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Abstract

We investigate the heterogeneity of the impact of World Bank foreign aid projects on local economic development across countries, sectors and time. Using a grid-cell dataset of geo-referenced aid data, satellite night-time light imagery, and climatic and socio-economic controls, we employ a difference-in-differences approach and an event-study design to estimate causal effects. Based on our grid-cell-level dataset, which includes 60,677 grid-cells in 133 countries and covers the period from 1992 to 2020, resulting in about 1.76 million grid-by-year observations, we find substantial heterogeneity in the effects of foreign aid on local economic development across countries, sectors, and time. These results suggest that the sample composition in terms of countries and sectors included explains in part the observed heterogeneity in the results on the impact of foreign aid on economic development.

Keywords: Aid Effectiveness, Geo-Referenced Aid Projects, Economic Development, Economic Growth, Grid-Cell Analysis, GIS Data, Satellite Night-Time Light Data

JEL Classification Numbers: C23, F35, O10, O20, O40, R10

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1 Introduction

Research on the impact of foreign aid on economic development has a long tradition in development economics. In recent years, research on this topic has even gained momentum with the availability of geo-referenced data on aid projects, allowing research at the sub-national level (Bitzer and Gören, 2024; Bunte et al., 2018; Civelli et al., 2018; Cruzatti C. et al., 2020; Dreher and Lohmann, 2015; Dreher et al., 2021a; Gehring et al., 2022; Greßer and Stadelmann, 2020; Isaksson and Kotsadam, 2018; Khomba and Trew, 2022; Kotsadam et al., 2018; Masaki, 2018, to name just a few). Despite this impressive body of literature, the different studies show a remarkable heterogeneity in the estimated effects of foreign aid on economic development. Not only between studies at different levels of aggregation (e.g., country-level vs. sub-national level), but also between studies at the same level of aggregation.

Evidence from large-scale meta-studies shed some light on this issue by comparing the results of different studies (Doucouliagos and Paldam, 2008, 2011; Mekasha and Tarp, 2013, 2019). One finding found in each of these meta-studies that explains some of the heterogeneity of the estimated effects in the articles analysed is the sample of countries used in the studies. Although this seems to be an obvious reason for the observed heterogeneity in the studies, it is somewhat surprising that, to the best of the authors' knowledge, there is no study that examines this issue on the basis of a single dataset and separately for single countries.

A further finding of the meta-analyses is that there is significant unexplained variance in the estimates of the impact of foreign aid on economic development. Interestingly, this unexplained variance remains even after controlling for a large number of study-specific characteristics. These include not only the design of the regression model, such as the estimation technique applied and the control variables used, but also, for example, the affiliation of the authors and the journal in which the article appeared, to control for publication bias.

A natural candidate for the heterogeneity of estimated effects found in the literature is the composition of foreign aid that is approved and implemented to a country or region. Aggregating the different types of aid[1] into a single aid variable obscures the fact that different aid projects in different sectors may have different effects on economic development. For example, aid projects in the health sector may have a different impact on economic development than aid projects in the infrastructure sector. Some initial insights into the heterogeneous impact of different sectors are provided by Kaya et al. (2012). Based on a sample of 66 countries, the authors distinguish between agricultural aid, social infrastructure aid, investment aid, and non-investment aid and find that the impact of foreign aid on economic development varies across these subcategories. Maruta et al. (2020), on the other hand focus on the education, health and agricultural sectors in 74 countries in Africa, Asia and South America. In addition, Haldar and Sethi (2022) extend the analysis by including more sectors in their analysis. These are agriculture, industry, social infrastructure and services, and economic infrastructure and

[1] In this paper, the term *"different types of foreign aid"* refer to foreign aid projects classified by the World Bank into the following nine categories/areas/sectors: • *Education* • *Health* • *Water Supply and Sanitation* • *Government and Civil Society* • *Other Social Infrastructure and Services* • *Economic Infrastructure and Services* • *Production Sectors* • *Industry, Mining, Construction* • *Multi-Sector/Cross-Cutting*.

services. The sample covers 32 sub-Saharan African countries. All studies show that there is considerable heterogeneity in the impact of foreign aid on economic development across sectors at the country level. At the micro level, Atitianti et al. (2024) show heterogeneity across aid sectors, distinguishing between economic and social aid that affects local wealth levels in Africa using data from the Afrobarometer survey. Again, there are differences, albeit small, in the impact of economic and social aid. However, all these studies analyse only a subset of sectors, leaving out the remaining foreign aid sectors.

In addition, aid projects differ in the time lag with which they become effective. For example, a completed aid project in the infrastructure sector may have an immediate impact on economic development, while an aid project in the education sector may take several years to have an impact on lights activity through other socioeconomic outcomes (e.g., literacy rate or employment status). This has been known at least since the seminal paper by Clemens et al. (2012), showing that early-impact aid differ in impact from total aid. Dreher and Lohmann (2015) extend this kind of analysis by categorising aid into early- and late-impact aid projects, and by taking the analysis to the sub-national level. The results based on sub-national ADM2 units, reveal significant differences in the impact of early- and late-impact aid projects. A more recent paper Dreher et al. (2021b) analyses the timing of Chinese aid projects. They find that the impact of Chinese aid projects occurs in the first three years after the project is committed.

In this paper, we contribute to the literature by analysing the heterogeneity of the impact of foreign aid on economic development along the following three dimensions: countries, sectors, and time. For our analysis, we use a sub-national panel dataset of rectangular grid cells with a spatial resolution of 0.5 decimal degrees latitude and longitude (approximately 55km $\times$ 55km at the equator) covering the whole world. We combine two main data sources: First, we use geo-referenced data on foreign aid projects from the AidData database (AidData, 2016) to create various treatment measures of foreign aid at the grid cell level (e.g., foreign aid presence, project counts, and disbursements). Second, we use satellite night-time light data from the National Oceanic and Atmospheric Administration (NOAA) (NOAA-NGDC, 2015) as a proxy for local economic development at the grid cell level.

