

THE IMPACT OF WEATHER SHOCKS ON EMPLOYMENT
OUTCOMES:
EVIDENCE FROM SOUTH AFRICA

ONLINE APPENDICES

HARRIET BROOKES GRAY

VIS TARAZ

SIMON D. HALLIDAY

Brookes Gray: Princeton University, Industrial Relations Section, Louis A. Simpson International Building, Princeton, NJ 08544 (email: harrietbrookesgray@gmail.com). Taraz: Corresponding author: Smith College, Department of Economics, Wright Hall, 5 Chapin Drive, Northampton, MA 01063-6317 (email: vtaraz@smith.edu). Halliday: University of Bristol, School of Economics, 12A Priory Rd, Bristol BS8 1TU, United Kingdom (email: simon.halliday@bristol.ac.uk).

APPENDIX A. APPENDIX FIGURES AND TABLES

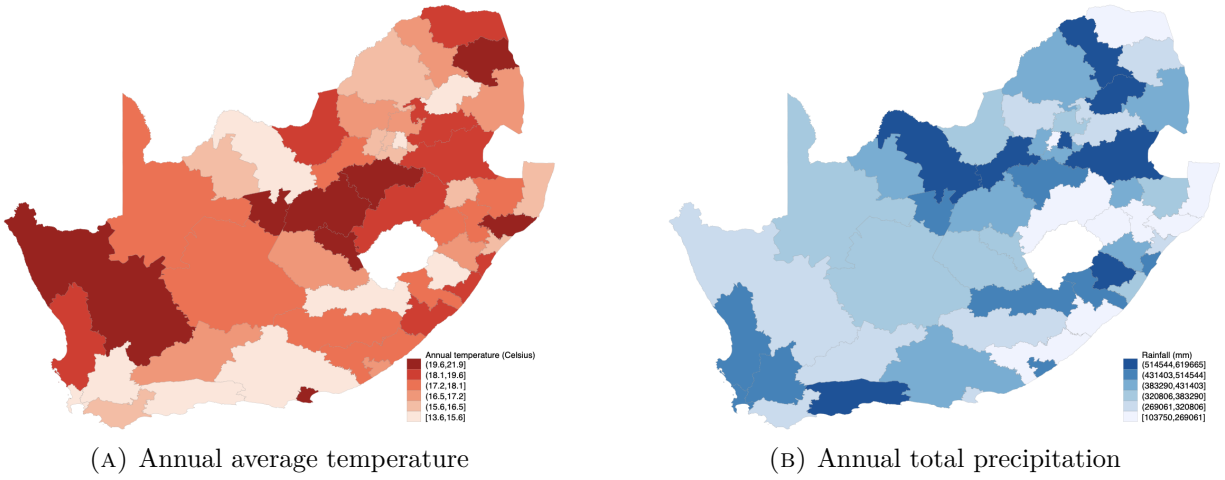


FIGURE A1. Annual average temperature and annual total precipitation for South African districts (2007–2017)

TABLE A1. Residual variation for different weather variables, conditional on different sets of fixed effects

<i>Panel A: Drought</i>		
	(1)	(2)
	R ²	Residual Variance
No fixed effects (FE)		0.3220
District FE, month FE, year FE, & province trends	0.3970	0.2501
<i>Panel B: Degree days (31C)</i>		
	(1)	(2)
	R ²	Residual Variance
No fixed effects (FE)		0.7287
District FE, month FE, year FE, & province trends	0.9451	0.1707
<i>Panel C: Average temperature (C)</i>		
	(1)	(2)
	R ²	Residual Variance
No fixed effects (FE)		1.9296
District FE, month FE, year FE, & province trends	0.9868	0.2220
<i>Panel D: Total precipitation (meters)</i>		
	(1)	(2)
	R ²	Residual Variance
No fixed effects (FE)		0.1353
District FE, month FE, year FE, & province trends	0.8533	0.0518

Note: Column 1 reports the R² of regressing that weather variable on the listed set of fixed effects. Column 2 reports the standard deviation of the variable, absent of any regression, as well as the standard deviation of the residuals from regressing that weather variable on the listed set of fixed effects.

