**Appendix F – Regression Model and Results, linear scale**

1. **The Regression Model**

$$ULS_{iy} = \beta_0 + \beta_1 CI + \beta_2\, year_y + \beta_3\, PC_i + \beta_4 OI + \epsilon$$

- $ULS_{iy}$ means the urban light estimators, including the urban light luminosity sum, the urban light counts of year y, and the paired closed city i.
- $CI$ is the close city indicator which is one if it is or contains a closed city, and is zero otherwise.
- $\beta_2$ measures the time fixed effect.
- $\beta_3$ measures the geographical fixed effect, and $PC_i$ means the paired closed city.
- $OI$ are other useful indicators, such as, urban-type settlement indicator, the TripAdvisor indicator, the sci-related indicator.

2. **Adjacent Cities**

TABLE F.1: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY SUM

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | SUM | SUM | SUM | SUM |
| closed_city | 10658.1*** | 5498.6*** | 17026.1*** | 19192.8*** |
| | (915.5) | (1016.3) | (940.0) | (1064.2) |
| sci_related | | 24347.1*** | 27630.9*** | 25784.8*** |
| | | (2207.7) | (1922.8) | (1965.9) |
| urban_settlement | | | -78178.0*** | -79870.7*** |

| | | | | |
|---|---|---|---|---|
| | | | (2163.6) | (2194.4) |
| Trip_Advisor | | | | 9707.0*** |
| | | | | (2252.4) |
| _cons | 21086.0*** | 21147.9*** | 21687.7*** | 11969.8*** |
| | (372.2) | (366.8) | (319.5) | (2277.4) |
| *N* | 4117 | 4117 | 4117 | 4117 |
| $R^2$ | 0.259 | 0.280 | 0.455 | 0.458 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE F.2: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY COUNT

| | (1) | (2) | (3) |
|---|---|---|---|
| | COUNT | COUNT | COUNT |
| closed_city | 1015.3*** | 918.5*** | 978.7*** |
| | (47.30) | (52.89) | (60.31) |
| sci_related | | 475.4*** | 415.2*** |
| | | (117.2) | (120.7) |
| Trip_Advisor | | | 260.0* |
| | | | (125.3) |

| | | | |
|---|---|---|---|
| _cons | 1374.6*** | 1375.2*** | 1115.0*** |
| | (18.39) | (18.35) | (126.8) |
| *N* | 3699 | 3699 | 3699 |
| $R^2$ | 0.365 | 0.367 | 0.368 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE F.3: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY SUM IN 1992

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | lnsum | lnsum | lnsum | lnsum |
| closed_city | 0.169 | 0.125 | 0.767** | 0.708** |
| | (0.239) | (0.271) | (0.234) | (0.261) |
| sci_related | | 0.206 | 0.370 | 0.419 |
| | | (0.585) | (0.475) | (0.486) |
| urban_settlement | | | -4.254*** | -4.208*** |
| | | | (0.533) | (0.542) |
| Trip_Advisor | | | | -0.301 |
| | | | | (0.595) |

| | | | | |
|---|---|---|---|---|
| _cons | 9.455*** | 9.456*** | 9.486*** | 9.788*** |
| | (0.0962) | (0.0966) | (0.0784) | (0.601) |
| *N* | 148 | 148 | 148 | 148 |
| $R^2$ | 0.241 | 0.242 | 0.506 | 0.508 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE F.4: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY COUNT IN 1992

| | (1) | (2) | (3) |
|---|---|---|---|
| | lncount | lncount | lncount |
| closed_city | 0.649*** | 0.651** | 0.583* |
| | (0.191) | (0.215) | (0.242) |
| sci_related | | -0.00936 | 0.0592 |
| | | (0.474) | (0.487) |
| Trip_Advisor | | | -0.341 |
| | | | (0.539) |
| _cons | 6.613*** | 6.613*** | 6.955*** |
| | (0.0733) | (0.0736) | (0.545) |
| *N* | 133 | 133 | 133 |

| | | | |
|---|---|---|---|
| $R^2$ | 0.448 | 0.448 | 0.450 |

Standard errors in parentheses

$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

### 3. Similar Cities

TABLE F.5: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY SUM

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | SUM | SUM | SUM | SUM |
| close_city | 3951.7*** | 3772.9*** | 4998.7*** | 2954.3*** |
| | (593.3) | (673.1) | (746.4) | (836.2) |
| sci_related | | 802.4 | 703.8 | 2388.6 |
| | | (1426.0) | (1422.3) | (1449.3) |
| urban_settlement | | | -5307.2*** | -3614.3* |
| | | | (1413.3) | (1440.9) |
| trip_advisor | | | | -9629.2*** |
| | | | | (1814.7) |
| _cons | 26804.9*** | 26811.0*** | 26760.8*** | 36385.2*** |
| | (319.4) | (319.6) | (319.0) | (1841.3) |

| | | | | |
|---|---|---|---|---|
| *N* | 2368 | 2368 | 2368 | 2368 |
| $R^2$ | 0.877 | 0.877 | 0.878 | 0.879 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE F.6: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY COUNT

| | (1) | (2) | (3) |
|---|---|---|---|
| | COUNT | COUNT | COUNT |
| close_city | 194.1*** | 256.7*** | 119.1** |
| | (33.38) | (37.78) | (40.95) |
| sci_related | | -280.7*** | -143.1 |
| | | (80.03) | (80.75) |
| trip_advisor | | | -801.1*** |
| | | | (98.82) |
| _cons | 1581.1*** | 1579.0*** | 2378.3*** |
| | (17.97) | (17.94) | (100.2) |
| *N* | 2368 | 2368 | 2368 |
| $R^2$ | 0.835 | 0.836 | 0.841 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE F.7: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY SUM IN 1992