The grid cell data are complemented with a full set of climatic (e.g., temperature and precipitation) and socio-economic (e.g., population counts and conflict incidence) controls, as well as a rich set of grid cell and country-by-year fixed effects to account for unobserved heterogeneity at the grid cell and country level. The final dataset includes 60,677 grid cells in 133 countries and covers the period from 1992 to 2020, resulting in about 1.76 million grid-by-year observations. We estimate difference-in-differences (DID) regressions to estimate the impact of foreign aid on local economic development at the grid cell level. We complement this analysis with an event-study design to estimate the impact of foreign aid on grid cell economic activity over time.

As a benchmark analysis, we find that grid cells with foreign aid interventions have higher levels of night-time light emissions than grid cells without foreign aid interventions. The parameter estimate from the benchmark DD regressions that control for grid cell and country-by-year fixed effects suggests that the presence of a foreign aid project in a grid cell increases annual satellite nighttime light intensity by about 2.01% on average. Similar results are obtained for alternative, more detailed measures of foreign aid. Specifically, we find a positive and statistically significant effect on local economic development for both the number of foreign aid projects in the grid cell and the total amount of aid flowing to projects in the grid cell, suggesting the presence of a general aid effect.

As a first contribution, we analyse the heterogeneity of the estimated effects of foreign aid on economic development across countries. To do this, we apply DID regressions to estimate the impact of foreign aid on economic development at the grid cell level for each of the 133 countries in our sample separately. The results are then pooled in a meta-regression using a random effects restricted maximum likelihood (REML) model. This analysis is conducted by region in order to gain insight into the heterogeneity of the aid effect across countries in different regions of the world. The results for the country-specific aid effects of the meta-analysis show, that there is considerable heterogeneity in aid effectiveness across world regions (e.g., Africa, Asia, the Americas or Europe). The overall impact of aid varies across continents, with the Americas showing the lowest impact and Europe showing the highest impact of aid on local economic development. The results across the single countries also show substantial heterogeneity in the direction, magnitude, and significance of the estimated coefficients. The significant impact of an additional foreign aid project range from -10.15% for Equatorial Guinea up to +37.03% for Saudi Arabia. These two results also show the strong contrast to results on aggregated continent level. Specifically, the average effect on night-time light emissions of an additional aid project for Africa is about 0.70% similar to the overall effect for Asia with 0.60%.

As a second contribution, we analyse the heterogeneity of the estimated impact of foreign aid on economic development across sectors. To do this, we run a series of DID regressions to estimate the impact of foreign aid on economic activity in grid cells separately for each of the nine World Bank sector categories of aid, while controlling for the presence of other foreign aid projects in the same grid cell. In the final fully specified model, all aid sectors are included separately, allowing a direct comparison of the estimated effects of different sectors. The results based on this sectoral decomposition confirm the expectation that the aid effect is heterogeneous across different types of aid projects. We find a positive and significant effect for aid projects earmarked for *Health*, *Economic Infrastructure and Services*, *Production Sectors* and *Multi-Sector/Cross-Cutting* in all specifications. However, we find no significant effect for aid projects in sectors such as *Water and Sanitation*, *Government and Civil Society*, *Other Social Infrastructure and Services* and *Industry, Mining and Construction*. Foreign aid in *Education* becomes statistically significant only in the fully specified model.

As our third and final contribution, we analyse the heterogeneity of the estimated effects of foreign aid on economic development with respect to the time lag with which aid projects become effective. We use an event-study approach to estimate the impact of foreign aid on grid cell economic activity for foreign aid projects in general and for each of the nine World Bank sector categories separately. The results show no evidence of a pre-treatment trend in the intensity of night-time light emissions, suggesting that the parallel trends assumption is not violated. In response to the treatment, we find a persistent positive and statistically significant effect for aid projects in general, starting in the year of project implementation and persisting for at least ten subsequent years. Again, we decompose this treatment effect into a sector-specific effects over time. This analysis reveals a heterogeneous pattern of aid effects across sectors, both in terms of timing and the sign and magnitude of the treatment effect. For example, we find that the positive effect of aid projects in production sectors does not materialise until five years after project implementation, while the effect of aid projects in economic infrastructure sectors is immediate but fades out after four years.

The remaining part of the paper is organized as follows. Section 2 describes the data and the econometric specification. Section 3 presents the main results. Section 4 discusses the results and places them in relation to the existing literature. Finally, Section 5 concludes.

2 Data Construction and Methodological Approach

2.1 Data

Structure of the Data. We gather and construct a large variety of geographic variables at the spatial level of grid cells covering the entire world. The grid cells have a spatial resolution of 0.5 decimal degrees latitude $\times$ longitude which equals the approximate size of a bounding box of 55 km $\times$ 55 km at the equator.[2] We assign grid cells to countries based on the grid cell centroid that lies within the country's border line. Excluding minor islands and larger lakes from the analysis, we are left with a balanced panel data set of 60,677 grid cells observed during the period 1992–2020. This results in a total of 1,759,633 grids-by-year observations depending on sample choice and data availability.

Dependent Variable. We use high-resolution satellite night-time images of light emissions collected by the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS) from the National Oceanic and Atmospheric Administration (NOAA) National Geophysical Data Centre (NGDC) during the period 1992 to 2013 (NOAA-NGDC, 2015).[3] Recently, EOG added additional global night-time light images from 2013 onward out to 2021, making this data a valuable source useful for long-run socio-economic analysis (Ghosh et al., 2021).[4] This type of data has been used quite extensively in economics research to measure economic activity at the sub-national level (Henderson et al., 2012)[5], where otherwise disaggregated income level data are either not available or prone severe downward bias in developing countries due to subsistence strategies (Anand and Harris, 1994).

