxi	0.04	0.02	0.07	0.11	0.07	0.11	0.07	0.08	0.02
Sichuan	0.05	0.07	0.05	0.08	0.06	0.10	–	–	0.03
Shandong	0.51	0.05	0.09	0.08	0.11	0.16	0.14	0.10	0.03
Shanghai	0.06	0.14	0.25	0.71	0.21	–	–	–	0.05
Shanxi	0.17	0.04	0.10	0.11	0.12	0.12	0.06	0.10	0.03
Tianjin	4.02	0.11	0.12	0.30	0.15	0.19	0.14	0.16	0.04
Xinjiang	0.09	0.06	0.05	0.21	0.25	0.14	0.37	0.12	0.05
Zhejiang	0.03	0.08	0.13	0.07	0.09	–	–	–	0.02
Other-regions	0.03	0.08	–	0.16	0.11	–	–	–	0.03
China	0.03	0.04	0.06	0.06	0.07	0.10	0.06	0.07	0.02

Table A2 Area Sown Variability Measured by APC2

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.07	0.06	0.21	0.09	0.13	0.26	0.23	0.22	0.04
Hubei	0.06	0.05	0.05	0.08	0.11	0.27	0.25	0.13	0.03
Hunan	0.04	0.18	0.11	0.10	0.12	0.23	–	–	0.04
Guangdong	0.02	0.35	–	0.07	0.09	–	–	–	0.03
Gansu	0.12	0.03	0.12	0.06	0.11	0.10	0.07	0.07	0.02
Guangxi	0.04	0.38	0.08	0.16	0.14	–	–	–	0.03
Guizhou	0.03	0.16	0.03	0.12	0.06	–	–	–	0.03
Heilongjiang	0.14	0.12	0.11	0.10	0.07	0.12	0.06	0.09	0.03
Henan	0.12	0.03	0.08	0.08	0.12	0.19	0.13	0.12	0.03
Jiangsu	0.05	0.07	0.08	0.10	0.13	0.42	0.46	0.09	0.03
Liaoning	0.16	0.30	0.14	0.30	0.06	0.16	0.12	0.31	0.03
Ningxia	0.08	0.06	–	0.16	0.13	–	–	–	0.04
Qinghai	0.00	0.06	–	0.10	–	–	–	–	0.03
Shaanxi	0.04	0.02	0.07	0.10	0.07	0.10	0.08	0.08	0.02
Sichuan	0.05	0.07	0.05	0.08	0.06	0.10	–	–	0.03
Shandong	0.56	0.05	0.08	0.07	0.13	0.19	0.18	0.13	0.03
Shanghai	0.06	0.14	0.24	1.12	0.30	–	–	–	0.05
Shanxi	0.17	0.04	0.11	0.11	0.12	0.12	0.06	0.10	0.03
Tianjin	2.00	0.11	0.11	0.28	0.15	0.20	0.14	0.17	0.04
Xinjiang	0.10	0.06	0.05	0.21	0.26	0.12	0.32	0.13	0.04
Zhejiang	0.03	0.08	0.14	0.07	0.09	–	–	–	0.02
Other-regions	0.03	0.08	–	0.15	0.11	–	–	–	0.03
China	0.03	0.03	0.06	0.05	0.07	0.11	0.07	0.08	0.02

Table A3 Area Sown Variability Measured by APC3

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.07	0.06	0.17	0.08	0.11	0.17	0.17	0.15	0.04
Hubei	0.05	0.05	0.05	0.07	0.09	0.20	0.18	0.10	0.03
Hunan	0.04	0.14	0.09	0.10	0.11	0.19	–	–	0.04
Guangdong	0.02	0.21	–	0.06	0.09	–	–	–	0.03
Gansu	0.11	0.03	0.10	0.05	0.10	0.09	0.06	0.07	0.02
Guangxi	0.04	0.25	0.07	0.13	0.13	–	–	–	0.03
Guizhou	0.03	0.14	0.03	0.11	0.05	–	–	–	0.03
Heilongjiang	0.13	0.11	0.10	0.09	0.07	0.10	0.05	0.08	0.03
Henan	0.10	0.03	0.07	0.07	0.11	0.15	0.10	0.09	0.03
Jiangsu	0.05	0.06	0.08	0.10	0.11	0.22	0.21	0.08	0.03
Liaoning	0.13	0.22	0.12	0.22	0.05	0.12	0.10	0.18	0.02
Ningxia	0.08	0.06	–	0.14	0.12	–	–	–	0.04
Qinghai	0.00	0.06	–	0.09	–	–	–	–	0.03
Shaanxi	0.03	0.02	0.06	0.10	0.07	0.09	0.07	0.07	0.02
Sichuan	0.05	0.06	0.05	0.07	0.06	0.09	–	–	0.03
Shandong	0.33	0.05	0.08	0.07	0.10	0.13	0.13	0.10	0.03
Shanghai	0.05	0.12	0.20	0.34	0.18	–	–	–	0.05
Shanxi	0.14	0.04	0.10	0.09	0.11	0.11	0.05	0.09	0.03
Tianjin	1.84	0.10	0.10	0.17	0.13	0.16	0.13	0.15	0.04
Xinjiang	0.09	0.05	0.05	0.18	0.19	0.11	0.24	0.11	0.04
Zhejiang	0.03	0.07	0.12	0.06	0.08	–	–	–	0.02
Other-regions	0.03	0.08	–	0.13	0.10	–	–	–	0.03
China	0.03	0.03	0.05	0.05	0.06	0.09	0.06	0.07	0.02

Table A4 Area Sown Variability Measured by APC4

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.01	0.01	0.12	0.01	0.30	0.13	0.09	0.08	0.00
Hubei	0.01	0.01	0.00	0.01	0.02	0.12	0.07	0.03	0.00
Hunan	0.01	0.06	0.03	0.03	0.03	0.09	–	–	0.00
Guangdong	0.00	0.21	–	0.01	0.01	–	–	–	0.00
Gansu	0.03	0.00	0.05	0.01	0.02	0.02	0.01	0.01	0.00
Guangxi	0.00	0.43	0.01	0.07	0.07	–	–	–	0.00
Guizhou	0.00	0.14	0.00	0.05	0.01	–	–	–	0.00
Heilongjiang	0.05	0.05	0.02	0.02	0.01	0.02	0.01	0.02	0.00
Henan	0.02	0.00	0.01	0.02	0.03	0.08	0.03	0.02	0.00
Jiangsu	0.01	0.01	0.01	0.02	0.03	0.16	0.12	0.01	0.00
Liaoning	0.11	0.12	0.07	0.15	0.01	0.04	0.02	0.15	0.00
Ningxia	0.01	0.01	–	0.07	0.04	–	–	–	0.00
Qinghai	0.00	0.01	–	0.03	–	–	–	–	0.01
Shaanxi	0.00	0.00	0.01	0.02	0.01	0.03	0.01	0.01	0.00
Sichuan	0.00	0.01	0.00	0.01	0.01	0.02	–	–	0.00
Shandong	0.82	0.01	0.02	0.01	0.02	0.07	0.04	0.02	0.00
Shanghai	0.01	0.04	0.11	2.39	0.09	–	–	–	0.00
Shanxi	0.06	0.00	0.02	0.03	0.03	0.02	0.01	0.02	0.00
Tianjin	431.25	0.02	0.02	0.67	0.04	0.06	0.03	0.04	0.00
Xinjiang	0.02	0.01	0.01	0.09	0.17	0.08	0.39	0.02	0.01
Zhejiang	0.00	0.01	0.03	0.01	0.02	–	–	–	0.00
Other-regions	0.00	0.01	–	0.05	0.03	–	–	–	0.00
China	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.00

Table A5 Area Sown Variability Measured by APC6

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.01	0.01	0.05	0.01	0.03	0.06	0.05	0.05	0.00
Hubei	0.01	0.01	0.00	0.01	0.02	0.06	0.05	0.02	0.00
Hunan	0.00	0.04	0.02	0.02	0.02	0.05	–	–	0.00
Guangdong	0.00	0.08	–	0.01	0.01	–	–	–	0.00
Gansu	0.02	0.00	0.02	0.01	0.02	0.02	0.01	0.01	0.00
Guangxi	0.00	0.10	0.01	0.04	0.03	–	–	–	0.00
Guizhou	0.00	0.04	0.00	0.02	0.00	–	–	–	0.00
Heilongjiang	0.03	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.00
Henan	0.02	0.00	0.01	0.01	0.02	0.04	0.02	0.02	0.00
Jiangsu	0.00	0.01	0.01	0.02	0.02	0.09	0.08	0.01	0.00
Liaoning	0.04	0.08	0.03	0.07	0.01	0.03	0.02	0.07	0.00
Ningxia	0.01	0.01	–	0.04	0.02	–	–	–	0.00
Qinghai	0.00	0.01	–	0.02	–	–	–	–	0.01
Shaanxi	0.00	0.00	0.01	0.02	0.01	0.02	0.01	0.01	0.00
Sichuan	0.00	0.01	0.00	0.01	0.01	0.01	–	–	0.00
Shandong	0.23	0.00	0.01	0.01	0.02	0.04	0.03	0.02	0.00
Shanghai	0.01	0.03	0.06	0.18	0.06	–	–	–	0.00
Shanxi	0.04	0.00	0.02	0.02	0.02	0.02	0.01	0.01	0.00
Tianjin	38.66	0.02	0.02	0.07	0.03	0.04	0.02	0.03	0.00
Xinjiang	0.02	0.01	0.00	0.05	0.06	0.02	0.09	0.02	0.01
Zhejiang	0.00	0.01	0.02	0.01	0.01	–	–	–	0.00
Other-regions	0.00	0.01	–	0.03	0.02	–	–	–	0.00
China	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.00

Table A6 Area Sown Variability Measured by CV1

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.15	0.15	0.38	0.12	0.22	0.64	0.67	0.65	0.15
Hubei	0.19	0.12	0.13	0.17	0.22	0.57	0.75	0.45	0.05
Hunan	0.15	0.23	0.23	0.24	0.28	0.35	–	–	0.09
Guangdong	0.05	0.68	–	0.17	0.21	–	–	–	0.07
Gansu	0.29	0.09	0.18	0.13	0.17	0.25	0.24	0.17	0.03
Guangxi	0.10	0.70	0.13	0.42	0.30	–	–	–	0.08
Guizhou	0.08	0.38	0.05	0.37	0.08	–	–	–	0.07
Heilongjiang	0.35	0.36	0.15	0.14	0.11	0.27	0.11	0.26	0.09
Henan	0.21	0.09	0.23	0.10	0.26	0.52	0.37	0.49	0.12
Jiangsu	0.20	0.14	0.16	0.13	0.40	0.78	0.84	0.27	0.09
Liaoning	0.43	0.48	0.22	0.42	0.17	0.29	0.35	0.38	0.09
Ningxia	0.18	0.19	–	0.33	0.27	–	–	–	0.08
Qinghai	0.00	0.21	–	0.19	–	–	–	–	0.10
Shaanxi	0.07	0.03	0.08	0.31	0.22	0.34	0.20	0.24	0.05
Sichuan	0.09	0.22	0.11	0.13	0.15	0.21	–	–	0.06
Shandong	0.65	0.06	0.27	0.11	0.42	0.50	0.52	0.51	0.10
Shanghai	0.23	0.23	0.47	1.19	0.86	–	–	–	0.14
Shanxi	0.38	0.08	0.20	0.14	0.43	0.23	0.16	0.22	0.07
Tianjin	0.55	0.26	0.31	0.53	0.31	0.34	0.30	0.19	0.10
Xinjiang	0.19	0.23	0.16	0.38	0.41	0.27	0.37	0.30	0.17
Zhejiang	0.10	0.14	0.30	0.16	0.32	–	–	–	0.05
Other-regions	0.09	0.17	–	0.28	0.25	–	–	–	0.04
China	0.10	0.07	0.14	0.11	0.19	0.33	0.25	0.26	0.04

Table A7 Area Sown Variability Measured by CI

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Hubei	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Hunan	0.01	0.01	0.01	0.01	0.01	0.01	–	–	0.01
Guangdong	0.01	0.02	–	0.01	0.01	–	–	–	0.01
Gansu	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Guangxi	0.01	0.02	0.01	0.01	0.01	–	–	–	0.01
Guizhou	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Heilongjiang	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Henan	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Jiangsu	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Liaoning	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ningxia	0.01	0.01	–	0.01	0.01	–	–	–	0.01
Qinghai	0.00	0.01	–	0.01	–	–	–	–	0.01
Shaanxi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sichuan	0.01	0.01	0.01	0.01	0.01	0.01	–	–	0.01
Shandong	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Shanghai	0.01	0.01	0.01	0.02	0.01	–	–	–	0.01
Shanxi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tianjin	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Xinjiang	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zhejiang	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Other-regions	0.01	0.01	–	0.01	0.01	–	–	–	0.01
China	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table A8 Yield Variability Measured by APC1