TABLE A2. Balance Table

<i>Panel A: Weather variables</i>	(1)		(2)		(3)	
	High-Tourism Districts		Low-Tourism Districts		Difference	
	mean	sd	mean	sd	b	t
Drought	0.33	0.11	0.29	0.14	0.04	(1.10)
Total precipitation (m)	0.32	0.11	0.44	0.10	-0.12	(-4.00)
Degree days, 31C threshold	0.77	0.88	0.52	0.52	0.25	(1.21)
Average temperature (C)	17.03	1.44	17.80	2.26	-0.76	(-1.47)
Observations	24		28		52	
<i>Panel B: Employment variables</i>	(1)		(2)		(3)	
	High-Tourism Districts		Low-Tourism Districts		Difference	
	mean	sd	mean	sd	b	t
Employed	0.44	0.09	0.28	0.09	0.16	(6.65)
Employed in primary sector	0.07	0.06	0.04	0.04	0.03	(1.93)
Employed in secondary sector	0.08	0.03	0.05	0.02	0.02	(3.45)
Employed in tertiary sector	0.29	0.07	0.19	0.06	0.11	(6.11)
Formally employed	0.39	0.09	0.23	0.08	0.16	(6.74)
Informally employed	0.06	0.02	0.06	0.02	0.01	(1.09)
Unemployed	0.16	0.03	0.17	0.02	-0.01	(-1.41)
Not economically active	0.40	0.07	0.54	0.09	-0.15	(-7.00)
Labor income	2714.49	1097.89	1387.88	896.37	1326.61	(4.72)
Observations	24		28		52	

Note: Column 1 provides the mean and standard deviations for the variables amongst the high-tourism districts (Free State, Gauteng, Mpumalanga, Northern Cape, and Western Cape), and Column 2 does the same but amongst the low-tourism districts (Eastern Cape, KwaZulu-Natal, Limpopo, and North West). Column 3 presents the t-test for the statistical significance of the difference across the two groups. The statistics are calculated based on our analysis sample of working aged individuals (individuals ages 15-64).

TABLE A3. The effect of drought on the likelihood of employment: By tourism levels and historical rainfall levels

<i>Panel A: All employment</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0025 (0.0088)	-0.0058 (0.0048)	0.0069 (0.0059)	-0.0050 (0.0083)
High tourism=1 × Drought	-0.0372 (0.0131)	-0.0022 (0.0075)	-0.0027 (0.0071)	-0.0320 (0.0141)
Low historical rain=1 × Drought	0.0044 (0.0145)	0.0128 (0.0078)	-0.0191 (0.0080)	0.0109 (0.0159)
Observations	83099	83099	83099	83099
R^2	0.241	0.086	0.060	0.140
Dep. var. mean	0.3530	0.0534	0.0668	0.2344
<i>Panel B: Formal employment</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0045 (0.0089)	-0.0052 (0.0049)	0.0084 (0.0051)	-0.0076 (0.0080)
High tourism=1 × Drought	-0.0112 (0.0133)	0.0044 (0.0072)	0.0021 (0.0061)	-0.0177 (0.0130)
Low historical rain=1 × Drought	0.0106 (0.0137)	0.0121 (0.0075)	-0.0225 (0.0066)	0.0211 (0.0142)
Observations	83099	83099	83099	83099
R^2	0.201	0.086	0.050	0.121
Dep. var. mean	0.2991	0.0478	0.0518	0.1995
<i>Panel C: Informal employment</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	0.0002 (0.0058)	-0.0005 (0.0024)	-0.0008 (0.0027)	0.0015 (0.0034)
High tourism=1 × Drought	-0.0272 (0.0080)	-0.0065 (0.0024)	-0.0056 (0.0035)	-0.0151 (0.0065)
Low historical rain=1 × Drought	-0.0047 (0.0079)	0.0007 (0.0022)	0.0039 (0.0034)	-0.0092 (0.0070)
Observations	83099	83099	83099	83099
R^2	0.053	0.010	0.021	0.032
Dep. var. mean	0.0579	0.0057	0.0151	0.0371