It is worth mentioning that pixel-level values of night-time light images from different DMSP-OLS satellite-by-year observations are not comparable across time and even within the same satellite F-series due to a lack

[2] Due to the curvature of the earth, the grid cells become smaller and less rectangular towards the poles. We do control for this circumstance through the use of grid cell fixed effects in the empirical analysis.

[3] The image data is archived and processed by the Earth Observation Group (EOG), Payne Institute for Public Policy, Colorado School of Mines, available online at https://payneinstitute.mines.edu/eog/.

[4] The raw data are freely available for download at https://eogdata.mines.edu/products/dmsp/#v4_dmsp_download.

[5] See Michalopoulos and Papaioannou (2018) for a non-comprehensive overview of the use satellite images of light emissions as a proxy for economic development at various spatial scales.

of in-flight calibration and technical degradation of optical sensors over time (Elvidge et al., 2014). In order to work with a consistent time series of night-light images over time, we apply the method of inter-annual calibration to ensure comparability of pixel level brightness values across the different satellite-by-year observations (Elvidge et al., 2009, 2014; Hsu et al., 2015).[6] Based on these inter-annual-calibrated light images, we construct a sum of lights index by summing up all pixel-level brightness values of the respective satellite-by-year image that are within the bounding box of each grid cell.

Geocoded Foreign Aid Data. We use geo-coded World Bank foreign aid data during the period 1995–2014 that are qualitatively approved and distributed by the AidData international development research lab (AidData, 2016). The recent data release covers World Bank projects from the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA) agency for 5,684 projects across 61,243 geo-coded project-locations. Each project-location has a corresponding latitude and longitude coordinate, but these differ with respect to the level of geo-coded precision. Considering the detailed spatial resolution of our sample, we only use project-locations with precision codes 1 to 3.[7] Figure 1 shows the distribution of project locations by geo-location precision codes. Overall, about 44,447 project locations out of a total of 61,243 have a precision code of 3 and smaller (about 72.57 percent). This pattern is also observed if we look at the main sector activity, as shown in Figure 2.

In the AidData (2016) database, we obtain detailed information on the main sector codes of the various World Bank foreign aid projects. The main sector coding methodology utilizes the OECD's Creditor Reporting System (CRS) to assign multi-sector coding to the available set of World Bank foreign aid projects that reflects the project's main purpose (e.g., education, health, or sanitation). Note that, when utilizing this additional dimension in the data, each project-location can be split into multiple types of foreign aid (sub-)projects. However, this distinction makes it possible to examine heterogeneous effects of different types of foreign aid on grid cell economic activity. For example, foreign aid flows aimed at improving human health may affect development outcomes quite differently than aid flows aimed at improving the economic infrastructure in a particular location.[8]

Figure 9 shows the distribution of World Bank foreign aid projects across grid cells over the period 1995–2014. Note that we consider foreign aid project locations with precision codes 3 and smaller. For each grid, we

[6]Specifically, we calibrate all satellite-by-year night-time light images to match the range of brightness values of satellite series F12 from the year 1999 as the reference year and Los Angeles as the reference area.

[7]The precision codes correspond to an exact location (classified as precision code 1), located "near", in the "area" of, or within a 25 km radius of an exact location (precision code 2), a second-order administrative division (ADM2; precision code 3), a first-order administrative division (ADM1; precision code 4), estimated latitude and longitude values or where projects cover several administrative regions (precision code 5), and nation-wide projects at the country level (precision code 6). In cases where information is unavailable at the project level or if foreign aid funds are directly given to various governmental units, the methodology assign precision codes 7 and 8. The interested reader is referred to the AidData geocoding methodology codebook by Strandow et al. (2011) for a more in-depth discussion of how World Bank foreign aid projects are assigned different geo-coded precision codes.

[8]Against this background, we address the well-known over-aggregation problem in the foreign aid literature in which foreign aid funds from different sectors and purposes are summarized into one single monetary value (Tierney et al., 2011; Clemens et al., 2012).

count the number of initiated foreign aid projects over time. It is apparent that the bulk of foreign aid projects is located in Africa, Latin America, East Europe and Asia (especially India and China). In Figures 10 to 12, we plot the distribution of foreign aid projects differentiated by main sector coding. Overall, there is large heterogeneity in the distribution of foreign aid projects across regions and main sectors.[9]

We use information on the project's start date to construct a treatment status variable that takes a value of one with the initiation of any foreign aid project and that increases accordingly by one unit with the start of any foreign aid project within each grid cell and year. In contrast to the standard staggered adoption design of DID style regression models, we are thus able to examine the impact of subsequent foreign aid projects on night-time lights activity. In addition, we construct alternative treatment variables that capture the intensity of foreign aid projects in a grid cell, such as the total amount of financial aid flows (in constant 2011 USD) to projects in the grid cell or the number of aid projects in the grid cell, respectively.[10] We provide evidence, that the results are robust to the use of these alternative treatment variables.

Other Geo-spatial Controls. We complement our empirical analysis with a full set of climatic and socioeconomic controls across grid cells and time to account for heterogeneity in the placement of foreign aid projects and differential developmental paths of grid cell night-time light activity due to local conditions. For example, we use measures of temperature (in mean degrees Celsius per year) and precipitation (in mean millimeters per year) that might be important for local economic development (Harris et al., 2014; Vicente-Serrano et al., 2010; Diffenbaugh and Burke, 2019). Additionally, we do control for population size (in log) and conflict events (in binary) that might affect the effectiveness of foreign aid projects on grid cell economic activity.

We provide basic summary statistics and correlation measures, respectively, of the main variables used in the empirical analysis in Tables C1 and C2.