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.15	0.25	0.20	0.26	0.35	0.29	0.29	0.18	0.12
Hubei	0.10	0.15	0.14	0.11	0.17	0.20	0.15	0.18	0.10
Hunan	0.09	0.14	0.21	0.24	0.16	0.19	–	–	0.09
Guangdong	0.07	0.36	–	0.11	0.12	–	–	–	0.07
Gansu	0.17	0.14	0.15	0.13	0.21	0.25	0.18	0.17	0.11
Guangxi	0.07	0.18	0.11	0.13	0.15	–	–	–	0.07
Guizhou	0.09	0.11	0.11	0.11	0.11	–	–	–	0.09
Heilongjiang	0.25	0.17	0.16	0.19	0.17	0.26	0.19	0.18	0.15
Henan	0.13	0.17	0.15	0.15	0.27	0.21	0.14	0.17	0.12
Jiangsu	0.11	0.19	0.15	0.16	0.16	0.27	0.15	0.20	0.10
Liaoning	0.19	0.27	0.16	0.11	0.18	0.16	0.13	0.23	0.14
Ningxia	0.18	0.19	–	0.25	0.18	–	–	–	0.14
Qinghai	0.00	0.13	–	0.15	–	–	–	–	0.12
Shaanxi	0.11	0.19	0.14	0.12	0.15	0.16	0.16	0.14	0.11
Sichuan	0.07	0.11	0.12	0.13	0.11	0.15	–	–	0.07
Shandong	0.12	0.19	0.12	0.14	0.15	0.15	0.14	0.12	0.11
Shanghai	0.10	0.28	0.19	0.19	0.30	–	–	–	0.10
Shanxi	0.16	0.27	0.10	0.14	0.24	0.16	0.12	0.26	0.11
Tianjin	0.24	0.25	0.30	0.24	0.24	0.47	0.33	0.40	0.22
Xinjiang	0.12	0.13	0.09	0.21	0.20	0.12	0.22	0.18	0.10
Zhejiang	0.09	0.25	0.16	0.14	0.16	–	–	–	0.09
Other-regions	0.10	0.17	–	0.18	0.26	–	–	–	0.10
China	0.07	0.11	0.09	0.08	0.10	0.11	0.10	0.26	0.06

Table A9 Yield Variability Measured by APC2

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.13	0.20	0.19	0.25	0.31	0.28	0.28	0.17	0.10
Hubei	0.09	0.13	0.13	0.10	0.17	0.18	0.16	0.17	0.09
Hunan	0.09	0.13	0.20	0.22	0.15	0.19	–	–	0.08
Guangdong	0.06	0.32	–	0.11	0.12	–	–	–	0.07
Gansu	0.16	0.13	0.14	0.13	0.21	0.25	0.19	0.17	0.11
Guangxi	0.07	0.19	0.11	0.14	0.14	–	–	–	0.07
Guizhou	0.10	0.11	0.11	0.11	0.11	–	–	–	0.09
Heilongjiang	0.27	0.17	0.16	0.19	0.17	0.27	0.19	0.18	0.15
Henan	0.11	0.15	0.13	0.15	0.26	0.21	0.14	0.16	0.11
Jiangsu	0.10	0.15	0.13	0.15	0.15	0.24	0.14	0.17	0.09
Liaoning	0.20	0.25	0.17	0.11	0.17	0.15	0.14	0.23	0.14
Ningxia	0.19	0.18	–	0.26	0.17	–	–	–	0.14
Qinghai	0.00	0.12	–	0.15	–	–	–	–	0.12
Shaanxi	0.11	0.18	0.13	0.12	0.15	0.16	0.15	0.14	0.10
Sichuan	0.06	0.10	0.10	0.12	0.10	0.14	–	–	0.07
Shandong	0.10	0.16	0.11	0.13	0.15	0.14	0.14	0.11	0.09
Shanghai	0.10	0.26	0.18	0.28	0.27	–	–	–	0.10
Shanxi	0.15	0.28	0.09	0.13	0.24	0.14	0.11	0.23	0.10
Tianjin	0.25	0.25	0.30	0.22	0.24	0.43	0.32	0.36	0.21
Xinjiang	0.12	0.12	0.09	0.21	0.21	0.14	0.24	0.16	0.10
Zhejiang	0.09	0.22	0.14	0.13	0.13	–	–	–	0.09
Other regions	0.09	0.14	–	0.19	0.22	–	–	–	0.10
China	0.06	0.09	0.07	0.07	0.09	0.09	0.09	0.26	0.06

Table A10 Yield Variability Measured by APC3

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.12	0.17	0.16	0.21	0.24	0.22	0.21	0.15	0.10
Hubei	0.09	0.12	0.11	0.09	0.15	0.16	0.13	0.15	0.09
Hunan	0.08	0.12	0.15	0.18	0.13	0.14	–	–	0.08
Guangdong	0.06	0.24	–	0.10	0.11	–	–	–	0.06
Gansu	0.13	0.12	0.13	0.12	0.17	0.19	0.15	0.15	0.10
Guangxi	0.06	0.16	0.10	0.12	0.12	–	–	–	0.06
Guizhou	0.09	0.10	0.09	0.10	0.10	–	–	–	0.08
Heilongjiang	0.21	0.15	0.14	0.15	0.15	0.21	0.16	0.16	0.13
Henan	0.10	0.13	0.12	0.13	0.21	0.17	0.12	0.14	0.10
Jiangsu	0.10	0.14	0.12	0.14	0.14	0.20	0.13	0.15	0.08
Liaoning	0.16	0.21	0.13	0.10	0.15	0.13	0.12	0.18	0.12
Ningxia	0.14	0.16	–	0.20	0.15	–	–	–	0.12
Qinghai	0.00	0.11	–	0.13	–	–	–	–	0.11
Shaanxi	0.10	0.16	0.12	0.11	0.13	0.14	0.14	0.12	0.10
Sichuan	0.06	0.10	0.09	0.11	0.09	0.12	–	–	0.07
Shandong	0.10	0.14	0.10	0.12	0.13	0.13	0.13	0.10	0.09
Shanghai	0.09	0.21	0.16	0.16	0.21	–	–	–	0.09
Shanxi	0.14	0.22	0.09	0.12	0.20	0.13	0.11	0.20	0.09
Tianjin	0.20	0.20	0.24	0.19	0.20	0.30	0.24	0.25	0.18
Xinjiang	0.10	0.11	0.08	0.17	0.16	0.11	0.18	0.15	0.09
Zhejiang	0.08	0.19	0.12	0.11	0.12	–	–	–	0.08
Other-regions	0.09	0.13	–	0.15	0.16	–	–	–	0.09
China	0.06	0.09	0.07	0.07	0.09	0.09	0.09	0.18	0.06

Table A11 Yield Variability Measured by APC4

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.05	0.19	0.08	0.12	0.30	0.16	0.23	0.07	0.05
Hubei	0.02	0.05	0.06	0.03	0.06	0.08	0.05	0.06	0.03
Hunan	0.02	0.03	0.17	0.13	0.07	0.16	–	–	0.02
Guangdong	0.01	0.42	–	0.02	0.02	–	–	–	0.01
Gansu	0.08	0.04	0.06	0.03	0.09	0.12	0.07	0.05	0.02
Guangxi	0.02	0.05	0.03	0.03	0.05	–	–	–	0.02
Guizhou	0.02	0.02	0.03	0.02	0.02	–	–	–	0.02
Heilongjiang	0.09	0.05	0.04	0.10	0.04	0.11	0.05	0.05	0.03
Henan	0.06	0.10	0.06	0.04	0.13	0.09	0.04	0.05	0.05
Jiangsu	0.02	0.13	0.06	0.05	0.05	0.14	0.04	0.12	0.04
Liaoning	0.07	0.12	0.06	0.02	0.05	0.06	0.03	0.12	0.06
Ningxia	0.09	0.06	–	0.14	0.05	–	–	–	0.03
Qinghai	0.00	0.03	–	0.04	–	–	–	–	0.04
Shaanxi	0.02	0.06	0.06	0.02	0.04	0.04	0.04	0.03	0.03
Sichuan	0.01	0.02	0.04	0.03	0.04	0.06	–	–	0.01
Shandong	0.05	0.11	0.04	0.03	0.04	0.04	0.03	0.02	0.04
Shanghai	0.02	0.17	0.07	0.08	0.28	–	–	–	0.02
Shanxi	0.04	0.11	0.03	0.03	0.10	0.10	0.03	0.13	0.03
Tianjin	0.10	0.12	0.14	0.13	0.09	0.55	0.21	0.63	0.08
Xinjiang	0.03	0.03	0.02	0.07	0.09	0.03	0.09	0.06	0.02
Zhejiang	0.02	0.13	0.07	0.10	0.10	–	–	–	0.02
Other-regions	0.03	0.08	–	0.06	0.39	–	–	–	0.02
China	0.01	0.04	0.03	0.01	0.02	0.04	0.02	0.29	0.02

Table A12 Yield Variability Measured by APC6

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.03	0.06	0.04	0.06	0.09	0.08	0.08	0.04	0.02
Hubei	0.01	0.03	0.02	0.02	0.04	0.04	0.03	0.03	0.01
Hunan	0.01	0.02	0.05	0.05	0.03	0.04	–	–	0.01
Guangdong	0.01	0.09	–	0.02	0.02	–	–	–	0.01
Gansu	0.04	0.03	0.03	0.02	0.05	0.06	0.04	0.03	0.02
Guangxi	0.01	0.04	0.02	0.02	0.03	–	–	–	0.01
Guizhou	0.01	0.02	0.02	0.02	0.02	–	–	–	0.01
Heilongjiang	0.06	0.03	0.03	0.04	0.03	0.06	0.04	0.04	0.02
Henan	0.02	0.03	0.03	0.03	0.07	0.05	0.02	0.03	0.02
Jiangsu	0.01	0.03	0.03	0.03	0.03	0.06	0.03	0.04	0.02
Liaoning	0.04	0.06	0.04	0.01	0.03	0.03	0.02	0.05	0.03
Ningxia	0.04	0.04	–	0.06	0.03	–	–	–	0.02
Qinghai	0.00	0.02	–	0.03	–	–	–	–	0.02
Shaanxi	0.02	0.04	0.02	0.02	0.03	0.03	0.03	0.02	0.02
Sichuan	0.01	0.01	0.02	0.02	0.02	0.03	–	–	0.01
Shandong	0.02	0.04	0.02	0.02	0.03	0.03	0.02	0.02	0.02
Shanghai	0.01	0.06	0.04	0.05	0.07	–	–	–	0.01
Shanxi	0.03	0.07	0.01	0.02	0.06	0.03	0.02	0.06	0.02
Tianjin	0.06	0.06	0.07	0.05	0.06	0.13	0.09	0.10	0.05
Xinjiang	0.02	0.02	0.01	0.04	0.05	0.02	0.06	0.03	0.01
Zhejiang	0.01	0.05	0.03	0.03	0.03	–	–	–	0.01
Other-regions	0.02	0.03	–	0.04	0.06	–	–	–	0.02
China	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.07	0.01

Table A13 Yield Variability Measured by CV1

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.32	0.52	0.44	0.40	0.33	0.33	0.41	0.39	0.42
Hubei	0.23	0.34	0.34	0.20	0.23	0.35	0.24	0.27	0.31
Hunan	0.23	0.34	0.30	0.32	0.35	0.29	–	–	0.28
Guangdong	0.27	0.41	–	0.27	0.24	–	–	–	0.27
Gansu	0.28	0.35	0.38	0.16	0.32	0.30	0.23	0.23	0.28
Guangxi	0.28	0.31	0.30	0.16	0.19	–	–	–	0.30
Guizhou	0.16	0.19	0.30	0.13	0.19	–	–	–	0.17
Heilongjiang	0.29	0.31	0.30	0.18	0.17	0.29	0.20	0.30	0.23
Henan	0.39	0.50	0.42	0.32	0.29	0.22	0.24	0.33	0.43
Jiangsu	0.28	0.52	0.44	0.35	0.29	0.47	0.24	0.50	0.41
Liaoning	0.35	0.47	0.39	0.12	0.18	0.42	0.21	0.47	0.41
Ningxia	0.46	0.29	–	0.38	0.19	–	–	–	0.27
Qinghai	0.00	0.34	–	0.22	–	–	–	–	0.27
Shaanxi	0.19	0.32	0.39	0.20	0.19	0.36	0.25	0.25	0.32
Sichuan	0.22	0.35	0.38	0.27	0.31	0.32	–	–	0.26
Shandong	0.46	0.48	0.42	0.34	0.26	0.27	0.28	0.30	0.41
Shanghai	0.14	0.42	0.22	0.30	0.76	–	–	–	0.21
Shanxi	0.34	0.42	0.29	0.24	0.23	0.44	0.24	0.34	0.35
Tianjin	0.26	0.46	0.43	0.26	0.42	0.52	0.36	0.39	0.36
Xinjiang	0.29	0.23	0.24	0.34	0.34	0.18	0.22	0.23	0.23
Zhejiang	0.25	0.40	0.24	0.22	0.34	–	–	–	0.28
Other-regions	0.21	0.37	–	0.24	0.24	–	–	–	0.23
China	0.24	0.40	0.36	0.20	0.19	0.36	0.22	0.28	0.30

Table A14 Yield Variability Measured by CI

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Hubei	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Hunan	0.01	0.01	0.01	0.01	0.01	0.01	–	–	0.01
Guangdong	0.01	0.01	–	0.01	0.01	–	–	–	0.01
Gansu	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Guangxi	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Guizhou	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Heilongjiang	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Henan	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Jiangsu	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Liaoning	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ningxia	0.01	0.01	–	0.01	0.01	–	–	–	0.01
Qinghai	0.00	0.01	–	0.01	–	–	–	–	0.01
Shaanxi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sichuan	0.01	0.01	0.01	0.01	0.01	0.01	–	–	0.01
Shandong	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Shanghai	0.01	0.01	0.01	0.03	0.01	–	–	–	0.01
Shanxi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tianjin	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01
Xinjiang	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zhejiang	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Other-regions	0.01	0.01	–	0.01	0.01	–	–	–	0.01
China	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table A15 Output Variability Measured by APC1