Note: Low historical rainfall is a binary indicator that equals one if an individual resides in a district whose historical rainfall (over the 30-year period 1978–2007) is below the median, relative to all South African districts. All columns control for degree days, degree days interacted with the high-tourism indicator, and degree days interacted with the low historical rainfall indicator. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends. All columns control for gender indicators, race indicators, age, and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A4. The effect of drought on labor income

<i>Panel A: All labor income</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.1481	-0.0232	-0.0022	-0.1293
	(0.0549)	(0.0288)	(0.0287)	(0.0530)
Degree days, 31C threshold	0.1089	0.0616	0.0493	0.0045
	(0.1075)	(0.0716)	(0.0471)	(0.0897)
Observations	78653	78653	78653	78653
R^2	0.239	0.088	0.059	0.141
Dep. var. mean	2.7556	0.4080	0.4798	1.8092
<i>Panel B: Formal labor income</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.1035	-0.0047	-0.0027	-0.0961
	(0.0567)	(0.0350)	(0.0287)	(0.0526)
Degree days, 31C threshold	0.0967	0.0445	0.0630	-0.0109
	(0.1043)	(0.0540)	(0.0442)	(0.0872)
Observations	78653	78653	78653	78653
R^2	0.219	0.087	0.052	0.132
Dep. var. mean	2.4686	0.3795	0.4163	1.6407
<i>Panel C: Informal labor income</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0504	-0.0191	0.0044	-0.0358
	(0.0326)	(0.0135)	(0.0106)	(0.0216)
Degree days, 31C threshold	0.0180	0.0153	-0.0142	0.0169
	(0.0406)	(0.0243)	(0.0173)	(0.0246)
Observations	78653	78653	78653	78653
R^2	0.028	0.008	0.013	0.016
Dep. var. mean	0.2279	0.0271	0.0570	0.1406

Note: The dependent variable in Panels A, B, and C is the inverse hyperbolic sine of an individual's labor income from the past 30 days, from all employment, formal employment, and informal employment, respectively, with individuals who are not employed assigned a labor income value of zero. Income is deflated to 2015 South African Rand. Some employed individuals are missing income data, which leads to a smaller sample size. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends. All columns control for gender indicators, race indicators, age, and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A5. The effect of drought on labor income, heterogeneity by tourism reliance

<i>Panel A: All labor income</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	0.0199 (0.0671)	-0.0227 (0.0354)	0.0283 (0.0349)	0.0082 (0.0625)
High tourism=1 × Drought	-0.4227 (0.1147)	0.0014 (0.0632)	-0.0763 (0.0591)	-0.3485 (0.1091)
Observations	78653	78653	78653	78653
R^2	0.239	0.088	0.059	0.141
Dep. var. mean	2.7556	0.4080	0.4798	1.8092
<i>Panel B: Formal labor income</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	0.0045 (0.0730)	-0.0205 (0.0388)	0.0172 (0.0350)	0.0078 (0.0634)
High tourism=1 × Drought	-0.2734 (0.1191)	0.0427 (0.0616)	-0.0516 (0.0581)	-0.2645 (0.1121)
Observations	78653	78653	78653	78653
R^2	0.219	0.087	0.052	0.132
Dep. var. mean	2.4686	0.3795	0.4163	1.6407
<i>Panel C: Informal labor income</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	0.0114 (0.0304)	-0.0018 (0.0163)	0.0157 (0.0124)	-0.0025 (0.0172)
High tourism=1 × Drought	-0.1536 (0.0433)	-0.0433 (0.0177)	-0.0266 (0.0191)	-0.0837 (0.0338)
Observations	78653	78653	78653	78653
R^2	0.028	0.008	0.013	0.016
Dep. var. mean	0.2279	0.0271	0.0570	0.1406