2.2 Econometric Specification and Estimation Approach

We use a Difference-in-Differences regression model to estimate the heterogeneous effect of foreign aid projects on grid cell economic activity using the following generic specification:

$$\ln(Light_{gt} + 0.01) = \alpha + \beta Foreign\ Aid_{gt} + X'_{gt}\Gamma + \lambda_g + \lambda_{c(g)t} + \varepsilon_{gt}, \quad (1)$$

where $\ln(Light_{gt} + 0.01)$ is the log of the sum of pixel level light values within grid cell g and year t. We add a small constant to the light values to avoid taking the logarithm of zero. $Foreign\ Aid_{gt}$ is a treatment status variable that takes a value of one in any year where a foreign aid project takes place and zero otherwise. We

[9]For example, Türkiye attracts a lot of foreign aid projects in the main sectors *Government and Civil Society* and *Economic Infrastructure and Services*, but less though in the area of *Education* and *Water Supply and Sanitation*, respectively. We argue that this heterogeneity in the distribution of foreign aid projects across countries and main sectors is crucial for the identification of heterogeneous effects of foreign aid on local economic development.

[10]Information on the total amount of financial aid flows to projects is only available at the project but not project-location level. Thus, we evenly assign the total amount of financial aid flows to project locations in a grid cell.

follow the approach in Schmidheiny and Siegloch (2023) to account for multiple treatment events in which our foreign aid variable increases accordingly by one unit with the start of any foreign aid project within grid cell g and year t. This generalization of the treatment status variable ensures that second and subsequent foreign aid projects still exert an additional effect on grid cell lights activity. As an additional sensitivity check, we consider two additional foreign aid variables that capture the intensity of foreign aid projects in a grid cell and year: (1) the number of foreign aid projects, and (2) the log of aid disbursement flows in a given grid cell and year.

The vector X_{gt} includes a baseline set of time-variant grid cell controls, i.e., log of population size, mean annual precipitation, mean annual temperature, and conflict incidence. Thus, we account for time-variant endogeneity problems in the spatial distribution of World Bank foreign aid projects across grid cells and years. These variables also account for potential omitted variables bias that might affect grid cell productivity and therefore lights activity.

We additionally control for grid cell fixed effects λ_g and country-by-year fixed effects $\lambda_{c(g)t}$ in which grid cell g is nested within country c. While the former variable accounts for omitted variables bias that are constant over time but different across grids (e.g., due to geographic and/or historical factors), the latter effectively accounts for arbitrary unobserved heterogeneity that is both country- and time-specific due to, for example, differences in institutional quality and macroeconomic factors. The method of estimation is Ordinary Least Squares (OLS) with standard errors clustered at the regional level that are robust to serial and spatial auto-correlation of grid cells within regions.

The regression parameter β captures the average effect of foreign aid projects in aid-receiving grids relative to non-aid receiving grids. The identification strategy is based on the assumption that the average difference in lights activity between aid-receiving and non-aid-receiving grids would have been the same in the absence of foreign aid projects. We test this assumption by examining the parallel trends assumption in the pre-treatment period by presenting the corresponding event-study-plots.

The empirical analysis is conducted as follows: (1) We begin by presenting DID estimates of our baseline regression equation above. This allows us to examine the robustness of the relationship between night-time light emissions and foreign aid allocation conditional on a full set of grid cell and country-by-year fixed effects. (2) Based on the grid cells within countries, we use meta-regression techniques to uncover heterogeneous effects of foreign aid across the set of aid-receiving countries. (3) We then present average DID estimates in aid-receiving and non-aid-receiving grid cells, but this time separately for different types of aid projects (e.g., *Education*, *Health*, *Water Supply and Sanitation*, and others). By controlling for the number of aid projects in the remaining sectors in the same grid cell throughout the empirical analysis, we can identify the relative importance of different types of foreign aid projects on local economic activity. (4) Finally, we examine the heterogeneity of the estimated effects of foreign aid on economic development with respect to dynamic effects over time. This allows us to investigate, respectively, the time lag with which aid projects become effective and to test for parallel pre-treatment trends and thus the validity of our DID identification strategy. We apply this analysis first for total foreign aid in a grid cell and then for the different types of aid projects.

3 Empirical Results

3.1 The Impact of Foreign Aid on Grid Cell Economic Activity

In Table A1 we show regression results from estimating our main specification of equation (1). This specification is intended to examine the impact of foreign aid on grid cell economic (i.e., light) activity using our DID study design. We present estimates from a series of regression models that employ different definitions of the foreign aid variables. In columns (1) to (5), we use the binary indicator *Foreign Aid* to capture the treatment status of grid cells that have received any foreign aid project, and zero otherwise. In column (6), our treatment variable increases accordingly with the number of foreign aid projects in a given grid cell and year. In column (7), we use annual aid disbursement flows (in constant 2011 USD) weighted by the number of foreign aid project locations in a grid cell for the construction of our continuous treatment variable.[11]

In column (1), we estimate a parsimonious regression model with our foreign aid indicator as the only explanatory variable. The resulting regression coefficient associated with the foreign aid variable is positive and statistically significant at the 1% significance level. This estimate implies that the initiation of any new foreign aid project in a given grid cell and year would, ceteris paribus, result in an increase of grid cell nighttime light activity by about $(\exp(0.1120) - 1 =)$ 11.82 percent. However, the estimated effect is likely to be overestimated due to the omitted variable bias, as the model does not account for grid cell fixed effects or a set of time-variant grid cell controls. We address these concerns in the subsequent model specifications.