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.18	0.29	0.27	0.28	0.46	0.43	0.34	0.20	0.12
Hubei	0.14	0.19	0.15	0.17	0.22	0.38	0.30	0.21	0.11
Hunan	0.12	0.20	0.21	0.24	0.22	0.31	–	–	0.11
Guangdong	0.07	0.50	–	0.11	0.16	–	–	–	0.07
Gansu	0.19	0.16	0.17	0.16	0.21	0.23	0.17	0.16	0.12
Guangxi	0.09	0.46	0.11	0.20	0.31	–	–	–	0.08
Guizhou	0.12	0.33	0.12	0.19	0.15	–	–	–	0.10
Heilongjiang	0.30	0.26	0.24	0.26	0.17	0.22	0.20	0.19	0.16
Henan	0.23	0.18	0.23	0.23	0.30	0.28	0.19	0.18	0.12
Jiangsu	0.13	0.20	0.15	0.19	0.18	0.47	0.33	0.18	0.10
Liaoning	0.27	0.32	0.26	0.28	0.20	0.18	0.18	0.43	0.15
Ningxia	0.19	0.20	–	0.28	0.28	–	–	–	0.15
Qinghai	0.00	0.17	–	0.17	–	–	–	–	0.11
Shaanxi	0.12	0.19	0.16	0.17	0.20	0.21	0.20	0.13	0.11
Sichuan	0.09	0.15	0.15	0.18	0.15	0.18	–	–	0.09
Shandong	0.58	0.21	0.21	0.16	0.18	0.22	0.20	0.13	0.10
Shanghai	0.12	0.30	0.25	0.68	0.32	–	–	–	0.10
Shanxi	0.24	0.25	0.16	0.19	0.29	0.19	0.12	0.31	0.11
Tianjin	0.86	0.31	0.29	0.27	0.26	0.52	0.35	0.45	0.23
Xinjiang	0.16	0.15	0.11	0.27	0.34	0.16	0.46	0.25	0.11
Zhejiang	0.10	0.26	0.21	0.18	0.18	–	–	–	0.10
Other-regions	0.11	0.22	–	0.31	0.38	–	–	–	0.12
China	0.08	0.13	0.12	0.10	0.11	0.14	0.12	0.20	0.07

Table A16 Output Variability Measured by APC2

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.15	0.23	0.27	0.29	0.37	0.50	0.32	0.25	0.11
Hubei	0.12	0.17	0.14	0.17	0.24	0.34	0.30	0.21	0.10
Hunan	0.10	0.21	0.20	0.25	0.20	0.31	–	–	0.10
Guangdong	0.07	0.85	–	0.12	0.15	–	–	–	0.07
Gansu	0.20	0.15	0.17	0.16	0.20	0.24	0.18	0.17	0.12
Guangxi	0.08	0.43	0.10	0.19	0.24	–	–	–	0.07
Guizhou	0.12	0.23	0.12	0.17	0.15	–	–	–	0.10
Heilongjiang	0.27	0.23	0.25	0.26	0.17	0.29	0.21	0.20	0.16
Henan	0.19	0.16	0.17	0.23	0.29	0.32	0.19	0.18	0.11
Jiangsu	0.11	0.15	0.13	0.18	0.17	0.60	0.45	0.18	0.08
Liaoning	0.23	0.36	0.25	0.29	0.19	0.21	0.20	0.65	0.15
Ningxia	0.18	0.18	–	0.26	0.25	–	–	–	0.15
Qinghai	0.00	0.14	–	0.17	–	–	–	–	0.10
Shaanxi	0.12	0.18	0.14	0.16	0.20	0.23	0.20	0.14	0.11
Sichuan	0.09	0.13	0.13	0.16	0.15	0.16	–	–	0.08
Shandong	0.51	0.18	0.16	0.15	0.19	0.25	0.22	0.14	0.09
Shanghai	0.12	0.29	0.24	0.51	0.35	–	–	–	0.10
Shanxi	0.20	0.27	0.15	0.18	0.29	0.18	0.12	0.26	0.10
Tianjin	1.39	0.30	0.25	0.29	0.27	0.57	0.36	0.51	0.22
Xinjiang	0.15	0.14	0.11	0.28	0.31	0.16	0.42	0.24	0.10
Zhejiang	0.09	0.23	0.22	0.17	0.18	–	–	–	0.09
Other-regions	0.10	0.18	–	0.23	0.27	–	–	–	0.11
China	0.07	0.11	0.10	0.10	0.10	0.15	0.13	0.20	0.06

Table A17 Output Variability Measured by APC3

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.14	0.19	0.22	0.22	0.29	0.29	0.23	0.17	0.10
Hubei	0.11	0.15	0.12	0.14	0.18	0.26	0.23	0.18	0.10
Hunan	0.09	0.17	0.16	0.19	0.17	0.23	–	–	0.09
Guangdong	0.07	0.32	–	0.10	0.14	–	–	–	0.06
Gansu	0.16	0.13	0.14	0.14	0.17	0.18	0.15	0.14	0.11
Guangxi	0.07	0.28	0.09	0.16	0.21	–	–	–	0.07
Guizhou	0.11	0.19	0.10	0.15	0.13	–	–	–	0.09
Heilongjiang	0.23	0.20	0.20	0.20	0.15	0.19	0.17	0.17	0.14
Henan	0.16	0.14	0.15	0.18	0.24	0.23	0.16	0.15	0.10
Jiangsu	0.11	0.14	0.12	0.15	0.15	0.30	0.26	0.15	0.08
Liaoning	0.19	0.25	0.19	0.22	0.17	0.16	0.16	0.22	0.13
Ningxia	0.14	0.16	–	0.22	0.21	–	–	–	0.13
Qinghai	0.00	0.13	–	0.15	–	–	–	–	0.09
Shaanxi	0.11	0.16	0.13	0.14	0.17	0.19	0.18	0.12	0.10
Sichuan	0.08	0.12	0.12	0.15	0.13	0.14	–	–	0.08
Shandong	0.36	0.16	0.15	0.13	0.16	0.18	0.17	0.12	0.09
Shanghai	0.10	0.23	0.20	0.33	0.24	–	–	–	0.09
Shanxi	0.17	0.21	0.13	0.16	0.23	0.15	0.11	0.22	0.09
Tianjin	0.40	0.23	0.21	0.19	0.21	0.34	0.26	0.26	0.19
Xinjiang	0.14	0.12	0.10	0.21	0.22	0.14	0.30	0.20	0.09
Zhejiang	0.09	0.20	0.18	0.14	0.15	–	–	–	0.09
Other-regions	0.09	0.16	–	0.19	0.19	–	–	–	0.10
China	0.07	0.10	0.09	0.09	0.10	0.13	0.11	0.16	0.06

Table A18 Output Variability Measured by APC4

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.09	0.26	0.12	0.14	0.63	0.40	0.37	0.07	0.04
Hubei	0.05	0.08	0.05	0.08	0.10	0.40	0.19	0.07	0.03
Hunan	0.04	0.08	0.14	0.12	0.10	0.22	–	–	0.04
Guangdong	0.01	0.70	–	0.02	0.05	–	–	–	0.01
Gansu	0.07	0.06	0.05	0.04	0.09	0.12	0.06	0.04	0.02
Guangxi	0.03	0.69	0.03	0.09	0.24	–	–	–	0.02
Guizhou	0.03	0.70	0.03	0.08	0.04	–	–	–	0.02
Heilongjiang	0.15	0.12	0.09	0.13	0.04	0.09	0.07	0.06	0.04
Henan	0.25	0.10	0.29	0.10	0.15	0.13	0.06	0.05	0.03
Jiangsu	0.05	0.14	0.05	0.06	0.05	0.62	0.17	0.06	0.03
Liaoning	0.25	0.17	0.20	0.13	0.07	0.07	0.05	1.32	0.04
Ningxia	0.11	0.08	–	0.15	0.17	–	–	–	0.04
Qinghai	0.00	0.07	–	0.04	–	–	–	–	0.02
Shaanxi	0.02	0.07	0.06	0.07	0.06	0.07	0.06	0.03	0.02
Sichuan	0.01	0.08	0.09	0.06	0.04	0.07	–	–	0.02
Shandong	1.46	0.12	0.15	0.04	0.05	0.10	0.06	0.03	0.02
Shanghai	0.02	0.15	0.11	3.06	0.19	–	–	–	0.02
Shanxi	0.22	0.10	0.07	0.08	0.14	0.11	0.03	0.30	0.02
Tianjin	6.02	0.17	0.26	0.23	0.12	0.54	0.21	0.89	0.09
Xinjiang	0.05	0.05	0.03	0.13	0.40	0.04	0.52	0.11	0.03
Zhejiang	0.03	0.15	0.07	0.10	0.06	–	–	–	0.03
Other-regions	0.03	0.12	–	0.41	0.92	–	–	–	0.02
China	0.02	0.06	0.07	0.02	0.03	0.03	0.02	0.11	0.02

Table A19 Output Variability Measured by APC6

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.03	0.07	0.07	0.07	0.11	0.13	0.09	0.05	0.02
Hubei	0.03	0.04	0.03	0.04	0.06	0.10	0.08	0.04	0.02
Hunan	0.02	0.05	0.05	0.06	0.05	0.08	–	–	0.02
Guangdong	0.01	0.16	–	0.02	0.03	–	–	–	0.01
Gansu	0.04	0.03	0.03	0.03	0.05	0.06	0.04	0.03	0.02
Guangxi	0.01	0.13	0.02	0.04	0.07	–	–	–	0.01
Guizhou	0.02	0.07	0.02	0.04	0.03	–	–	–	0.01
Heilongjiang	0.07	0.06	0.06	0.06	0.03	0.06	0.05	0.04	0.03
Henan	0.05	0.04	0.04	0.05	0.08	0.08	0.04	0.03	0.02
Jiangsu	0.02	0.04	0.03	0.04	0.03	0.14	0.10	0.04	0.01
Liaoning	0.06	0.09	0.06	0.07	0.04	0.05	0.04	0.11	0.03
Ningxia	0.04	0.04	–	0.07	0.07	–	–	–	0.03
Qinghai	0.00	0.03	–	0.03	–	–	–	–	0.02
Shaanxi	0.02	0.04	0.03	0.03	0.04	0.05	0.04	0.02	0.02
Sichuan	0.01	0.02	0.03	0.03	0.03	0.04	–	–	0.01
Shandong	0.35	0.04	0.04	0.03	0.04	0.06	0.05	0.02	0.01
Shanghai	0.02	0.07	0.06	0.15	0.09	–	–	–	0.02
Shanxi	0.05	0.06	0.03	0.04	0.08	0.04	0.02	0.07	0.01
Tianjin	0.38	0.08	0.07	0.07	0.07	0.16	0.10	0.11	0.05
Xinjiang	0.03	0.03	0.02	0.07	0.09	0.03	0.13	0.06	0.02
Zhejiang	0.01	0.06	0.05	0.04	0.04	–	–	–	0.01
Other-regions	0.02	0.05	–	0.07	0.08	–	–	–	0.02
China	0.01	0.02	0.02	0.01	0.02	0.03	0.02	0.05	0.01

Table A20 Output Variability Measured by CV1

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.40	0.50	0.51	0.40	0.38	0.58	0.53	0.50	0.34
Hubei	0.37	0.43	0.28	0.32	0.23	0.46	0.71	0.31	0.31
Hunan	0.36	0.32	0.27	0.30	0.39	0.39	–	–	0.34
Guangdong	0.27	0.89	–	0.20	0.40	–	–	–	0.26
Gansu	0.25	0.43	0.36	0.21	0.28	0.47	0.23	0.22	0.28
Guangxi	0.36	0.60	0.34	0.44	0.44	–	–	–	0.34
Guizhou	0.19	0.47	0.31	0.42	0.24	–	–	–	0.22
Heilongjiang	0.45	0.59	0.42	0.27	0.23	0.24	0.21	0.21	0.30
Henan	0.47	0.49	0.60	0.38	0.26	0.46	0.28	0.28	0.35
Jiangsu	0.40	0.56	0.35	0.29	0.20	0.69	0.77	0.31	0.36
Liaoning	0.64	0.53	0.54	0.44	0.24	0.31	0.30	0.61	0.34
Ningxia	0.49	0.44	–	0.35	0.34	–	–	–	0.32
Qinghai	0.00	0.51	–	0.27	–	–	–	–	0.28
Shaanxi	0.23	0.33	0.39	0.47	0.20	0.67	0.17	0.14	0.28
Sichuan	0.22	0.52	0.46	0.34	0.27	0.24	–	–	0.28
Shandong	0.79	0.49	0.62	0.33	0.31	0.44	0.43	0.33	0.33
Shanghai	0.33	0.41	0.44	1.21	0.49	–	–	–	0.31
Shanxi	0.59	0.38	0.45	0.27	0.36	0.57	0.16	0.27	0.29
Tianjin	0.60	0.65	0.63	0.40	0.31	0.60	0.45	0.40	0.38
Xinjiang	0.40	0.41	0.35	0.35	0.55	0.22	0.35	0.27	0.34
Zhejiang	0.33	0.44	0.25	0.21	0.16	–	–	–	0.31
Other-regions	0.27	0.49	–	0.49	0.28	–	–	–	0.22
China	0.31	0.45	0.46	0.20	0.15	0.23	0.18	0.22	0.28

Table A21 Output Variability Measured by CI

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other-grains	Food-grain
Anhui	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01
Hubei	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Hunan	0.01	0.01	0.01	0.01	0.01	0.01	–	–	0.01
Guangdong	0.01	0.02	–	0.01	0.01	–	–	–	0.01
Gansu	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Guangxi	0.01	0.02	0.01	0.01	0.01	–	–	–	0.01
Guizhou	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Heilongjiang	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Henan	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Jiangsu	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.01
Liaoning	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Ningxia	0.01	0.01	–	0.01	0.01	–	–	–	0.01
Qinghai	0.00	0.01	–	0.01	–	–	–	–	0.01
Shaanxi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sichuan	0.01	0.01	0.01	0.01	0.01	0.01	–	–	0.01
Shandong	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Shanghai	0.01	0.01	0.01	0.02	0.02	–	–	–	0.01
Shanxi	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tianjin	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01
Xinjiang	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Zhejiang	0.01	0.01	0.01	0.01	0.01	–	–	–	0.01
Other regions	0.01	0.01	–	0.01	0.02	–	–	–	0.01
China	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Appendix B

SUPPLEMENTARY TABLES OF CHAPTER 4

Note: '--' indicates data unavailable in all the tables.