Note: The dependent variable in Panels A, B, and C is the inverse hyperbolic sine of an individual's labor income from the past 30 days, from all employment, formal employment, and informal employment, respectively, with individuals who are not employed assigned a labor income value of zero. Income is deflated to 2015 South African Rand. Some employed individuals are missing income data, which leads to a smaller sample size. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends. All columns control for gender indicators, race indicators, age, and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A6. The effect of drought on the likelihood of employment: Alternative heat control (average temperature)

<i>Panel A: All employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0127 (0.0058)	-0.0010 (0.0050)	-0.0020 (0.0038)	-0.0107 (0.0061)
Average temperature (C)	-0.0004 (0.0106)	-0.0020 (0.0085)	0.0054 (0.0057)	-0.0032 (0.0080)
Observations	83099	83099	83099	83099
R^2	0.241	0.085	0.060	0.140
Dep. var. mean	0.3530	0.0534	0.0668	0.2344
<i>Panel B: Formal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	0.0002 (0.0068)	0.0007 (0.0054)	0.0005 (0.0037)	-0.0010 (0.0054)
Average temperature (C)	-0.0077 (0.0108)	0.0006 (0.0077)	0.0042 (0.0055)	-0.0125 (0.0076)
Observations	83099	83099	83099	83099
R^2	0.201	0.085	0.050	0.121
Dep. var. mean	0.2991	0.0478	0.0518	0.1995
<i>Panel C: Informal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0140 (0.0061)	-0.0017 (0.0017)	-0.0019 (0.0018)	-0.0104 (0.0050)
Average temperature (C)	0.0078 (0.0070)	-0.0030 (0.0021)	0.0014 (0.0018)	0.0094 (0.0054)
Observations	83099	83099	83099	83099
R^2	0.053	0.010	0.021	0.031
Dep. var. mean	0.0579	0.0057	0.0151	0.0371

Note: Temperature is averaged over the 12 months prior to the interview date. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends. All columns control for gender indicators, race indicators, age, and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A7. The effect of weather on the likelihood of employment: Using total precipitation instead of drought

<i>Panel A: All employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Total precipitation (meters)	-0.0161 (0.0437)	0.0050 (0.0228)	-0.0051 (0.0232)	-0.0150 (0.0357)
Degree days, 31C threshold	0.0078 (0.0121)	0.0053 (0.0096)	0.0055 (0.0058)	-0.0016 (0.0097)
Observations	83099	83099	83099	83099
R^2	0.241	0.085	0.060	0.140
Dep. var. mean	0.3530	0.0534	0.0668	0.2344
<i>Panel B: Formal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Total precipitation (meters)	-0.0283 (0.0413)	-0.0166 (0.0220)	-0.0135 (0.0198)	0.0018 (0.0327)
Degree days, 31C threshold	0.0089 (0.0114)	0.0016 (0.0076)	0.0066 (0.0043)	0.0008 (0.0087)
Observations	83099	83099	83099	83099
R^2	0.201	0.085	0.050	0.121
Dep. var. mean	0.2991	0.0478	0.0518	0.1995
<i>Panel C: Informal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Total precipitation (meters)	0.0176 (0.0283)	0.0215 (0.0077)	0.0085 (0.0113)	-0.0125 (0.0253)
Degree days, 31C threshold	0.0025 (0.0075)	0.0031 (0.0035)	-0.0006 (0.0041)	-0.0001 (0.0062)
Observations	83099	83099	83099	83099
R^2	0.052	0.010	0.021	0.031
Dep. var. mean	0.0579	0.0057	0.0151	0.0371

Note: Total precipitation measures the total precipitation (in meters) for the 12 months prior to the interview date. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends. All columns control for gender indicators, race indicators, age, and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A8. The effect of weather on the likelihood of employment: Early vs late effects