In columns (2), (3), and (4), we subsequently add grid cell fixed effects, climatic, and socioeconomic controls to the regression model, respectively. Although the estimated regression coefficients for *Foreign Aid* decrease in magnitude, they remain positive and statistically significant at the 1% significance level. These results demonstrate that the estimated effect of foreign aid on grid cell economic activity is robust to the inclusion of grid cell fixed effects and a set of time-variant grid cell controls. More importantly, we still find a robust and statistically significant effect, when controlling for country-by-year fixed effects in the regression model, although the estimated regression coefficient for *Foreign Aid* drops to 0.0199 (column 5). The estimated effect corresponds to an increase of grid cell light activity by about $(\exp(0.0199) - 1) \approx 2.01$ percent in response to the initiation of a single foreign aid project. Country-by-year fixed effects are important to consider, since the eligibility of countries to World Bank funds might be conditional to observed or unobserved country-specific circumstances (e.g., level of economic development, macroeconomic conditions, or political-strategic considerations for the distribution of foreign aid funds). In column (6), we consider the number of foreign aid projects in the grid cell as our treatment variable, which is intended to capture the intensity of foreign aid projects in the grid cell. The estimated regression coefficient is positive and statistically significant, indicating that an increase in the number of foreign aid projects in the grid cell is associated with an increase in grid cell light activity. In particular, one additional foreign aid project in the grid cell would, ceteris paribus, result in an increase of grid

[11] We use the natural logarithm of the aid disbursement flows to account for the skewed distribution of aid disbursements. Again, we add a small constant of 0.01 to the aid disbursement flows to avoid taking the logarithm of zero.

cell light activity by about $(\exp(0.0051)-1) \approx 0.51$ percent. Last, column (7) shows the results of an alternative definition of the foreign aid variable, where we consider the total amount of foreign aid disbursements as the explanatory variable. The estimated regression coefficient remains positive and statistically significant. Changes in the magnitude of the estimated coefficients are due to the different scaling of the explanatory variables. The adjusted R^2 as a measure of goodness-of-fit shows no significant improvement compared to the model in column (6). Overall, we find that the implementation of foreign aid projects has a positive and statistically significant impact on grid cell economic activity conditional on the inclusion of various fixed effects and a set of time-variant grid cell control variables.

In the following, we use column (6) as our preferred model specification, as the World Bank foreign aid data comes with some limitations regarding the spatial distribution of project-level financial disbursements. In particular, no information on the relative distribution of disbursements across project locations is available. Therefore, we prefer the number of foreign aid project locations variable as our main explanatory variable, as it is less prone to measurement error and more directly interpretable.

3.2 Heterogeneity across Countries

We then proceed to investigate the heterogeneity of the aid effect across countries by estimating our main specification in column (6) of Table A1 for each country separately. This is possible because we have a sufficient number of grid cells within each country to estimate the effect of foreign aid on grid cell economic activity separately for each country. The results are then pooled in a meta-regression using a random effects restricted maximum likelihood (REML) model. This analysis is conducted by regions with the aim of providing insights into the heterogeneity of the aid effect across countries. The results are shown as forest plots, and are depicted in Figures 5 (Africa), 6 (Asia), 7 (Americas), and 8 (Europe).

First and foremost, we find that within the four regions, the estimated regression coefficients for the aid effect display a wide range of magnitudes and statistical significance levels across countries, ranging from negative to positive effects. This finding is underlined by the joint hypothesis tests of coefficient equality across countries, which are all rejected at the 1% significance level for all regions. Therefore, the results indicate substantial heterogeneity in the impact of foreign aid on grid cell economic activity across countries. The heterogeneity statistic I^2 is close to 100% for all four world regions, indicating that the majority of the variation in the estimated coefficients is due to heterogeneity across countries.[12]

Second, it is important to note that the country-specific estimates are not only heterogeneous in terms of the magnitude of the estimated regression coefficients, but also in terms of the statistical significance. Strikingly, many countries differ largely with respect to the sample size (as indicated by the number of grid cells), as well as the number of foreign aid projects in the country (as indicated by the number of treated grid cells).

[12] We do not overemphasize the I^2 statistic, as it has been criticized for its sensitivity to the sample size of the studies included in the meta-regression (Rücker et al., 2008), however, its proximity to 100% is a strong indication of substantial heterogeneity in the impact of foreign aid on grid cell economic activity across countries.

For example, Figure 5 shows that while Somalia has a relatively large number of grid cells, only one of them is treated with a foreign aid project in our sample. As a consequence, the estimated regression coefficient is significantly positive and almost ten times as large as the overall effect for Africa. The regression coefficient would correspond to an increase of grid cell night-time light activity by about $(\exp(0.070) - 1) \approx 7.25$ percent. However, one explanation for the large effect size is the small number of treated grid cell-years in Somalia $(19/6061 \approx 0.31$ percent). Equatorial Guinea, on the other hand, has a relatively small number of grid cells and also just one single treated grid cell. Nevertheless, the estimated regression coefficient is significantly negative, with a magnitude of almost fifteen times of the overall effect for Africa. This would correspond to a decrease of grid cell light activity by about $(\exp(-0.107) - 1) \approx 10.15$ percent. These two contrasting examples illustrate that the apparent outliers in the forest plots are not necessarily implausible, but rather reflect the heterogeneity of the aid effect across countries, as the effect sizes still fall within a credible range.

Third and last, despite the observed heterogeneity across countries, the pooled estimates for the four regions indicate that the overall meta-regression coefficients are positive and statistically significant. Furthermore, they are of similar effect magnitudes, with the exception of Europe, where the estimated coefficient is notably larger, approximately by a factor of two. Nonetheless, it is noteworthy that the overall coefficients differ notably from the pooled estimates obtained from the DID results in the prior analysis. The overall coefficients from the meta-regression suggest that, for example for Africa, the implementation of an additional foreign aid project would, on average, result in an increase of grid cell night-time light activity by about $(\exp(0.007) - 1) \approx 0.70$ percent. Reassuringly, these effects are fairly close to the overall effect of about 0.51 percent estimated in column (6) of Table A1.

We conclude that the impact of foreign aid on grid cell economic activity varies substantially across countries, with some countries experiencing positive effects, while others experience negative effects. The observed heterogeneity in the impact of foreign aid on grid cell economic activity across countries is likely driven by a multitude of factors, such as the type of foreign aid projects, the sectoral composition of the foreign aid projects within countries, or the recipient country's institutional and economic environment. These circumstances are important to consider when evaluating the effectiveness of foreign aid projects in different countries. In the following, we investigate the heterogeneity of the aid effect across different sectors of foreign aid projects.[13]

3.3 Heterogeneity across Foreign Aid Sectors

In Table A2, we show regression results from estimating our main specification (1) for different sectors of foreign aid projects, in order to examine sectoral heterogeneity in the impact of foreign aid on grid cell economic activity. The obtained estimates are based on our preferred model specification in column (6) of Table A1 and include the same set of control variables and fixed effects, respectively.