Table B1 Components of Area Sown Variability by Crop and Region

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other--grain	Residual Grain	Covariance Among Crops
Anhui	0.32	0.30	0.02	0.03	0.08	0.13	0.00	0.97	0.00	1.63
Hubei	0.70	0.06	0.01	0.01	0.01	0.00	0.01	0.45	0.00	-0.70
Hunan	1.07	0.01	0.00	0.03	0.01	0.00	–	–	0.10	-0.45
Guangdong	0.17	0.05	–	0.06	0.00	–	–	–	0.01	0.18
Gansu	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.07	0.00	-0.11
Guangxi	0.23	0.02	0.02	0.05	0.00	–	–	–	0.01	0.03
Guizhou	0.01	0.04	0.00	0.01	0.00	–	–	–	0.02	0.01
Heilongjiang	0.01	0.74	0.20	0.00	0.09	0.05	0.04	0.02	0.00	-0.03
Henan	0.02	0.47	0.25	0.05	0.27	0.21	0.13	1.00	0.00	2.36
Jiangsu	0.70	0.18	0.02	0.01	0.15	0.05	0.00	0.42	0.00	-0.12
Liaoning	0.04	0.00	0.16	0.01	0.03	0.24	0.09	0.06	0.00	-0.21
Ningxia	0.00	0.01	–	0.00	0.00	–	–	–	0.00	0.00
Qinghai	0.00	0.00	–	0.00	0.00	–	–	–	0.00	0.00
Shaanxi	0.00	0.01	0.02	0.02	0.01	0.01	0.01	0.11	0.00	-0.01
Sichuan	0.29	0.41	0.08	0.12	0.00	0.00	–	–	0.37	-0.23
Shandong	0.02	0.18	0.53	0.09	0.88	0.46	0.33	0.14	0.00	0.82
Shangha	0.01	0.00	0.00	0.00	0.00	–	–	–	0.00	0.00
Shanxi	0.00	0.02	0.04	0.00	0.04	0.01	0.04	0.08	0.00	0.04
Tianjin	0.00	0.00	0.01	0.00	0.00	0.00	0.00	–	0.00	-0.01
Xinjiang	0.00	0.21	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.10
Zhejiang	0.16	0.00	0.00	0.00	0.00	–	–	–	0.02	-0.11
Other-regions	0.87	1.51	–	0.90	0.63	–	–	–	3.10	-3.48
Residual Region	0.00	0.00	3.89	0.00	0.00	0.71	1.24	7.88	6.48	-20.20
Covariance Among Regions	27.21	7.43	11.14	2.89	7.83	8.70	6.42	40.34	-10.12	24.29

Table B2 Components of Output Variability by Crop and Region

	Rice	Wheat	Maize	Tubers	Soy-beans	Sor-ghum	Millet	Other--grain	Residual Grain	Covariance Among Crops
Anhui	0.14	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.20
Hubei	0.24	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Hunan	0.50	0.00	0.00	0.00	0.00	0.00	–	–	0.00	0.07
Guangdong	0.22	0.00	–	0.00	0.00	–	–	–	0.00	0.04
Gansu	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Guangxi	0.13	0.00	0.00	0.00	0.00	–	–	–	0.00	0.03
Guizhou	0.01	0.00	0.00	0.00	0.00	–	–	–	0.00	0.02
Heilongjiang	0.00	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Henan	0.01	0.17	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.38
Jiangsu	0.30	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.41
Liaoning	0.01	0.00	0.06	0.00	0.00	0.01	0.00	0.00	0.00	0.08
Ningxia	0.00	0.00	–	0.00	0.00	–	–	–	0.00	0.00
Qinghai	0.00	0.00	–	0.00	0.00	–	–	–	0.00	0.00
Shaanxi	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Sichuan	0.18	0.04	0.04	0.03	0.00	0.00	–	–	0.00	0.67
Shandong	0.00	0.14	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.39
Shanghai	0.00	0.00	0.00	0.00	0.00	–	–	–	0.00	0.00
Shanxi	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Tianjin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xinjiang	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Zhejiang	0.18	0.00	0.00	0.00	0.00	–	–	–	0.00	0.05
Other-regions	0.53	0.11	–	0.12	0.01	–	–	–	0.49	1.31
Residual Region	0.00	0.00	0.62	0.00	0.00	0.01	0.01	0.25	0.57	-1.46
Covariance Among Regions	20.39	4.92	4.48	0.34	0.02	0.04	0.02	0.01	-1.07	62.60