<i>Panel A: All employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0252 (0.0134)	-0.0064 (0.0077)	0.0001 (0.0051)	-0.0196 (0.0105)
Late=1 \times Drought	0.0157 (0.0200)	0.0069 (0.0104)	-0.0034 (0.0076)	0.0113 (0.0135)
Observations	83099	83099	83099	83099
R^2	0.241	0.086	0.060	0.140
Dep. var. mean	0.3530	0.0534	0.0668	0.2344
<i>Panel B: Formal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0211 (0.0136)	-0.0046 (0.0072)	0.0005 (0.0048)	-0.0170 (0.0109)
Late=1 \times Drought	0.0270 (0.0164)	0.0084 (0.0091)	-0.0010 (0.0078)	0.0196 (0.0130)
Observations	83099	83099	83099	83099
R^2	0.201	0.085	0.050	0.121
Dep. var. mean	0.2991	0.0478	0.0518	0.1995
<i>Panel C: Informal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0069 (0.0051)	-0.0022 (0.0016)	-0.0004 (0.0017)	-0.0043 (0.0036)
Late=1 \times Drought	-0.0091 (0.0118)	-0.0008 (0.0035)	-0.0015 (0.0030)	-0.0068 (0.0091)
Observations	83099	83099	83099	83099
R^2	0.053	0.011	0.021	0.031
Dep. var. mean	0.0579	0.0057	0.0151	0.0371

Note: The late indicator is one for observations from the later two waves of the NIDS survey (2014/15 and 2017), and zero otherwise. All columns control for degree days and degree days interacted with the late indicator. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends. All columns control for gender indicators, race indicators, age, and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A9. The effect of drought on the likelihood of employment, adding individual fixed effects

<i>Panel A: All employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0102 (0.0065)	-0.0046 (0.0048)	0.0015 (0.0048)	-0.0083 (0.0072)
Degree days, 31C threshold	0.0039 (0.0148)	0.0061 (0.0054)	0.0016 (0.0085)	-0.0023 (0.0121)
Observations	70254	70254	70254	70254
R^2	0.651	0.621	0.515	0.618
Dep. var. mean	0.3530	0.0534	0.0668	0.2344
<i>Panel B: Formal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	0.0009 (0.0062)	-0.0014 (0.0047)	0.0032 (0.0044)	-0.0009 (0.0061)
Degree days, 31C threshold	0.0047 (0.0118)	0.0058 (0.0046)	0.0020 (0.0068)	-0.0030 (0.0089)
Observations	70254	70254	70254	70254
R^2	0.665	0.637	0.521	0.639
Dep. var. mean	0.2991	0.0478	0.0518	0.1995
<i>Panel C: Informal employment</i>	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0128 (0.0067)	-0.0033 (0.0023)	-0.0013 (0.0024)	-0.0082 (0.0050)
Degree days, 31C threshold	0.0035 (0.0094)	-0.0001 (0.0031)	0.0005 (0.0048)	0.0032 (0.0078)
Observations	70254	70254	70254	70254
R^2	0.419	0.341	0.394	0.388
Dep. var. mean	0.0579	0.0057	0.0151	0.0371

Note: All columns include individual fixed effects, district fixed effects, month fixed effects, year fixed effects, and province-specific time trends, as well as age and age squared. Standard errors, in parentheses, are clustered at the district level.

TABLE A10. The effect of drought on the likelihood of employment, wild cluster bootstrap standard errors