In columns (1) to (9), we show the results for different sectors of foreign aid projects, where we group the remaining sectors into a single category labeled as *Other Foreign Aid Sectors*. Interestingly, we find that

[13] We leave a detailed analysis of other potential drivers of heterogeneity for future research as it is beyond the scope of this paper.

the estimated regression coefficients for sectors display a wide range of magnitudes and statistical significance levels. Individually, we find significant positive effects for the sectors *Health* (Column 2), *Economic Infrastructure and Services* (6), *Production Sectors* (7), and *Multi-Sector/Cross-Cutting* (9). In contrast, we find no statistically significant DID effects for the sectors *Education* (1), *Water Supply and Sanitation* (3), *Other Social Infrastructure and Services* (5), and *Industry, Mining, and Construction* (8). It is important to note that the estimated regression coefficients for *Other Foreign Aid Sectors* are all statistically significant at conventional significance levels and approximately half the size of the baseline result for any type of aid, as shown in column (6) of Table A1. Not accounting for these projects in the other foreign aid sectors entails biased estimates of the sector-specific effects due to the correlation of foreign aid projects across sectors, for example, due to the implementation of multi-sector projects or donor coordination (Nunnenkamp et al., 2016).

In column (10), we include all different types of foreign aid projects at once, rendering the inclusion of the *Other Foreign Aid Sectors* category obsolete. In this horse-race specification, the estimated regression coefficients for the sectors *Health*, *Economic Infrastructure and Services*, *Production Sectors*, and *Multi-Sector/Cross-Cutting* remain statistically significant and positive in magnitude, indicating that these sectors consistently and positively contribute to grid cell economic activity. Interestingly, the significant effects are primarily found in sectors that are likely to have a more direct and immediate impact on grid cell economic activity. Additionally, the coefficient for the *Education* sector, which was previously statistically not significant, has now become significant and positive. This change suggests that the impact of the *Education* sector is more pronounced in this specification, aligning it with the other key sectors that positively influence grid cell economic activity. From this specification, we conclude that aid effectiveness in the *Education* sector is likely conditional on the presence of other foreign aid projects in the grid cell. In contrast, the sectors for which we find no significant effects are the ones for which a more indirect and long-term impact on grid cell economic activity is expected.

Overall, the lessons learned from this DID analysis shows that the effect of foreign aid on economic activity within grid cells differs depending on the sector of the foreign aid projects. The results suggest that the allocation of foreign aid projects entails increased grid cell economic activity in some of the main sectors, while no significant effects are found for others. Intuitively, the sectors *Economic Infrastructure and Services*, *Production Sectors*, and *Multi-Sector/Cross-Cutting* are likely to have a more direct and immediate impact on grid cell economic activity, whereas, especially *Government and Civil Society* and *Other Social Infrastructure and Services* might have a more indirect and long-term impact on grid cell economic activity. Therefore, these results align with the existing literature on the effectiveness of foreign aid projects in different sectors (Clemens et al., 2012; Dreher and Lohmann, 2015).

3.4 Event Study Results

Methodological Framework for Event Study Analysis. We complement our empirical analysis with event study plots based on a dynamic specification of equation (1) that contains leads and lags of the treatment status variable relative to treatment timing. Thus we consider the following event study specification:

$$\ln(Light_{gt}) = \alpha + \sum_{j=-2}^{-J} \beta_j \left(D_{gt}^{j} \times s_{gt}^{j} \right) + \sum_{k=0}^{K} \gamma_k \left(D_{gt}^{j} \times s_{gt}^{j} \right) + X_{gt}'\Gamma + \lambda_g + \lambda_{c(g)t} + \varepsilon_{gt}. \tag{2}$$

In equation (2), the lead terms D_{gt}^{j} for $j \in \{-2, \ldots, -(J-1)\}$ are binary variables for the pre-treatment periods, indicating for a particular grid cell g at time t that the foreign aid project is exactly j periods away. Similarly, for the post-treatment period, the lag terms D_{gt}^{k} for $k \in \{0, \ldots, K-1\}$ are binary variables, indicating that the foreign aid project (i.e., event) has been passed exactly k periods relative to the foreign aid event date.

We multiply these leads and lags variables with a treatment intensity indicator s_{gt}^{j} that reflects the number (i.e., intensity) of foreign aid projects in a given grid cell and year. Therefore, the estimated magnitudes of the lead and lag coefficients, β_j and γ_k, reflect the impact of foreign aid events on economic activity within a grid cell, contingent upon the intensity of foreign aid projects in that grid cell and year.

Note that we exclude the first lead D_{gt}^{-1} from the event study specification. Thus, we set the β_{-1} coefficient equal to zero in the year prior to the foreign aid event. Thus, the estimated leads and lags regression coefficients should be interpreted relative to this normalization. In the standard event study specification, J and K refer to binned endpoints that accumulate leads and lags effects outside the event window.