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | SUM | SUM | SUM | SUM |
| close_city | 5130.9 | 5637.7 | 7365.1* | 4240.0 |
| | (2628.2) | (3022.0) | (3378.2) | (3669.2) |
| sci_related | | -2186.4 | -2420.4 | 154.2 |
| | | (6276.9) | (6264.5) | (6255.3) |
| urban_settlement | | | -7031.8 | -4439.3 |
| | | | (6207.9) | (6203.3) |
| trip_advisor | | | | -16206.3 |
| | | | | (8355.5) |
| _cons | 26091.0*** | 26076.0*** | 26013.4*** | 42226.5*** |
| | (1400.2) | (1411.8) | (1409.3) | (8471.3) |
| *N* | 82 | 82 | 82 | 82 |
| $R^2$ | 0.935 | 0.935 | 0.936 | 0.940 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE F.8: THE RESULTS FROM REGRESSING URBAN LIGHT LUMINOSITY COUNT IN 1992

| | (1) | (2) | (3) |
|---|---|---|---|
| | COUNT | COUNT | COUNT |
| close_city | 245.6 | 309.9* | 179.4 |
| | (127.2) | (145.4) | (153.0) |
| sci_related | | -277.5 | -147.0 |
| | | (301.9) | (298.4) |
| trip_advisor | | | -850.0* |
| | | | (390.4) |
| _cons | 1269.7*** | 1267.8*** | 2116.9*** |
| | (67.79) | (67.91) | (395.5) |
| *N* | 82 | 82 | 82 |
| $R^2$ | 0.910 | 0.912 | 0.919 |

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

**4. Reason for Dropping this Model**

Using the example of Regression on Urban Light Luminosity COUNT for adjacent cities, the residual plot has a clear pattern (shown in Figure F.9), which is problematic. By using the ln scale to normalize the values, the residual plot becomes less problematic (shown in Figure F.10). Such a problem also arises in the SUM case, so we apply the ln scale in the SUM regression.

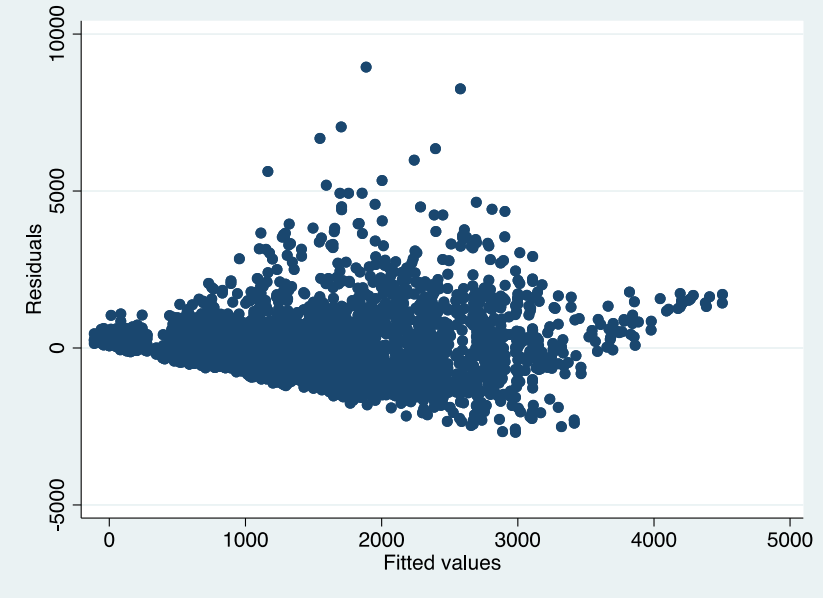


FIGURE F.9: THE RESIDUAL PLOT OF REGRESSION ON

URBAN LIGHT LUMINOSITY COUNT FOR ADJACENT CITIES

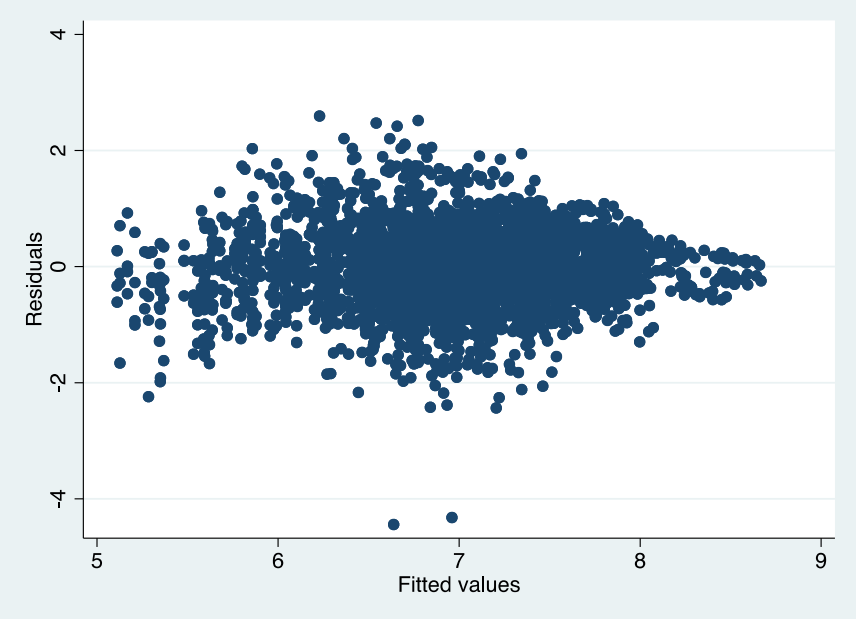


FIGURE F.10: THE RESIDUAL PLOT OF REGRESSION ON

LN URBAN LIGHT LUMINOSITY COUNT FOR ADJACENT CITIES