**Appendix A: Results of the regression analysis**

**Table 1:** Summary statistics for variables used in the regression analysis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| Population 2005 | 193 | 21587.7 | 38926.4 | 111.851 | 205714 |
| Population 2011 | 193 | 29914.9 | 54976.5 | 144.13 | 326112 |
| Population 2020 | 193 | 50302.7 | 98426.8 | 232.702 | 695096 |
| House Price 2005 | 193 | 10.4277 | 12.9423 | 3.69276 | 90.9091 |
| House Price 2011 | 193 | 20.8553 | 14.8413 | 4.05965 | 112.271 |
| House Price 2020 | 193 | 41.7106 | 17.3057 | 15.1685 | 137.42 |
| Building Density 2005 | 193 | 21587.6 | 24446 | 8866.39 | 173605 |
| Building Density 2011 | 193 | 29914.9 | 30528.1 | 14028.7 | 219753 |
| Building Density2020 | 193 | 50302.7 | 46598.4 | 26053.8 | 340074 |
| Maintenance Level 2005 | 193 | 1.78304 | 0.61464 | 1.07876 | 4.30953 |
| Maintenance Level 2011 | 193 | 1.78307 | 0.61471 | 1.1238 | 4.3875 |
| Maintenance Level 2020 | 193 | 1.8012 | 0.61427 | 1.17692 | 4.47016 |

Notes on Table 1: While we used 223 localities in the simulation, we used 193 in the regression analysis because of missing data from OpenStreetMap. However, in the simulation the missing data points were filled with taking the average of the variable of localities in the same area during a given year.

**Table A2:** Building density is measured as a function of construction permits. Column (1) reports the results of regressing the natural logarithm (log) of building density in 2005 on log of population, inverse of distance from Beirut Central District (BCD). The regression line is then used to fill density in every location covered in the study. Columns (2) and (3) report the results for years 2011 and 2020.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | (1) | (2) | (3) |
|  | density1 | density2 | density3 |
| VARIABLES | logdens2005 | logdens2011 | logdens2020 |
|  |  |  |  |
| logpop2005 | 0.132\*\*\* |  |  |
|  | (0.00886) |  |  |
| invesrsedistance | 3.091\*\*\* | 2.963\*\*\* | 2.837\*\*\* |
|  | (0.107) | (0.0899) | (0.0771) |
| logpop2011 |  | 0.112\*\*\* |  |
|  |  | (0.00744) |  |
| logpop2020 |  |  | 0.0969\*\*\* |
|  |  |  | (0.00639) |
| Constant | 8.254\*\*\* | 8.772\*\*\* | 9.427\*\*\* |
|  | (0.0732) | (0.0641) | (0.0583) |
|  |  |  |  |
| Observations | 193 | 193 | 193 |
| R-squared | 0.921 | 0.932 | 0.940 |
| Standard errors in parentheses | |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | |  |  |

Notes on Table 2: Recall that we use a reduced-form model rather than structural model for a lack of theory and data. However, in our regression, we find that the coefficients on population are positive as shown in Table A2 for the three cases (i.e., logpop2005, logpop2011, and logpop2020), indicating that as population increases so do work permits. Otherwise, we would have found the coefficients to be negative.

**Table A3:** House Price is adapted from Termos at al. (2021) which is constructed based on a two-stage least squares model (2SLS) as a housing price index for Greater Beirut area. Column (1) presents the results of regressing house price on population (both in log) and inverse of the distance of each locality from Beirut Central District (BCD) in 2005. Columns (2) and (3) present the results for 2011 and 2020, respectively.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | (1) | (2) | (3) |
|  | price1 | price2 | price3 |
| VARIABLES | logp2005 | logp2011 | logp2020 |
|  |  |  |  |
| logpop2005 | 0.153\*\*\* |  |  |
|  | (0.0102) |  |  |
| invesrsedistance | 3.236\*\*\* | 2.558\*\*\* | 1.859\*\*\* |
|  | (0.124) | (0.177) | (0.154) |
| logpop2011 |  | 0.0340\*\* |  |
|  |  | (0.0147) |  |
| logpop2020 |  |  | -0.0124 |
|  |  |  | (0.0128) |
| Constant | 0.381\*\*\* | 2.334\*\*\* | 3.596\*\*\* |
|  | (0.0845) | (0.126) | (0.117) |
|  |  |  |  |
| Observations | 193 | 193 | 193 |
| R-squared | 0.911 | 0.649 | 0.493 |
| Standard errors in parentheses | |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | |  |  |