Our motivation for estimating the event study specification in (2) are twofold: First, we are interested in dynamic treatment effects γ_k of foreign aid projects in the post-treatment period of treated grid cells relative to non-treated grid cells. Second, the pre-treatment parameters β_j either capture anticipation effects of foreign aid projects close to the event date or provide a formal test for parallel pre-treatment trends that might pose a threat to our DID identification strategy.[14]

Overall Impact of Foreign Aid Projects on Economic Activity. In Figure 3, we show the event study plot from estimating equation (2) for the arrival of any foreign aid project. We include $J = 7$ leads for the pre-treatment and $K = 10$ lags for the post-treatment period in order to examine dynamic treatment effects relative to the reference period. We do not observe any pronounced pre-treatment dynamics in lights activity before the start of any foreign aid project, but a positive and statistically significant effect on grid cell lights activity at the year where the foreign aid project were implemented. Hence, we provide evidence that our DID identification strategy is valid, as the parallel trends assumption is not violated in the pre-treatment period. The estimated effects remain positive and statistically significant over time and gains additional dynamics seven years after the start of the foreign aid project. Overall, we find that the implementation of any type of foreign aid project not only has a positive impact on grid cell economic activity, but, more interestingly, that the estimated effects persists over time and even gains momentum in the long run. The effect is strongest in the tenth year and beyond after the start of the foreign aid project, where the estimated effect is about 0.006, so it corresponds to a

[14] We do not consider statistically significant pre-treatment effects close to the event date as a violation of the parallel trends assumption, but rather as an indication of possible anticipation effects of foreign aid projects during the pre-implementation phase.

persistent long-run increase of grid cell light activity by about $(\exp(0.006)-1) \approx 0.60$ percent after ten years and beyond in response to the implementation of a single foreign aid project.

Impact of Foreign Aid Projects Across Different Sectors. In the following, we estimate the event study specification in equation (2) for each sector of foreign aid projects separately, again with $J = 7$ leads for the pre-treatment and $K = 10$ lags for the post-treatment period. The event study plots shown in Figure 4 provide insights into the dynamic treatment effects of foreign aid projects in the nine different broad sectors on grid cell economic activity. Throughout all model specifications, we control for the presence of foreign aid projects in the remaining sectors. Thus, the interpretation of the estimated effects is conditional on the presence of foreign aid projects in the remaining sectors in the same grid cell.

Unlike the event study plot for the overall foreign aid measure, the results at the sector-specific level exhibit greater heterogeneity. For instance, the event study plot for the *Education* sector reveals no significant change in grid cell economic activity during the first nine years following the initiation of foreign aid projects. It is only after ten years and beyond that we observe a positive and statistically significant effect on grid cell economic activity. In contrast, the event study plot for the *Health* sector reveals positive and predominantly statistically significant effects on grid cell economic activity during the second to sixth years following the commencement of the project. Furthermore, we observe a continued positive and statistically significant impact on grid cell economic activity from the tenth year onward, indicating a long-term effect of foreign aid projects in the health sector. We interpret this finding as evidence that improved health outcomes (e.g., lower disease burden) is beneficial for economic activity in the long run, due to, for example an increased labor productivity. The event study plot for the sector *Water Supply and Sanitation* shows positive and statistically significant effects on grid cell economic activity directly from the start of the project, which persist, with decreasing magnitude, until nine years after the start of the project. A similar, but even more short-term pattern is observed for aid projects earmarked for the sector *Economic Infrastructure and Services*. Here, the initially positive and statistically significant effects on grid cell economic activity fades out after the fourth year, indicating that its impact on economic activity is only short-lived and transitory. In contrast, we find a positive and statistically significant effect on grid cell economic activity for the *Production Sectors*, but only starting from the fifth year after the project initiation. Interpreting these projects as more complex and long-term endeavors aligns with our expectations. For instance, the establishment of a new factory or the development of a new industry sector may require time before a noticeable impact on grid cell economic activity becomes evident. Moreover, knowledge about crop-specific production techniques or the development of new technologies may need time to diffuse and be adopted by local populations (Conley and Udry, 2010). For the sectors *Government and Civil Society* and *Other Social Infrastructure and Services*, we predominantly observe statistically no significant effects on grid cell economic activity during the period following project initiation. However, for the *Government and Civil Society* sector, we identify a positive and statistically significant effect on grid cell economic activity beginning in the tenth year after the project's commencement. This finding further supports the notion of a long-term impact of foreign aid projects in these sectors. In contrast to our earlier findings presented in Table A2, projects within the *Multi-Sector/Cross-Cutting* category demonstrate no statistically significant impact on grid cell economic activity during the event window. Additionally, the event study plot for the sector *Industry, Mining, and Construction* reveals an intriguing and unexpected pattern. The results indicate that the implementation of foreign aid projects in this sector has a negative and statistically significant effect on grid cell economic activity during the first nine years following project initiation. This could be attributed to potential disruptions caused by project activities, such as land acquisition, construction delays, or resettlement of local populations[15], which may initially hinder economic activity before any positive effects materialize. However, it is also possible that the negative effects are due to the nature of the projects themselves, such as the extraction of natural resources, which may have negative environmental and social consequences (e.g., civil conflicts, predation, or corruption) if not well managed or supervised (Moscona, 2024).

Overall, the event study results highlight that the effects of foreign aid projects on grid cell economic activity differ remarkably across various sectors. We observe that some sectors experience immediate and short-lived effects, while others show delayed and enduring impacts. These dynamics are crucial for assessing the effectiveness of foreign aid projects across different sectors and may be obscured when employing static model specifications or aggregate measures of foreign aid.

4 Discussion of Main Findings

The results of our empirical analysis show that foreign aid still exert a positive impact on local (i.e, grid cell) economic development. This finding is in line with the results of previous studies that have examined the impact of foreign aid at the sub-national level (Bitzer and Gören, 2024; Dreher et al., 2015; Greßer and Stadelmann, 2020; Isaksson and Kotsadam, 2018). We extend these findings by showing that the positive impact of foreign aid on local economic development is robust to the use of DID and event study style regressions, respectively.

In addition, our DID analysis of the heterogeneous impact of foreign aid on local economic development reveals that there is substantial heterogeneity in direction, magnitude, and significance of the estimated coefficients across the 133 countries in our sample. The estimated effects of an additional aid project on local economic development ranges from -10% for Equatorial Guinea up to +37.03% for Saudi Arabia. Thus, a part of the unexplained heterogeneity found in meta studies such as in Doucouliagos and Paldam (2008, 2011) or Mekasha and Tarp (2013, 2019) can most likely be attributed to the composition of the country sample. However, more research is needed why the regression results differ so much across countries. An obvious avenue for further research is the composition of aid projects in the different countries, as the aid in different sectors may have different effects on local economic development and may also affect local economic development with a time lag. Some exploratory steps in this direction are already taken in this paper.