Appendix C PROGRAM LISTING

Explanatory notes are given where appropriate. Further details regarding the code and operation of this program can be obtained from the author.

```
************************************************************
C       Main Program to Estimate Just-Pope Model          C
C       Single or Multiple Eq. by Guang Hua Wan           C
C         Cf. Chapter 6,  Griffiths & Anderson(1982)      C
C INPUTS: (1)INSTRUCTION FILE; (2) DATA FILE;             C
C          (3)FUNX SUBROUTINE; (4) OUTPUT FILE NAME       C
C***********************************************************
C        The following specify the maximum array
C              sizes allowed by this program:
C        NT=no. of observations for each eq.
C        MNT=no. of observations for SUR
C        NP=no. of parameters in SUR
C        NE=no. of eq
C        NP1=no. of parameters in each eq.
        PARAMETER(NT=200,MNT=600,NP=30,NE=3,NP1=10)
        CHARACTER*30 INFIL,DATFIL,OUTFIL
        DIMENSION FMT(1800),A2(NP),B2(NP),PH(MNT,MNT)
        REAL U2(MNT),U(MNT),LNU2(MNT),LNUS(MNT),E(MNT)
        REAL LNXS(MNT,NP),HH(MNT),X(MNT,NP),LNX(MNT,NP)
        REAL B00(NP),X1(600,30),B1(NP),B0(NP)
        REAL AE(3),AE1(3),BE(3),BE1(3),A1(NP)
        COMMON/FUN/HH,AE,PH
        COMMON/FUN1/ND,KI(NE)
        COMMON/PARA/NEQ1,NF,NY,NT1,NS,KS1,JUD
        COMMON/DAT/W(600,30)
C
        WRITE(6,101)
 101        FORMAT(' ENTER INSTRUCTION FILE NAME: ',$)
        READ(5,102) INFIL
```

```
 102        FORMAT(2A)
       WRITE(6,103)
 103        FORMAT(' ENTER DATA FILE NAME: ',$)
       READ(5,102) DATFIL
       WRITE(6,104)
 104        FORMAT(' ENTER OUTPUT FILE NAME: ',$)
       READ(5,102) OUTFIL
C
       OPEN(UNIT=20,FILE=INFIL)
       OPEN(UNIT=36,FILE=DATFIL)
       OPEN(UNIT=25,FILE=OUTFIL)
C
       READ(20,*)NV,NVT,INT,NS,KZ,KZZ,NF
C       NV=no. of original variables;
C       NVT=no. of variables after transformation;
C       INT=no. of transformations;
C       NS=no. of rows;
C       KZ: 0-data read by variable
C           1-data read by observation
C       KZZ:0-data printed
C           1-data not printed
C       NF=no. of firms
C
C
       CALL SETUP(X,NV,NS,KZ)    !  Read in data
C
       CALL DATA1(X,NS,NVT,INT,KZZ,FMT)
C           Data1 performs data transformations
C          Data2 extracts data for estimation
```

```
        CALL DATA2(X,NS,X1)  !X = TRANSFORMED DATA
C
         READ(20,*)NEQ,(KI(I),I=1,NEQ)  !NEQ=no. of eq
C            KI(I) = parameter no. in I-th eq
          READ(20,*)MIT,JUD,NT1
C         MIT=maximum iterations
C         JUD: 0-numerical derivative; 1-analytical
C         NT1=no. of observations for each eq.
C
          KK=KI(1)
          NY=NT1/NF
C
         ND=0          !NORMAL NLR
            NEQ1=1
            KS=0
            K1=1
         DO 69 I=1,NEQ
            KS=KS+KI(I)
            KS1=KI(I)
           READ(20,*) (B0(J),J=1,KI(I))
C             starting values for normal NLR
           READ(20,*) (B00(J),J=K1,KS)
C             starting values for Just-Pope NLR
             K1=K1+KI(I)
             KI(1)=KI(I)
C
              J1=(I-1)*NT1+1
              J2=I*NT1
            DO 5 J=J1,J2
```

```
            K=J-J1+1
          DO 35 L=1,KI(I)
 35         W(K,L)=X1(J,L)
C       PRINT*,(W(K,L),L=1,KI(I))
 5        CONTINUE
C
          NS=NT1*NEQ1
      CALL NLR1(A1,E,B0,MIT)
        DO 15 J=J1,J2
           K=J-J1+1
 15        U(J)=E(K)
C
 69      CONTINUE
          NS=NT1*NEQ
C
       DO 25 I=1,NS
        DO 25 J=1,10
 25      W(I,J)=X1(I,J)
C
       NEQ1=NEQ
       KS1=KS
       ND=1
       KI(1)=KK
      CALL BXLN(U,LNU2,X1,600,LNX)
C
        IF(NEQ.EQ.1) THEN !Just-Pope model
C
        CALL OLS(LNU2,LNX,B1,KS,NS,E)    !B1(2...)=2*BK
        CALL CAL1(B1,U,BE1,AE1)          !Now,B1(..)=BK
```

```
C
      DO 39 ND=1,3
        DO 49 I=1,3
          AE(I)=AE1(I)
          BE(I)=BE1(I)
 49         CONTINUE
C
       IF(ND.EQ.1) THEN !no time effect
          BE(3)=0.0
          AE(3)=0.0
          BE(2)=0.0
          AE(2)=0.0
       ELSE IF(ND.EQ.2) THEN  !no firm effect
          BE(3)=0.0
          AE(3)=0.0
          BE(1)=0.0
          AE(1)=0.0
       ENDIF
C
       CALL WX(LNU2,LNX,LNUS,LNXS,BE)
       CALL OLS(LNUS,LNXS,B2,KS,NS,E)
C
        B2(1)=B2(1)/(1.-BE(1)-BE(2)+BE(3))
         DO 29 I=2,KS
 29            B2(I)=B2(I)/2.
C
      DO 19 I=1,NS
       HH(I)=1.
      DO 19 J=2,KS
```

```
         HH(I)=HH(I)*X1(I,J)**B2(J)
 19        CONTINUE
C
        DO 55 JJ=1,KS
         BO(JJ)=BOO(JJ)
 55        CONTINUE
        CALL NLR1(A2,U2,BO,MIT)
C
 39        CONTINUE
C
        ELSE                 !SUR Just-Pope model
C
         WRITE(25,1)
           CALL MLSDV(LNU2,LNX,E,B2,KI)
           CALL SIGMAS(E,U,B2)
         WRITE(25,2)
           CALL NLR1(A2,U2,BOO,MIT)
        ENDIF
C
        STOP
 1        FORMAT(/,' **   Results for Output
     1  Variance Function **        ',/)
 2        FORMAT(/,' ** Final Results for Mean
     1  Output Function **        ',/)
        END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       Reading Data from a File          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE SETUP (W,ME,N,KV)
```

```
      REAL W(600,*)
C
      IF(KV.EQ.1) GO TO 2
       DO 1 I=1, ME
        READ(36,*) (W(I,J),J=1,N)
 1       CONTINUE
      GO TO 4
 2       CONTINUE
        DO 3 J=1,N
          READ(36,*) (W(J,I),I=1,ME)
 3       CONTINUE
 4       CONTINUE
C
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C      Performs Data Transformations     C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE DATA1 (W,N,ME,M,KZ,FMT)
      REAL W(600,*)
      DIMENSION FMT(ME,20)
C     W is the data pack with ME variables and
C         N observations, read in previously, M1
C         replace ME as no. of transformed variables
      WRITE (25,33)
      WRITE (25,34) ME,M,N
      IF (M.EQ.0) GO TO 28
C     PERFORM DATA TRANSFORMATIONS
      WRITE (25,35)
```

```
      DO 27 LK=1,M
      READ(20,*) IAIII,IBIII,ICIII,IDIII,IEIII,CONST
      WRITE (25,36)IAIII,IBIII,ICIII,IDIII,IEIII,CONST
      N1=IBIII
      N2=ICIII
      N3=IDIII
      II=IAIII
      GO TO (1,3,5,7,10,13,16,18,20,22,24), II
1     DO 2 I=1,N
2     W(I,N3)=W(I,N1)+W(I,N2)
      GO TO 26
3     DO 4 I=1,N
4     W(I,N3)=W(I,N1)-W(I,N2)
      GO TO 26
5     DO 6 I=1,N
6     W(I,N3)=W(I,N1)*W(I,N2)
      GO TO 26
7     DO 9 I=1,N
      IF (W(I,N2).EQ.0.) GO TO 8
      W(I,N3)=W(I,N1)/W(I,N2)
      GO TO 9
8     WRITE (25,37)
      WRITE (25,38)I,N2
        W(I,N3)=W(I,N1)/(1.0E-8)
9     CONTINUE
      GO TO 26
10    DO 12 I=1,N
      IF (W(I,N1).LE.0.) GO TO 11
      W(I,N3)=LOG(W(I,N1))
```

```
      GO TO 12
11    WRITE (25,39)
      WRITE (25,38) I,N1
        W(I,N3)=0.
12    CONTINUE
      GO TO 26
13    N4=IEIII
      NN=N-N4
      DO 14 I=1,NN
14    W(N-I+1,N3)=W(N-I-N4+1,N1)
      IF (N4.EQ.0) GO TO 26
      DO 15 KJ=1,N4
      W(KJ,N3)=1.0
15    CONTINUE
      GO TO 26
16    DO 17 I=1,N
17    W(I,N3)=W(I,N1)
      GO TO 26
18    DO 19 I=1,N
19    W(I,N3)=W(I,N1)*CONST
      GO TO 26
20    DO 21 I=1,N
      W(I,N3)=W(I,N1)+CONST
21    CONTINUE
      GO TO 26
22    DO 23 I=1,N
      W(I,N3)=W(I,N1)**CONST
23    CONTINUE
      GO TO 26
```

```
24    DO 25 I=1,N
      W(I,N3)=W(I,N1)/CONST
25    CONTINUE
26    CONTINUE
27    CONTINUE
28    CONTINUE
C     read variable names into FMT(I,J)
        DO 29 I=1,ME
        READ(20,46) (FMT(I,J),J=1,20)
29    WRITE (25,42) I,(FMT(I,J),J=1,20)
      IF (KZ.EQ.1) GO TO 31
C     print transformed data
      WRITE (25,41)
      DO 30 I=1,ME
      WRITE(25,43)I
      WRITE (25,44) (FMT(I,J),J=1,20)
30    WRITE (25,45) (W(J,I),J=1,N)
31    CONTINUE
      RETURN
C
33    FORMAT (' ',5X,'NO. OF TRANSFORMED VARS',5X,
     1         ' NO. OF TRANSFORMATIONS',
     1 5X,'NO. OF OBSERVATIONS')
34    FORMAT (' ',10X,I4,20X,I4,20X,I4)
35    FORMAT (' ',5X,'ANALYSIS OF TRANSFORMATIONS',/)
36    FORMAT (' ',5X,5I4,F12.4)
37    FORMAT (' ',5X,'WARNING: DIVISION BY 0 REPLACED
     1 BY 1.E-8')
38    FORMAT (' ',5X,'VARIABLE NO.',1X,I4,
```

```
     1        5X,'OBSERVATION NO.',1X,I4)
39    FORMAT (' ',5X,'WARNING: TAKE LOGS OF X <= 0
     1  REPLACED BY 1.0')
41    FORMAT ('0',5X,'DATA INPUT AFTER TRANSFORMATION'/)
42    FORMAT (' ',2X,I4,2X,20A1)
43    FORMAT(/,'      VARIABLE NUMBER  ',I4)
44    FORMAT (' ',2X,20A1)
45    FORMAT (' ',100(5X,6F10.2,/))
46    FORMAT(80A1)
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       Extract Data from the Transformed Set   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE DATA2(W,NS,W1)
         REAL W(600,*),W1(600,*)
         INTEGER PY,PX(30)
C
        READ(20,*)NIV,PY,(PX(I),I=1,NIV)
C        NIV=no. of Xs for this estimation
C        PY=column no. for Y in transed data.
C        PX(I): see PY
C
        DO 9 I=1,NS
          W1(I,1)=W(I,PY)
           DO 19 J=1,NIV
          W1(I,J+1)=W(I,PX(J))
 19         CONTINUE
 9        CONTINUE
C
```

```
      RETURN
      END
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C                Output Subroutine             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE OUTPUT (B,A,ESS,SB,E)
      PARAMETER(NE=3)
      DOUBLE PRECISION SRES,DW,E,F,RSQ
      DOUBLE PRECISION XALI,XBLI,D,SE,T,SUM
      DIMENSION B(*),A(30,*),E(*),SB(*),SE(30),T(30)
        COMMON/PARA/NEQ,NF,NY,NT1,N,M,ID
        COMMON/FUN1/MF,KI(NE)
        COMMON/DAT/W(600,30)
C     Cal mean corrected sum of squares
      XALI=0.0
        N6=N-M
      SUM=0.0
      DO 1 I=1,N
      SUM=SUM+E(I)
      XALI=XALI+W(I,1)
1     CONTINUE
      SUM=SUM*SUM
      SUM=SUM/N
C        ESS=ESS - SUM
      XALI=XALI/N
      D=0.0
      DO 2 I=1,N
      XBLI=W(I,1)-XALI
      D=D+XBLI*XBLI
```

```
2     CONTINUE
C     FORM FIT STATISTICS
        IF(ESS/N.LT.0.) ESS=1.
      SRES=SQRT(ESS/N)
      RSQ=1.0-(ESS/D)
      K=M-1
      F=((D-ESS)/K)/(ESS/N6)
      NN1=2
      DW=0.0
      DO 3 I=NN1,N
      SUM=E(I)-E(I-1)
3     DW=DW+SUM*SUM
      DW=DW/ESS
        IF(SB(1).EQ.1.0) THEN
         SIG=1.
        ELSE
         SIG=SRES
        ENDIF
C
      DO 5 I=1,M
        IF(A(I,I).LE.0.) THEN
          PRINT*,'A(I,I)= ',A(I,I),' ','I= ',I
         SE(I)=1.0
        ELSE
         SE(I)=SIG*SQRT(A(I,I))
        ENDIF
C
 5        T(I)=B(I)/SE(I)
C
```

```
C
      WRITE (25,14)
      WRITE (25,15) D
      WRITE (25,16) ESS
      WRITE (25,17) SRES
      WRITE (25,18) RSQ
      WRITE (25,19) K,N6,F
      WRITE (25,20) DW
      WRITE (25,12)
C
        K1=0
      DO 6 I=1,NEQ
        WRITE(25,22)I
       DO 29 J=1,KI(I)
        K2=K1+J
       WRITE (25,13) J,B(K2),SE(K2),T(K2)
 29   CONTINUE
C
        K1=K2
 6    CONTINUE
C
        WRITE(25,21)
C
        RETURN
C
 21        FORMAT(/,/,/)
 22     FORMAT(' EQUATION ', I3,/)
 12    FORMAT(2X,'NUMBER    BETA-COEFFICIENT
     1 STANDARD-ERROR   '
```

```
    1,14X,'STUDENTS',/)
 13   FORMAT(I7,1X,4F20.8)
 14   FORMAT ('0',//)
 15   FORMAT (' ',5X,' TOTAL SUM OF SQUARES=',D20.8,/)
 16   FORMAT(5X,'RESIDUAL SUM OF SQUARES IS=',E20.8/)
 17   FORMAT (' ',5X,' STANDARD ERROR OF RESIDUAL=',
    1        F20.10,/)
 18   FORMAT (' ',5X,
    1        'COEFFICIENT OF DETERMINATION',F10.6,/)
 19   FORMAT (' ',5X,' DEGREES OF FREEDOM=',2I4,
     1       ' F TEST=',F16.8,/)
 20   FORMAT (' ',5X,
     1       ' DURBIN-WATSON STATISTIC=',F12.6,/,/)