**Table A4**: Building Maintenance. The baseline data is a primary data obtained from a survey in Termos et al. (2021). Column (1) presents the regression output for 2005 of maintenance on house price and building density and an interaction term between price and density to account for any non-linearity as explained in the text, all in logs. Columns (2) and (3) present the regression outputs for 2011 and 2020, respectively.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) |  |
|  | main1 | main2 | main3 |  |
| VARIABLES | logmaint2005 | logmaint2011 | logmaint2020 |  |
|  |  |  |  |  |
| logp2005 | 2.556\*\*\* |  |  |  |
|  | (0.00369) |  |  |  |
| logdens2005 | -2.044\*\*\* |  |  |  |
|  | (0.00700) |  |  |  |
| pd2005 | -0.0170\*\*\* |  |  |  |
|  | (0.000225) |  |  |  |
| logp2011 |  | 1.401\*\*\* |  |  |
|  |  | (0.0407) |  |  |
| logdens2011 |  | 1.085\*\*\* |  |  |
|  |  | (0.0151) |  |  |
| pd2011 |  | -0.141\*\*\* |  |  |
|  |  | (0.00391) |  |  |
| logp2020 |  |  | 2.119\*\*\* |  |
|  |  |  | (0.0744) |  |
| logdens2020 |  |  | 1.429\*\*\* |  |
|  |  |  | (0.0287) |  |
| pd2020 |  |  | -0.200\*\*\* |  |
|  |  |  | (0.00679) |  |
| Constant | 15.52\*\*\* | -10.34\*\*\* | -14.60\*\*\* |  |
|  | (0.0562) | (0.151) | (0.311) |  |
|  |  |  |  |  |
| Observations | 193 | 193 | 193 |  |
| R-squared | 0.983 | 0.995 | 0.994 |  |
| Standard errors in parentheses | | |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | |  |  |  |

**Appendix B: Exogenous Events Implementation Details**

**B.1. Case 1**

For Case 1, in the ABM we model the assassination and war as follows:

* An influx of capital and immigration (of diaspora) after 2005: immigration-rate increases by 0.05 and kapital increases by 0.01.
* Widespread destruction to residential dwellings in the most-affected bombed districts with building conditions set to 0: Chiyah and Haret Hreik.
* Varying damage to residential dwellings in other districts, and a decrease in maintenance level in general (reflecting the collateral and intentional infrastructure damage): Bourj El-Brajneh, Hadath, Laylakeh, Keyfoun, Qmatiyeh; other districts’ condition reduced to 80%.
* Household agents who were living in destroyed or badly damaged buildings have to move, and seek another place.
* Influx to Greater Beirut of households displaced from southern Lebanon: immigration-rate increases by 0.05 further.
* An increase in the tolerable cognitive dissonance, due to the (forced) mixing of sectarian backgrounds as displaced persons sought shelter: tolerable-dissonance increases by 2.
* Increase in available household mortgage credit ratio: credit increases by 2.
* Targeted post-war regeneration. Namely, reconstruction of destroyed neighbourhoods, increased lending credit, and an increase in economic capital due to external injections, e.g. from Iran and Qatar: regeneration? set to regular (in 2005) then to eu-slums (in 2006); kapital increases by 0.01 further. Destroyed areas cannot be regenerated for 12 months.

**B.2. Case 2**

For Case 2, in the ABM we model the refugee influx as follows:

* Immigration of large numbers of generally low-income households from January 2011: parameters as in Termos et al. (2021).

**B.3. Case 3**

For Case 3, in the ABM we model the currency crisis and explosion as follows:

* Decrease in household incomes: income decreases by 50%.
* Widespread destruction to residential dwellings in the most-affected districts with building conditions set to 0: Marfaa, Medawar, Remeil.
* Varying damage to residential dwellings in other districts: Beirut Central District, Bachoura, Saifeh, Achrafieh, Zoukak el-Blatt", Bourj Hammoud, Minet el-Hosn, Ain el-Mreisseh, Mazraa, Moussaytbeh, Ras Beyrouth, Sinn El-Fil; other districts’ condition reduced to 80%.
* Household agents who were living in destroyed or badly damaged buildings have to move, and seek another place.
* Increased emigration rate from metropolitan Beirut, and Greater Beirut: emigration-rate increases by 0.1.
* Most damaged areas cannot be regenerated for some time: at least 12 months, and 24 months for destroyed areas.