<i>Panel A: All employment</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0156395 (0.00) [-0.0258, -0.00547]	-0.0026134 (0.52) [-0.0106, 0.00605]	-0.0015395 (0.67) [-0.00845, 0.00578]	-0.0125833 (0.04) [-0.0244, -0.000350]
Degree days, 31C threshold	.0156079 (0.23) [-0.0118, 0.0423]	.0057714 (0.59) [-0.0151, 0.0246]	.0066097 (0.33) [-0.00738, 0.0194]	.0049407 (0.65) [-0.0165, 0.0278]
Observations	83099	83099	83099	83099
R^2	0.241	0.086	0.060	0.140
Dep. var. mean	0.3530	0.0534	0.0668	0.2344
<i>Panel B: Formal employment</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0045557 (0.53) [-0.0185, 0.0103]	.0003384 (0.93) [-0.00951, 0.0102]	.0003096 (0.92) [-0.00629, 0.00717]	-0.0052037 (0.40) [-0.0175, 0.00650]
Degree days, 31C threshold	.0137941 (0.26) [-0.0117, 0.0379]	.0032415 (0.63) [-0.0128, 0.0176]	.0079165 (0.17) [-0.00353, 0.0182]	.0026361 (0.79) [-0.0164, 0.0235]
Observations	83099	83099	83099	83099
R^2	0.201	0.085	0.050	0.121
Dep. var. mean	0.2991	0.0478	0.0518	0.1995
<i>Panel C: Informal employment</i>				
	(1)	(2)	(3)	(4)
	All	Primary	Secondary	Tertiary
Drought	-0.0126591 (0.03) [-0.0239, -0.000888]	-0.0029584 (0.09) [-0.00632, 0.000536]	-0.0013219 (0.43) [-0.00477, 0.00252]	-0.0083787 (0.04) [-0.0179, -0.000315]
Degree days, 31C threshold	.0054945 (0.49) [-0.0118, 0.0228]	.0019162 (0.72) [-0.00533, 0.0103]	-0.0009762 (0.80) [-0.0102, 0.00742]	.0045546 (0.46) [-0.00838, 0.0167]
Observations	83099	83099	83099	83099
R^2	0.052	0.010	0.021	0.031
Dep. var. mean	0.0579	0.0057	0.0151	0.0371

Note: This table reports our main results, but using wild cluster bootstrap standard errors. The table reports regression coefficients, with p-value beneath in parentheses, and the 95% confidence interval in brackets below that. All columns include district fixed effects, month fixed effects, year fixed effects, and province-specific time trends, as well as gender and race dummies and age and age squared.

APPENDIX B. DIVISIONS OF THE TERTIARY SECTOR IN SOUTH AFRICA

The NIDS survey divides tertiary sector employment into the following subsectors, based on the classifications given in Statistics South Africa (2005).

Major division 6: wholesale & retail trade: repair of motor vehicles, motorcycles & personal & household goods; hotels & restaurants

- 610 wholesale and commission trade, except of motor vehicles and motor cycles
- 620 retail trade, except of motor vehicles and motor cycles; repair of
- 630 sale, maintenance and repair of motor vehicles and motor cycles; retail trade in automotive fuel
- 640 hotels and restaurants

Major division 7: transport, storage & communication

- 710 land transport; transport via pipelines
 - includes buses, taxis, rail travel, truck rentals with drivers, safaris, and sightseeing bus tours
- 720 water transport
- 730 air transport
- 741 supporting and auxiliary transport activities; activities of travel agencies
- 750 post and telecommunication

Major division 8: financial intermediation, insurance, real estate & business services

- 810 financial intermediation, except insurance and pension funding
- 821 insurance and pension funding, except compulsory social security
- 830 activities auxiliary to financial intermediation
- 840 real estate activities
- 850 renting of machinery and equipment, without operator and of personal and household goods
- 860 computer and related activities
- 870 research and development
- 880 other business activities

Major division 9: community, social & personal services

- 910 public administration and defence activities
- 920 education
- 930 health and social work
- 940 other community, social and personal service activities
- 950 activities of membership organisations n.e.c.
- 960 recreational, cultural and sporting activities

- 990 other service activities

Major division 0: private households, extraterritorial organisations, representatives of foreign governments & other activities not adequately defined

- 010 private households with employed persons
 - includes domestic workers, gardeners, security guard, governess, tutors, valets, butlers, chauffeurs, caretakers, baby-sitters employed by private households
- 020 extraterritorial organisations
- 030 representatives of foreign governments