C
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    NLS Estimation by Modified Levenberg-           C
C         Marquardt-Nash Approach, See Chapter 6.    C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE NLR1(BN,E,BO,MIT)
         DIMENSION BO(*),E(*),BN(*),DIR(30)
         DIMENSION Z(600,30),ZTZ(30,30),SB(30),UU(3)
         COMMON/PARA/NEQ,NF,NY,NT1,NS,M,ID
C
        EPS=1.0E-9
 15        CONTINUE
        DLMDA=0.1
        PHI=10.
C          Dlmda & PHI set for Marquardt modification
```

```
      UU(2)=FUNC(BO) !Cal. RSS
C
      NIT=1
20    CONTINUE
      UU(1)=UU(2)
      IF(ID.EQ.1) THEN
       CALL D1ST2(BO,Z) !analytical derivative
      ELSE
       CALL D1ST(BO,Z)  !numerical derivative
      ENDIF
      CALL DFUNC(BO,SB) !SB store gradients
C

      DO 39 I=1,M
       S=S+ABS(SB(I))
39    CONTINUE
      IF(S.LT.0.0001) THEN
        WRITE(25,5)
         GO TO 30     !exit if SB=0.
      ENDIF
C
25    CONTINUE
      CALL ZZ(Z,ZTZ)
C **  Marquardt modification of dir matrix
      DO 69 I=1,M
       ZTZ(I,I)=ZTZ(I,I)+DLMDA*(ZTZ(I,I)+DLMDA*PHI)
69    CONTINUE
      CALL AINV1(ZTZ,M,30)
C
```

```
      CALL DIRMX(ZTZ,SB,DIR)
      DO 49 I=1,M
       BN(I)=BO(I)-0.5*DIR(I)
 49         CONTINUE
C
       UU(2)=FUNC(BN)
C
      IF(UU(2).GT.UU(1))THEN
        DLMDA=10.*DLMDA
          GO TO 25
      ELSE
          DLMDA=0.4*DLMDA
      ENDIF
C
        DO 9 I=1,M
          T1=ABS(BO(I)-BN(I))
          IF(T1.GT.EPS) GO TO 10
 9          CONTINUE
      GO TO 30
C
 10         CONTINUE
        NIT=NIT+1
        IF(NIT.GT.MIT) THEN
         NIT=NIT-1
         WRITE(25,1)
         GO TO 30
        END IF
C
       IF(NIT.EQ.2)THEN
```

```
       WRITE(25,4)
       CALL FUNX(BO,E)
       CALL OUTPUT(BO,ZTZ,UU(1),SB,E)
      ENDIF
C
      DO 19 I=1,M
       BO(I)=BN(I)
 19      CONTINUE
C
      GO TO 20
C
 30      CONTINUE
      IF(ID.EQ.1) THEN
       CALL D1ST2(BN,Z)
      ELSE
       CALL D1ST(BN,Z)
      ENDIF
       CALL ZZ(Z,ZTZ)
       CALL AINV1(ZTZ,M,30)
C
       WRITE(25,2)
       WRITE(25,3)NIT
       CALL FUNX(BN,E)
       CALL OUTPUT(BN,ZTZ,UU(2),SB,E)
C
      IF(NIT.GT.MIT) GO TO 15
      RETURN
C
 1      FORMAT(' ***   MAXIMUM ITERATION REACHED ',/)
```

```
 2        FORMAT(' %%%%%%   FINAL RESULTS  %%%%%% ',/,/,/)
 3        FORMAT(/,' NO. OF ITERATIONS =  ',I4,/)
 4        FORMAT(/,/,'* * INITIAL NLR RESULT & & * ',/,/)
 5        FORMAT(' *** GRADIENTS ALL ZERO *** ',/)
C
      END
C %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C        2 Subroutines for NLR1:              C
C        Z'Z AND DIRECTION MATRIX

      SUBROUTINE ZZ(Z,ZTZ)
C
      DIMENSION Z(600,*),ZTZ(30,*)
      COMMON/PARA/NEQ,NF,NY,NT1,NS,M,JUD
      DO 9 I=1,M
       DO 19 J=I,M
        ZTZ(I,J)=0.0
       DO 29 K=1,NS
        ZTZ(I,J)=ZTZ(I,J)+Z(K,I)*Z(K,J)
 29       CONTINUE
       ZTZ(J,I)=ZTZ(I,J)
 19       CONTINUE
 9       CONTINUE
C
      RETURN
      END
C  -------   Direction   --------
      SUBROUTINE DIRMX(A,SB,DIR)
      DIMENSION A(30,*),SB(*),DIR(*)
```

```
      COMMON/PARA/NEQ,NF,NY,NT1,NS,M,JUD
C
      DO 9 I=1,M
        DIR(I)=0.0
       DO 19 J=1,M
        DIR(I)=DIR(I)+A(I,J)*SB(J)
 19         CONTINUE
 9         CONTINUE
C
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C   Specify the Functional Form and Cal Residuals   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE FUNX(B,RES)
      REAL AA(3),H(600),B(1),RES(1),PH(600,600)
      REAL E(600), SFY(40),STY(50)
C
      COMMON/DAT/W(600,30)
      COMMON/PARA/NE,NF,NY,NT1,NS,KS,JUD
      COMMON/FUN/H,AA,PH
      COMMON/FUN1/ND,KI(3)
C
      K1=2
      K2=0
      DO 19 M=1,NE
        I1=(M-1)*NT1+1
        I2=M*NT1
        K2=K2+KI(M)
```

```
        DO 29 I=I1,I2
         P=B(K1-1)
          DO 39 K=K1,K2
            J1=K-K1+2
            P=P*W(I,J1)**B(K)   !F(X)
 39          CONTINUE
           RES(I)=W(I,1)-P    !residuals
           E(I)=RES(I)
 29         CONTINUE
           K1=K1+KI(M)
 19         CONTINUE
C
        IF(ND.EQ.0) RETURN   !normal NLR
C
        IF(NE.EQ.1) THEN    !Just-Pope NLR
          DO 9 I=1,NS
           RES(I)=RES(I)/H(I)
           E(I)=RES(I)
 9         CONTINUE
            CALL MEANS(SFY,STY,GY,RES)
            CALL TRAN(E,RES,SFY,STY,GY,AA)
        ELSE                 ! SUR Just-Pope NLR
            CALL MULTY(PH,NS,NS,600,E,RES,0)
        ENDIF
C
        RETURN
        END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C        Estimate Linear SUR with Error Components C
```

```
C          See Baltagi (1980, p.1548)                 C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE MLSDV(BY,W,EI,B,KI)
        PARAMETER(NT=200,MNT=600,NP=30,NE=3,NP1=10)
C
        REAL INT(NT,NT),EE(NT,NT),AT(NT,NT),BN(NT,NT)
        REAL Q(NT,NT),Y(NT),DT(NT,NT),RSQ(NE,NE)
        REAL X(MNT,NP1),W(MNT,NP),EI(*),U(NT,NE)
        REAL S1(NE,NE),S2(NE,NE),S3(NE,NE),SV(NE,NE)
        REAL PHI(MNT,MNT),VAR(MNT,MNT),BX(MNT,NP),BY(*)
        REAL XTX(NP,NP),XS(NP,NP),YS(NP),B(*),SUM1(MNT)
        INTEGER KI(*)
        COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
        COMMON/QAB/Q,AT,BN,EE,TJN
C
        EQUIVALENCE (X,SUM1,BX,RSQ),(DT,S2),
     1             (U,S3),(Y,PHI)
C
        NF1=NF*1.0
        NY1=NY*1.0
C
        DO 19 I=1,NT1
          DO 19 J=1,NT1
            INT(I,J)=0.
            IF(I.EQ.J) INT(I,J)=1.
          EE(I,J)=1.
 19         CONTINUE
C
        TJN=1./(NT1*1.)
```

```
C
      CALL KRON(INT,NF,NT,EE,NY,NT,AT,NT)
      CALL KRON(EE,NF,NT,INT,NY,NT,BN,NT)
C
      DO 29 I=1,NT1
        DO 29 J=1,NT1
          AT(I,J)=AT(I,J)/NY1
          BN(I,J)=BN(I,J)/NF1
          Q(I,J)=INT(I,J)-AT(I,J)-BN(I,J)+TJN
C
          AT(I,J)=AT(I,J)-TJN
          BN(I,J)=BN(I,J)-TJN
          EE(I,J)=TJN
 29      CONTINUE
C
        DO 9 M=1,NEQ
           I1=(M-1)*NT1
          DO 39 I=1,NT1
              I2=I1+I
               Y(I)=BY(I2)
               X(I,1)=1.
C
          DO 49 J=2,KI(M)
               X(I,J)=W(I2,J)
 49           CONTINUE
 39         CONTINUE
C
      CALL OLS(Y,X,B,KI(M),NT1,EI)
       DO 229 I=1,NT1
```

```
      DO 229 J=1,KI(M)-1
229        X(I,J)=X(I,J+1)
      CALL LSDV(Y,X,NT1,KI(M),MNT,B,EI)
C
      DO 59 I=1,NT1
       U(I,M)=EI(I)
59         CONTINUE
9         CONTINUE
C
      CALL MULT(U,NT1,NEQ,NT,Q,NT1,NT,PHI,MNT,1)
      CALL MULT(PHI,NEQ,NT1,MNT,U,NEQ,NT,SV,NE,0)
C
      CALL MULT(U,NT1,NEQ,NT,AT,NT1,NT,PHI,MNT,1)
      CALL MULT(PHI,NEQ,NT1,MNT,U,NEQ,NT,S1,NE,0)
C
      CALL MULT(U,NT1,NEQ,NT,BN,NT1,NT,PHI,MNT,1)
      CALL MULT(PHI,NEQ,NT1,MNT,U,NEQ,NT,S2,NE,0)
C
      DO 69 I=1,NEQ
        DO 69 J=1,NEQ
              SV(I,J)=SV(I,J)/(NF1-1.)/(NY1-1.)
              S1(I,J)=S1(I,J)/(NF1-1.)
               S2(I,J)=S2(I,J)/(NY1-1.)
           S3(I,J)=S1(I,J)+S2(I,J)-SV(I,J)
                RSQ(I,J)=(S3(I,J)-S1(I,J))/NF1
               XTX(I,J)=(S3(I,J)-S2(I,J))/NY1
                XS(I,J)=4.9348-XTX(I,J)-RSQ(I,J)
69         CONTINUE
C
```

```
      WRITE(25,1)
C
      WRITE(25,3)
 3      FORMAT(' BELOW ARE 4 MATRICES:
     1  Tau(lmda),Tau(u) Tau(v) & TAU ',/)
 4      FORMAT(4X,10F20.3)
      WRITE(25,*)
        DO 179 I=1,NEQ
 179              WRITE(25,4) (RSQ(I,J),J=1,NEQ)
      WRITE(25,*)
        DO 189 I=1,NEQ
              WRITE(25,4) (XTX(I,J),J=1,NEQ)
 189      CONTINUE
      WRITE(25,*)
        DO 199 I=1,NEQ
 199              WRITE(25,4) (SV(I,J),J=1,NEQ)
      WRITE(25,*)
C
C
      CALL AINV1(SV,NEQ,NE)
      CALL AINV1(S1,NEQ,NE)
      CALL AINV1(S2,NEQ,NE)
      CALL AINV1(S3,NEQ,NE)
C  ** construct BX
        K1=1
        K2=0
       DO 99 M=1,NEQ
             I1=(M-1)*NT1+1
             I2=M*NT1
```

```
            K2=K2+KI(M)
         DO 109 I=I1,I2
C
              DO 89 J=1,KS
 89                        BX(I,J)=0.
C
            BX(I,K1)=1.
          DO 109 J=K1+1, K2
            J2=J-K1+1
             BX(I,J)=W(I,J2)
 109         CONTINUE
            K1=K1+KI(M)
 99      CONTINUE
C
      CALL KRON(S1,NEQ,NE,AT,NT1,NT,PHI,MNT)
      CALL MULT(BX,NS,KS,MNT,PHI,NS,MNT,VAR,MNT,1)
      CALL MULT(VAR,KS,NS,MNT,BX,KS,MNT,XTX,NP,0)
      CALL MULTY(VAR,KS,NS,MNT,BY,B,0)
C
      CALL KRON(S2,NEQ,NE,BN,NT1,NT,PHI,MNT)
      CALL MULT(BX,NS,KS,MNT,PHI,NS,MNT,VAR,MNT,1)
      CALL MULT(VAR,KS,NS,MNT,BX,KS,MNT,XS,NP,0)
      CALL MULTY(VAR,KS,NS,MNT,BY,YS,0)
      CALL ADD(KS,XTX,XS,NP)
      CALL ADD1(KS,B,YS)
C
      CALL KRON(SV,NEQ,NE,Q,NT1,NT,PHI,MNT)
      CALL MULT(BX,NS,KS,MNT,PHI,NS,MNT,VAR,MNT,1)
      CALL MULT(VAR,KS,NS,MNT,BX,KS,MNT,XTX,NP,0)
```

```
      CALL MULTY(VAR,KS,NS,MNT,BY,B,0)
      CALL ADD(KS,XTX,XS,NP)
      CALL ADD1(KS,B,YS)
C
      CALL KRON(S3,NEQ,NE,EE,NT1,NT,PHI,MNT)
      CALL MULT(BX,NS,KS,MNT,PHI,NS,MNT,VAR,MNT,1)
      CALL MULT(VAR,KS,NS,MNT,BX,KS,MNT,XTX,NP,0)
      CALL MULTY(VAR,KS,NS,MNT,BY,B,0)
      CALL ADD(KS,XTX,XS,NP)
      CALL ADD1(KS,B,YS)
C
      CALL AINV1(XS,KS,NP)
C
C      XS IS THE VAR-COV MATRIX
C
      CALL MULTY(XS,KS,KS,NP,YS,B,0)
C           B contains the Alpha's
      CALL MULTY(BX,NS,KS,MNT,B,EI,0)


C
      DO 79 I=1,NS
         EI(I)=BY(I)-EI(I)
 79      CONTINUE
C
      DO 119 I=1,NT1
        DO 119 J=1,NT1
          DT(I,J)=INT(I,J)-TJN
 119      CONTINUE
C
```

```
      DO 129 M=1,NEQ
        I1=(M-1)*NT1
       DO 219 M2=M,NEQ
        RSQ(M,M2)=0.
         J1=(M2-1)*NT1
        DO 139 I=1,NT1
         J=I+J1
         I2=I1+I
        RSQ(M,M2)=RSQ(M,M2)+EI(I2)*EI(J)
 139       CONTINUE
        RSQ(M,M2)=RSQ(M,M2)*TJN
        RSQ(M2,M)=RSQ(M,M2)
 219       CONTINUE
        WRITE(25,4) (RSQ(M,M2),M2=1,NEQ)
 129       CONTINUE
C
       CALL AINV1(RSQ,NEQ,NE)
       CALL KRON(RSQ,NEQ,NE,INT,NT1,NT,PHI,MNT)
       CALL KRON(RSQ,NEQ,NE,DT,NT1,NT,VAR,MNT)
       CALL MULTY(PHI,NS,NS,MNT,EI,SUM1,0)
C
       RSS=0.
      DO 149 I=1,NS
 149       RSS=RSS+EI(I)*SUM1(I)
C
      CALL MULTY(VAR,NS,NS,MNT,BY,SUM1,0)
        ESS=0.
       DO 159 I=1,NS
 159        ESS=ESS+BY(I)*SUM1(I)
```

```
C
       RSQ2=1. - RSS/ESS
       FT=RSQ2*(NS-KS)/((1.-RSQ2)*(KS-NEQ))
C
         ESS=0.
       DO 169 I=1,NS
 169          ESS=ESS+EI(I)*EI(I)
C
      WRITE(25,2) RSQ2,FT
C
      CALL OUTPUT(B,XS,ESS,1.0,EI)
C
      RETURN
 1      FORMAT(/,2X,
     1        '** SUR WITH ERROR COMPONENTS RESULTS ** ',/)
 2      FORMAT(5X,
     1        'COEFF OF DETERMINATION FOR SUR: ',F6.3,/,/,
     1         4X,' F-RARIO FOR SUR: ',F15.3)
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C        Cal. P*INV(H) for FUNX  see Chapter 6  C        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE SIGMAS(XI,U1,A)
       PARAMETER(NT=200,MNT=600,NP=30,NE=3,NP1=10)
       REAL EE(NT,NT),AT(NT,NT),BN(NT,NT),AA(3)
       REAL XI(*),H(MNT),PH(MNT,MNT),QQ(NT,NT)
       REAL Q(MNT),U1(*),UH(MNT),SIG(NE,NE),A(*)
       REAL SIG1(NE,NE),SIG2(NE,NE),SIG3(NE,NE)
       REAL SIGU(NE,NE),SIGL(NE,NE),SIGV(NE,NE)
```

```
      REAL P1(NE,NE),P2(NE,NE),P3(NE,NE),P4(NE,NE)
      REAL PHI(MNT,MNT),VAR(MNT,MNT),RHO(NE,NE)
      COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
      COMMON/QAB/QQ,AT,BN,EE,TJ
      COMMON/FUN/H,AA,PH
      COMMON/FUN1/MF,KI(NE)
      COMMON/DAT/W(600,30)
      EQUIVALENCE (Q,PHI),(RHO,SIGV),(PH,SIG,VAR)
C
      DO 9 I=1,NS
        Q(I)=SQRT(EXP(XI(I)-1.2704))
 9      CONTINUE
C
       K1=2
       K2=0
      DO 19 M=1,NEQ
       I1=(M-1)*NT1+1
       I2=M*NT1
       K2=K2+KI(M)
C
      DO 29 I=I1,I2
        H(I)=1.
      DO 39 J=K1,K2
         J2=J-K1+2
        H(I)=H(I)*W(I,J2)**(A(J)*0.5)
 39      CONTINUE
 29      CONTINUE
         SIG(M,M)=EXP(A(K1-1)+1.2704)
        K1=K1+KI(M)
```

```
 19        CONTINUE
C
        DO 219 I=1,NS
          UH(I)=U1(I)/H(I)
          H(I)=1./H(I)
 219         CONTINUE
C
       DO 49 M=1,NEQ
          I1=(M-1)*NT1
          M1=M+1
         DO 49 M2=M1,NEQ
            RHO(M,M2)=0.
            J1=(M2-1)*NT1
          DO 59 I=1,NT1
             J=I+J1
             I2=I1+I
            RHO(M,M2)=RHO(M,M2)+Q(I2)*Q(J)
 59          CONTINUE
C
           RHO(M,M2)=RHO(M,M2)*TJ
C
         SIG(M,M2)=RHO(M,M2)*SQRT(SIG(M,M)*SIG(M2,M2))
C         SIG(M2,M)=SIG(M,M2)
 49        CONTINUE
C
        NY2=NY-2
C

        DO 79 M=1,NEQ
```

```
          I1=(M-1)*NT1+1
         DO 79 M1=M,NEQ
          I2=(M1-1)*NT1+2
        SIGU(M,M1)=0.
C
         DO 89 I=1,NF
            K1=(I-1)*NY
            II1=I1+K1
            II2=I2+K1
            J1=II1+NY2
            J2=II2+NY2
C
         DO 89 IS=II1,J1
            K1=IS-II1
            I3=II2+K1
         DO 89 IT=I3,J2
        SIGU(M,M1)=SIGU(M,M1)+UH(IS)*UH(IT)
 89       CONTINUE
C
                 SIGU(M,M1)=2.*SIGU(M,M1)/(NT1*(NY-1)*1.)
        IF(M.EQ.M1) GO TO 79
          SIGU(M1,M)=SIGU(M,M1)
 79       CONTINUE
C
        DO 99 M=1,NEQ
          I1=(M-1)*NT1
          JI=M*NT1
         DO 99 M1=M,NEQ
            J1=M1*NT1
```

```
      J2=(M1-1)*NT1
     SIGL(M,M1)=0.
C
      DO 109 I=1,NY
         I2=I1+I
       DO 109 J=I2,JI,NY
           KJ=J-I2+I
           K2=J2+NY+KJ
         DO 109 K=K2,J1,NY
      SIGL(M,M1)=SIGL(M,M1)+UH(J)*UH(K)
 109       CONTINUE
C
       SIGL(M,M1)=2.*SIGL(M,M1)/(NT1*(NF-1)*1.)
     IF(M.EQ.M1) GO TO 99
       SIGL(M1,M)=SIGL(M,M1)
 99        CONTINUE
C
     DO 169 I=1,NEQ
      DO 169 J=I,NEQ
      SIGV(I,J)=SIG(I,J)-SIGU(I,J)-SIGL(I,J)
C
       SIG1(I,J)=SIGV(I,J)+NY*1.*SIGU(I,J)
       SIG2(I,J)=SIGV(I,J)+NF*1.*SIGL(I,J)
       SIG3(I,J)=SIG1(I,J)+SIG2(I,J)-SIGV(I,J)
          IF(I.NE.J) THEN
            SIGV(J,I)=SIGV(I,J)
            SIG1(J,I)=SIG1(I,J)
            SIG2(J,I)=SIG2(I,J)
            SIG3(J,I)=SIG3(I,J)
```

```
            ENDIF
 169      CONTINUE
C
         WRITE(25,2)
 2       FORMAT('** SIGU, SIGL',
     1        ' AND SIGNU FOR MEAN-MEAN MODEL **',/,/)
 1       FORMAT(4X,10F20.3)
        DO 189 M=1,NEQ
 189          WRITE(25,1) (SIGU(M,M1),M1=1,NEQ)
        WRITE(25,*)
        DO 199 M=1,NEQ
 199          WRITE(25,1) (SIGL(M,M1),M1=1,NEQ)
        WRITE(25,*)
        DO 209 M=1,NEQ
 209          WRITE(25,1) (SIGV(M,M1),M1=1,NEQ)
        WRITE(25,*)
       CALL AINV1(SIG1,NEQ,NE)
       CALL AINV1(SIG2,NEQ,NE)
       CALL AINV1(SIG3,NEQ,NE)
       CALL AINV1(SIGV,NEQ,NE)
C
       CALL PPT(SIG1,NEQ,NE,P1)
       CALL PPT(SIG2,NEQ,NE,P2)
       CALL PPT(SIG3,NEQ,NE,P3)
       CALL PPT(SIGV,NEQ,NE,P4)
C
       CALL KRON(P1,NEQ,NE,AT,NT1,NT,PHI,MNT)
       CALL KRON(P2,NEQ,NE,BN,NT1,NT,VAR,MNT)
       CALL ADD(NS,VAR,PHI,MNT)
```

```
C
        CALL KRON(P3,NEQ,NE,EE,NT1,NT,VAR,MNT)
        CALL ADD(NS,VAR,PHI,MNT)
C
        CALL KRON(P4,NEQ,NE,QQ,NT1,NT,VAR,MNT)
        CALL ADD(NS,VAR,PHI,MNT)
C
        DO 179 I=1,NS
         DO 179 J=1,NS
        PH(I,J)=PHI(I,J)*H(J)
 179        CONTINUE
C
        RETURN
        END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       LSDV Estimation; See Baltagi (1980,p.1550)   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE LSDV(Y,X,NR,NC,NPX,B,E)
         PARAMETER (MNT=600,NT=200,NP1=10)
          REAL Y(*),X(NPX,*),B(*),E(*)
          REAL TEM(NP1,NT),TEM1(30,30)
          REAL Q(NT,NT),AT(NT,NT),BN(NT,NT),EE(NT,NT)
C
        COMMON/PARA/NEQ1,NF,NY,NT1,NS,KS1,JUD
        COMMON/QAB/Q,AT,BN,EE,TJN
        NN=NEQ1
C
        CALL MULT(X,NR,NC-1,NPX,Q,NR,NT,TEM,NP1,1)
c          Tem = X'Q, Tem1 = X'QX
```

```
      CALL MULT(TEM,NC-1,NR,NP1,X,NC-1,NPX,TEM1,30,0)
      CALL AINV1(TEM1,NC-1,30)
C        TEM1 IS VAR-COV MATRIX
C        E = X'QY
      CALL MULTY(TEM,NC-1,NR,NP1,Y,E,0)
      CALL MULTY(TEM1,NC-1,NC-1,30,E,B,0)
      CALL MULTY(X,NR,NC-1,NPX,B,E,0)
C                        E=XB
       EBAR=0.
       ESS=0.
       DO 9 I=1,NR
        E(I)=Y(I)-E(I)
        EBAR=E(I)+EBAR
 9      CONTINUE
        EBAR=EBAR/(NR*1.)
        B(NC)=EBAR
       DO 19 I=1,NR
        E(I)=E(I)-EBAR
 19         ESS=ESS+E(I)*E(I)
C
       WRITE(25,1)
       NEQ1=1
        CALL OUTPUT(B,TEM1,ESS,Y,E)
       NEQ1=NN
      RETURN
 1      FORMAT(/,/, '%%%%% LSDV RESULTS %%%%%%',/,/)
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                 OLS Program                      C
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE OLS(Y,X,B,NIV1,NS,E)
        REAL  Y(*),X(600,*),B(*),XT(30,30),XY(30),E(*)
        COMMON/PARA/NEQ1,NF,NY,NT1,NS1,KS1,JUD
        NN=NEQ1
         TSS=0.
         S1=0.
C
        DO 9 I=1,NS
         X(I,1)=1.0
         TSS=TSS+Y(I)*Y(I)
         S1=S1+Y(I)
 9        CONTINUE
          S1=S1/(NS*1.)*S1
         TSS=TSS-S1
C
        CALL MULT(X,NS,NIV1,600,X,NIV1,600,XT,30,1)
        CALL MULTY(X,NS,NIV1,600,Y,XY,1)
        CALL AINV1(XT,NIV1,30)
        CALL MULTY(XT,NIV1,NIV1,30,XY,B,0)
        CALL MULTY(X,NS,NIV1,600,B,E,0)
C
        ESS=0.0
        DO 69 I=1,NS
          E(I)=Y(I)-E(I)
          ESS=E(I)*E(I) + ESS
 69        CONTINUE
C
         RSQ=1. - ESS/TSS
```

```
       F=RSQ*(NS-NIV1)/(NIV1-1.)/(1.-RSQ)
      WRITE(25,101)
      WRITE(25,103)RSQ,F
       NEQ1=1
       CALL OUTPUT(B,XT,ESS,Y,E)
       NEQ1=NN
C
      RETURN
 101      FORMAT(/,' * *  OLS  OUTPUT * * ',/)
 103      FORMAT('  OLS RSQ= ',F6.3,'
     1          F RATIO = ',F15.3)
C
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    Variable Transformation, e.g., eq (2.36)    C
C        of Griffiths & Anderson (1982)          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE WX(LNU,LNX,WS,XS,PA)
       REAL PA(*),WS(*),XS(600,*),LNU(*)
       REAL TEM(600),WT(50),WF(40),LNX(600,*)
       COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
C
      DO 59 J=2,KS
C
      DO 29 I=1,NS
       TEM(I)=LNX(I,J)
 29      CONTINUE
       CALL MEANS(WF,WT,WE,TEM)
       CALL TRAN(TEM,WS,WF,WT,WE,PA)
```

```
C
      DO 49 I=1,NS
       XS(I,J)=WS(I)
 49     CONTINUE
C
 59     CONTINUE
C
      CALL MEANS(WF,WT,WE,LNU)
      CALL TRAN(LNU,WS,WF,WT,WE,PA)
C
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C   Variable transformation, e.g., (2.36)     C
C     cf Griffiths and Anderson (1982)        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE TRAN(W,TR,WI,WT,WM,PA)
        REAL W(*),WI(*),WT(*),PA(*),TR(*)
        COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
C
       DO 9 I=1,NF
       DO 19 J=1,NY
        KI=(I-1)*NY+J
       TR(KI)=W(KI)-PA(1)*WI(I)-PA(2)*WT(J)+PA(3)*WM
 19     CONTINUE
 9      CONTINUE
C
      RETURN
      END
```

```
cccccccccccccccccccccccccccccccccccccccccccccccccc
C   Cal. Means, e.g., Ws Following (2.36) of      C
C          Griffiths and Anderson (1982)          C
cccccccccccccccccccccccccccccccccccccccccccccccccc
        SUBROUTINE MEANS(SF,ST,G,E)
        DIMENSION SF(*),ST(*),E(*)
        COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
C
         G=0.0
        DO 50 K=1,NF
        SF(K)=0.
        K1=(K-1)*NY
        DO 60 I=1,NY
        KI=K1+I
         G=G+E(KI)
  60    SF(K)=SF(K)+E(KI)
  50    SF(K)=SF(K)/(NY*1.)
C
        DO 150 I=1,NY
        ST(I)=0.
        DO 160 K=1,NF
        KI=(K-1)*NY+I
 160    ST(I)=ST(I)+E(KI)
 150    ST(I)=ST(I)/(NF*1.)
        G=G/(NS*1.)
        RETURN
        END
ccccccccccccccccccccccccccccccccccccccccccccccc
C    Cal. a(3), b(3) of p.532 of Griffiths    C
```

```
C        and Anderson  (1932)                 C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE CAL1(B1,U,BE,AE)
         PARAMETER(NE=3)
        REAL HB(600),U(*),BE(*),B1(*),AE(*)
        COMMON/PARA/NEQ,NF,NY,NT1,NS,NIV1,JUD
        COMMON/DAT/X(600,30),KI(NE)
C
        SIG2=EXP(B1(1)+1.2704)
C
        DO 79 J=2,NIV1
          B1(J)=B1(J)/2.0
 79         CONTINUE
C
        DO 69 I=1,NS
          HB(I)=1.0
         DO 9 J=2,NIV1
 9           HB(I)=HB(I)*X(I,J)**B1(J)
          U(I)=U(I)/HB(I)
 69         CONTINUE
C
        SIGM=0.0
C
        DO 19 I=1,NF
          I1=(I-1)*NY+1
          J2=I*NY
          I2=J2-1
        DO 19 J=I1,I2
          J1=J+1
```

```
        DO 19 K=J1,J2
         SIGM=SIGM+U(J)*U(K)
 19       CONTINUE
C
       SIGL=0.0
        DO 29 I=1,NY
         DO 29 J=I,NS,NY
          DO 29 J1=J+NY,NS,NY
 29       SIGL=SIGL+U(J)*U(J1)
C
       SIGL=2.0*SIGL/(NF-1.0)/NS
       SIGM=2.0*SIGM/(NY-1.0)/NS
C
       SIGE=SIG2-SIGM-SIGL
C
       RHO=SIGM/SIG2
       CALL RH(RHO,TM2)
C
       RHO=SIGL/SIG2
       CALL RH(RHO,TL2)
C
       TE2=4.9348-TM2-TL2
        CALL PARAS(TM2,TL2,TE2,BE)
        CALL PARAS(SIGM,SIGL,SIGE,AE)
C
       RETURN
       END
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C     Cal. Sigma(3) & Tau(3) of p.532 of    C
```

```
C           Griffiths and Anderson (1982)   C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
        SUBROUTINE PARAS(UU,LL,EE,BE)
         REAL LL
         REAL BE(*)
         COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,JUD
        T12=NY*UU+EE
        T22=NF*LL+EE
        T32=T12+NF*LL
        BE(1)=EE/T12
        BE(2)=EE/T22
        BE(3)=EE/T32
C
        BE(1)=1.0-SQRT(BE(1))
        BE(2)=1.0-SQRT(BE(2))
        BE(3)=BE(1)+BE(2)-1.0+SQRT(BE(3))
C
        RETURN
        END
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
C  Cal. (2.28) of Griffiths & Anderson (1982) C
C&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
        SUBROUTINE RH(RH1,CORR)
         DIMENSION A(1000),FAC(1000)
        DOUBLE PRECISION  AJ,A,FAC,RHO,CJ,S
C
        N=500
        RHO=RH1**2.0
        FAC(1)=0.0
```

```
      A(1)=LOG(0.5)
      CORR=0.0
      DO 9 J=1,N
      AJ=J
      IF(J.EQ.1) GO TO 10
      FAC(J)=FAC(J-1)+DLOG(AJ)
      A(J)=A(J-1)+DLOG(AJ-0.5)
 10      CJ=AJ**2.0*EXP(A(J)-FAC(J))
      S=RHO**J/CJ
C
       CORR=CORR+S
 9      CONTINUE
C
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C        Cal. 1st Derivetives of Y w.r.t. B        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C---------------- Numerically --------------------
      SUBROUTINE D1ST(B,Z)
      DIMENSION B(*),Z(600,*),P(600),E(600)
C
      COMMON/PARA/NEQ,NF,NY,NT1,NS,M,ID
C
      DO 19 I=1,M
         DELTA=MAX(0.001,0.001*ABS(B(I)))
C          See Chow & Megdal in Handbook of Econ'trics
          CONST=2.*DELTA
        B(I)=B(I)+DELTA
```

```
          CALL FUNX(B,E)
         B(I)=B(I)-DELTA*2.
          CALL FUNX(B,P)
        DO 29 J=1,NS
        Z(J,I)=(E(J)-P(J))/CONST
 29       CONTINUE
         B(I)=B(I)+DELTA
 19       CONTINUE
C
      RETURN
      END
C---------------  Analytically  -------------------
C--------- this is for Power Function only --------
      SUBROUTINE D1ST2(B,Z)
       REAL B(*),Z(600,*),E(600)
       COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
       COMMON/DAT/W(600,30)
       CALL FUNX(B,E)
        DO 19 J=1,NS
C
       Z(J,1)=(E(J)-W(J,1))/B(1)
      DO 9 I=2, KS
       Z(J,I)=(E(J)-W(J,1))*B(I)/W(J,I)
 9        CONTINUE
C
 19       CONTINUE
      RETURN
      END
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
C              Cal. RSS                         &
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
        FUNCTION FUNC(B)
        DIMENSION B(*),RES(600)
        COMMON/PARA/NEQ,NF,NY,NT1,NS,M,ID
C
        CALL FUNX(B,RES)
C
        FUNC=0.0
        DO 9 I=1,NS
         FUNC=FUNC+RES(I)*RES(I)!/10000.
 9        CONTINUE
C
        RETURN
        END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C         Cal. Gradients of Objective Function  C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE DFUNC(B,SB)
        DIMENSION B(*),SB(*),Z(600,30),E(600)
        COMMON/PARA/NEQ,NF,NY,NT1,NS,M,ID
C
        IF(ID.EQ.0) THEN
         CALL D1ST(B,Z)
        ELSE
         CALL D1ST2(B,Z)
        ENDIF
C
        CALL FUNX(B,E)
```

```
      CALL MULTY(Z,NS,M,600,E,SB,1)
C
      DO 9 I=1,M
       SB(I)=2.0*SB(I)
 9      CONTINUE
C
      RETURN
      END
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C        Inverse Any Matrix by SVD                      C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE AINV1(XT,NIV1,NPP)
      PARAMETER (MPP=100)   !Maximum dimension
      REAL V(MPP,MPP),W(MPP),XT(NPP,*),INV(MPP,MPP)
      DOUBLE PRECISION EPS,EPS1,RATIO,WMAX
C
      EPS=1.E-20
      EPS1=1.E-18
      WMAX=0.D0
      NO=0
C
       CALL SVDCMP(XT,NIV1,NIV1,NPP,NPP,W,V)
C
      DO 29 I=1,NIV1
       IF(W(I).LE.EPS) THEN
         NO=NO+1
        IF(W(I).GT.WMAX)WMAX=W(I)
       ENDIF
```

```
 29        CONTINUE
         IF(NO.GE.1) THEN
          WRITE(25,1) NO,NIV1
          WRITE(6,1)NO,NIV1
 1         FORMAT(/,/, '*** MATRIX SINGULAR  ',
      1    I3,' OS OUT OF',I3,/,/)
         ENDIF
C
        DO 9 I=1,NIV1
         RATIO=W(I)/WMAX
         IF(RATIO.LT.EPS1) THEN
           W(I)=0.
         ELSE
           W(I)=1./W(I)
        ENDIF
         DO 9 J=1,NIV1
          V(J,I)=V(J,I)*W(I)
 9        CONTINUE
C
        DO 39 I=1,NIV1
          DO 59 K=1,NIV1
            INV(I,K)=0.0
          DO 59 J=1,NIV1
            INV(I,K)=INV(I,K)+V(I,J)*XT(K,J)
 59        CONTINUE
C        WRITE(27,*) (INV(I,K),K=1,NIV1)
 39        CONTINUE
C
        DO 49 I=1,NIV1
```

```
         DO 49 J=1,NIV1
        XT(I,J)=INV(I,J)
 49      CONTINUE
C
      RETURN
      END
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C        SVD Subroutine for AINV1                $
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE SVDCMP(A,M,N,MP,NP,W,V)
      PARAMETER (NMAX=100)
      DIMENSION A(MP,NP),W(NP),V(NMAX,*),RV1(NMAX)
      G=0.0
      SCALE=0.0
      ANORM=0.0
      DO 25 I=1,N
        L=I+1
        RV1(I)=SCALE*G
        G=0.0
        S=0.0
        SCALE=0.0
        IF (I.LE.M) THEN
          DO 11 K=I,M
            SCALE=SCALE+ABS(A(K,I))
11        CONTINUE
          IF (SCALE.NE.0.0) THEN
            DO 12 K=I,M
              A(K,I)=A(K,I)/SCALE
              S=S+A(K,I)*A(K,I)
```

```
12          CONTINUE
            F=A(I,I)
            G=-SIGN(SQRT(S),F)
            H=F*G-S
            A(I,I)=F-G
            IF (I.NE.N) THEN
              DO 15 J=L,N
                S=0.0
                DO 13 K=I,M
                  S=S+A(K,I)*A(K,J)
13              CONTINUE
                F=S/H
                DO 14 K=I,M
                  A(K,J)=A(K,J)+F*A(K,I)
14              CONTINUE
15            CONTINUE
            ENDIF
            DO 16 K= I,M
              A(K,I)=SCALE*A(K,I)
16          CONTINUE
          ENDIF
        ENDIF
        W(I)=SCALE *G
        G=0.0
        S=0.0
        SCALE=0.0
        IF ((I.LE.M).AND.(I.NE.N)) THEN
          DO 17 K=L,N
            SCALE=SCALE+ABS(A(I,K))
```

```
17          CONTINUE
            IF (SCALE.NE.C.O) THEN
              DO 18 K=L,N
                A(I,K)=A(I,K)/SCALE
                S=S+A(I,K)*A(I,K)
18            CONTINUE
              F=A(I,L)
              G=-SIGN(SQRT(S),F)
              H=F*G-S
              A(I,L)=F-G
              DO 19 K=L,N
                RV1(K)=A(I,K)/H
19            CONTINUE
              IF (I.NE.M) THEN
                DO 23 J=L,M
                  S=0.0
                  DO 21 K=L,N
                    S=S+A(J,K)*A(I,K)
21                CONTINUE
                  DO 22 K=L,N
                    A(J,K)=A(J,K)+S*RV1(K)
22                CONTINUE
23              CONTINUE
              ENDIF
              DO 24 K=L,N
                A(I,K)=SCALE*A(I,K)
24            CONTINUE
            ENDIF
          ENDIF
```

```
      ANORM=MAX(ANORM,(ABS(W(I))+ABS(RV1(I))))
25    CONTINUE
      DO 32 I=N,1,-1
        IF (I.LT.N) THEN
          IF (G.NE.0.0) THEN
            DO 26 J=L,N
              V(J,I)=(A(I,J)/A(I,L))/G
26          CONTINUE
            DO 29 J=L,N
              S=0.0
              DO 27 K=L,N
                S=S+A(I,K)*V(K,J)
              CONTINUE
              DO 28 K=L,N
                V(K,J)=V(K,J)+S*V(K,I)
              CONTINUE
            CONTINUE
          ENDIF
          DO 31 J=L,N
            V(I,J)=0.0
            V(J,I)=0.0
          CONTINUE
        ENDIF
        V(I,I)=1.0
        G=RV1(I)
        L=I
      CONTINUE
      DO 39 I=N,1,-1
        L=I+1
```

```
      G=W(I)
      IF (I.LT.N) THEN
        DO 33 J=L,N
          A(I,J)=0.0
33      CONTINUE
      ENDIF
      IF (G.NE.0.0) THEN
        G=1.0/G
        IF (I.NE.N) THEN
          DO 36 J=L,N
            S=0.0
            DO 34 K=L,M
              S=S+A(K,I)*A(K,J)
34          CONTINUE
            F=(S/A(I,I))*G
            DO 35 K=I,M
              A(K,J)=A(K,J)+F*A(K,I)
35          CONTINUE
36        CONTINUE
        ENDIF
        DO 37 J=I,M
          A(J,I)=A(J,I)*G
37      CONTINUE
      ELSE
        DO 38 J= I,M
          A(J,I)=0.0
38      CONTINUE
      ENDIF
      A(I,I)=A(I,I)+1.0
```

```
39    CONTINUE
      DO 49 K=N,1,-1
        DO 48 ITS=1,30
          DO 41 L=K,1,-1
            NM=L-1
            IF ((ABS(RV1(L))+ANORM).EQ.ANORM)  GO TO 2
            IF ((ABS(W(NM))+ANORM).EQ.ANORM)  GO TO 1
41        CONTINUE
1         C=0.0
          S=1.0
          DO 43 I=L,K
            F=S*RV1(I)
            IF ((ABS(F)+ANORM).NE.ANORM) THEN
              G=W(I)
              H=SQRT(F*F+G*G)
              W(I)=H
              H=1.0/H
              C= (G*H)
              S=-(F*H)
              DO 42 J=1,M
                Y=A(J,NM)
                Z=A(J,I)
                A(J,NM)=(Y*C)+(Z*S)
                A(J,I)=-(Y*S)+(Z*C)
42            CONTINUE
            ENDIF
43        CONTINUE
2         Z=W(K)
          IF (L.EQ.K) THEN
```

```
      IF (Z.LT.0.0) THEN
        W(K)=-Z
        DO 44 J=1,N
          V(J,K)=-V(J,K)
44      CONTINUE
      ENDIF
      GO TO 3
    ENDIF
    IF (ITS.EQ.30) PAUSE 'NO CONVERGENCE N=30'
    X=W(L)
    NM=K-1
    Y=W(NM)
    G=RV1(NM)
    H=RV1(K)
    F=((Y-Z)*(Y+Z)+(G-H)*(G+H))/(2.0*H*Y)
    G=SQRT(F*F+1.0)
    F=((X-Z)*(X+Z)+H*((Y/(F+SIGN(G,F)))-H))/X
    C=1.0
    S=1.0
    DO 47 J=L,NM
      I=J+1
      G=RV1(I)
      Y=W(I)
      H=S*G
      G=C*G
      Z=SQRT(F*F+H*H)
      RV1(J)=Z
      C=F/Z
      S=H/Z
```

```
      F= (X*C)+(G*S)
      G=-(X*S)+(G*C)
      H=Y*S
      Y=Y*C
      DO 45 NM=1,N
        X=V(NM,J)
        Z=V(NM,I)
        V(NM,J)= (X*C)+(Z*S)
        V(NM,I)=-(X*S)+(Z*C)
45    CONTINUE
      Z=SQRT(F*F+H*H)
      W(J)=Z
      IF (Z.NE.0.0) THEN
        Z=1.0/Z
        C=F*Z
        S=H*Z
      ENDIF
      F= (C*G)+(S*Y)
      X=-(S*G)+(C*Y)
      DO 46 NM=1,M
        Y=A(NM,J)
        Z=A(NM,I)
        A(NM,J)= (Y*C)+(Z*S)
        A(NM,I)=-(Y*S)+(Z*C)
46    CONTINUE
47    CONTINUE
    RV1(L)=0.0
    RV1(K)=F
    W(K)=X
```

```
48        CONTINUE
3         CONTINUE
49      CONTINUE
        RETURN
        END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C       Find P' Such That PP'=A             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE PPT(A,N,MP,P)
          REAL A(MP,*),P(MP,*)
C
             P(1,1)=SQRT(ABS(A(1,1)))
C
         DO 19 I=2,N
            P(I,1)=A(I,1)/P(1,1)
            P(1,I)=P(I,1)
 19         CONTINUE
C
         DO 29 J=2,N
          DO 29 I=J,N
                S=0.
               JM=J-1
            DO 39 K=1,JM
 39                S=S+P(I,K)*P(J,K)
             V=A(I,J)-S
C
           IF(I.EQ.J)THEN
                IF(V.LT.0.) THEN
                  V=ABS(V)
```

```
              ENDIF
                P(I,J)=SQRT(V)
          ELSE
                P(I,J)=V/P(J,J)
                 P(J,I)=P(I,J)
       ENDIF
C
 29       CONTINUE
C
        DO 9 J=2,N
          DO 9 I=1,J-1
 9            P(J,I)=0.
C
       RETURN
       END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C  Following Are Some Simple Subroutines          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C  *****      Logarithm transformation     *****
       SUBROUTINE BXLN(Y,Y1,X,MPX,X1)
          REAL Y(*),Y1(*),X(MPX,*),X1(MPX,*)
C
       COMMON/PARA/NEQ,NF,NY,NT1,NS,KS,ID
C
       DO 29 M=1,NEQ
          I1=(M-1)*NT1+1
          I2=M*NT1
       DO 9 I=I1,I2
```

```
        S=Y(I)*Y(I)
     IF(S.LE.0.0) THEN
     pause 'S < 0. '
      Y1(I)=0.
     ELSE
      Y1(I)=LOG(S)
     ENDIF
C
    DO 19 J=1,KS/NEQ
      IF(X(I,J).LE.0.0) THEN
      type*, 'I= ',I, 'J= ',J
     pause 'X(I,J) < 0  '
       X1(I,J)=0.
      ELSE
       X1(I,J)=LOG(X(I,J))
      ENDIF
 19     CONTINUE
 9     CONTINUE
 29     CONTINUE
C
    RETURN
    END
C
C *****   Multiply Matrices   *****
    SUBROUTINE MULT(X,M,N,MX,Q,NQ,MQ,P,MP,JUD)
        REAL X(MX,*),Q(MQ,*),P(MP,*)
C
     IF(JUD.EQ.1) THEN   !CAL X'Q
        DO 9 I=1,N
```

```
          DO 9 J=1,NQ
                P(I,J)=0.
                DO 9 K=1,M
       P(I,J)=P(I,J)+X(K,I)*Q(K,J)
 9          CONTINUE
        ELSE                   !CAL XQ
           DO 19 I=1,M
             DO 19 J=1,NQ
               P(I,J)=0.
                DO 19 K=1,N
          P(I,J)=P(I,J)+X(I,K)*Q(K,J)
 19          CONTINUE
        ENDIF
C
        RETURN
        END
C *****   Multiply Matrix by Vector   *****
        SUBROUTINE MULTY(X,M,N,MP,Y,XY,JUD)
           REAL X(MP,*),Y(*),XY(*)
C
        IF(JUD.EQ.1) THEN             !CAL X'Y
          DO 9 I=1,N
            XY(I)=0.
                DO 9 J=1,M
            XY(I)=XY(I)+X(J,I)*Y(J)
 9          CONTINUE
C
        ELSE          !Cal XY
           DO 19 I=1,M
```

```
          XY(I)=0.
            DO 19 J=1,N
        XY(I)=XY(I)+X(I,J)*Y(J)
 19      CONTINUE
C
      ENDIF
C
      RETURN
      END
C *****   Kronmecker Multiplication   *****
C   Multiplication of 2 Square Matrices
C
      SUBROUTINE KRON(A,M1,MPA,B,M2,MPB,C,MPC)
      REAL A(MPA,*),B(MPB,*),C(MPC,*)
C
        N1=M1
        N2=M2
C
      DO 9 I=1,M1
        I1=(I-1)*M2
       DO 9 J=1,N1
         J1=(J-1)*N2
        DO 9 I2=1,M2
          I3=I1+I2
         DO 9 J2=1,N2
              J3=J1+J2
 9       C(I3,J3)=A(I,J)*B(I2,J2)
C
      RETURN
```

```
      END
C
C *****   Add Vectors or Matrices   ****
      SUBROUTINE ADD(N,X,Y,MP)
         REAL X(MP,*),Y(MP,*)
C
      DO 9 I=1,N
        DO 9 J=1,N
       Y(I,J)=Y(I,J)+X(I,J)
 9      CONTINUE
C
       RETURN
       END
C ----------------------------------------
      SUBROUTINE ADD1(N,X,Y)
        REAL X(*),Y(*)
C
       DO 9 I=1,N
        Y(I)=Y(I)+X(I)
 9      CONTINUE
C
      RETURN
      END
```

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