Foreign aid projects differ substantially in their impact on local economic development across sectors (see Figure 2). We also show that the sectoral compostion of foreign aid projects differs substantially across countries (see Figures 9 to 12). Regarding the different impacts of foreign aid projects in different sectors on local

[15] Not surprisingly, Croft (1978) have already shown that satellite night-time light imagery can be used to detect large settlement areas (e.g., major U.S. cities) and potential changes over time, respectively.

economic development, our DID estimates are in line with studies that examine the impact of aid in single or a few sectors (Atitianti et al., 2024; Haldar and Sethi, 2022; Kaya et al., 2012; Maruta et al., 2020). Like these, we find substantial differences in the size and significance of the estimated coefficients across sectors. In contrast to these studies, we estimate the impact of foreign aid in all different sectors in one single model specification. This allows us to compare the size of the impact across sectors. The results show that among the types of aid that have a significant impact on local economic development, the impact of the most effective type of foreign aid (*Multi-Sector/Cross-Cutting*) is about 6.7 times larger than the impact of the least effective type of foreign aid (*Health*). Now, taking into account the different number of projects in these two sectors (see Figure 2) and the very uneven distribution of these two sectors across countries (see Figures 10 and 12), further investigation of the differences in the impact of aid in different sectors and its distribution across countries is needed to better understand the heterogeneity found in different studies on the impact of foreign aid on local economic development. Furthermore, as we have also shown that other foreign aid projects in the same grid cell have a significant impact on local economic development, it is highly likely that there are complementarities between different foreign aid projects. However, this has to be left to further research as it is beyond the scope of this paper.

Finally, our event study style regressions of the impact of different types of aid projects on local economic development reveals strong heterogeneity in the lag structure with which the impact of aid projects materialises. While we find a positive and significant effect of any foreign aid projects on local economic development from the year of the project start until 10 years after the project implementation (see Figure 3), the event study analysis for the different types of foreign aid reveal a completely different picture. Some sectors (*Water Supply and Sanitation*, *Government and Civil Society*, *Economic Infrastructure and Services*) show immediate effects, while others (*Health*, *Production Sectors*, *Industry, Mining, Construction*) are affected only after a delay (see Figure 4). Moreover, aid projects classified as *Industry, Mining, Construction* are characterised by a trajectory of effects that shows a negative impact in the first nine years after the start of the project. Our findings that the impact of foreign aid projects on local economic development is dynamic and varies over time are in line with the results of Dreher et al. (2021b) for Chinese foreign aid.

Furthermore, our event study results can be discussed in the light of the a priori definition of aid projects into early- and late-impact sectors by Clemens et al. (2012) and Dreher and Lohmann (2015). Although their a priori categories are not fully congruent with the World Bank foreign aid classifications, some insights can still be drawn. For example, our results for the sectors *Education* and *Health* are consistent with the a priori categorisation as late-impact sectors. However, our results show that the effect of foreign aid projects in *Water Supply and Sanitation* is immediate and lasts for nine years after implementation, while Dreher and Lohmann (2015) classifies this sector as an late-impact sector. As our result on the timely impact of foreign aid projects in *Water Supply and Sanitation* is somewhat surprising, it highlights the importance of further research on the timing of the effect of different types of foreign aid projects.

In addition to the findings on the different timing of the effect of foreign aid projects, the results of the event study analysis also show that the magnitude of the effect of foreign aid projects on local economic development varies over time. For example, while foreign aid projects in *Production Sectors* show an increasing effect with the passage of time since the implementation of a project, the effect of foreign aid projects in *Water Supply and Sanitation* shows a slightly decreasing effect over time (see Figure 4). Foreign aid in the sector *Industry, Mining, Construction* again shows a negative effect which increases in absolute value until the fourth year after the start of the project and then decreases in absolute value again, even becoming positive in the last year, although the last coefficient is not statistically significant at conventional significance levels (see Figure 4).

Overall, we have been able to provide evidence on the dimension of heterogeneity in the impact of foreign aid on local economic development across countries, sectors, and time. This heterogeneity is most likely a part of the explanation for the mixed results found in the literature on the impact of foreign aid on local economic development. However, further research is needed to link the findings on the different dimensions of heterogeneity.

5 Conclusion

This paper has examined the heterogeneity in the effects of foreign aid on local economic development, focusing on variations across countries, sectors, and temporal dimensions.

To analyze the heterogeneity in the effects of foreign aid across countries, we conducted difference-in-differences (DID) regressions at the grid-cell level for each of the 133 countries in our sample. The resulting estimates were then synthesized using a meta-analysis framework, employing a random-effects restricted maximum likelihood (REML) estimation. Our findings reveal considerable heterogeneity in the direction, magnitude, and statistical significance of the estimated coefficients across countries. The impact of an additional foreign aid project varies widely, ranging from a significant reduction of -10% in outcomes for Equatorial Guinea to an increase of 37% in Saudi Arabia.

In our DID analysis examining the heterogeneity of foreign aid effects across the nine World Bank sector categories, we identified significant positive impacts on local economic development in five sectors: *Education*, *Health*, *Economic Infrastructure and Services*, *Productions Sectors*, and *Multi-Sector/Cross-Cutting*. Among these, the most effective sector, *Multi-Sector/Cross-Cutting* demonstrated an impact approximately 6.7 times greater than that of the least effective sector with significant results, *Health*. The effects for the remaining four sectors were not statistically significant.

Finally, our event-study analysis investigating the timing of the impact of various types of aid projects on local economic development highlights substantial heterogeneity in the lag structure through which aid impacts materialize. For aggregated aid projects, we observe a significant positive effect on local economic development starting from the year of project initiation and persisting up to 10 years post-implementation. However, when disaggregated by sector, the timing of impacts varies considerably. For instance, projects in *Water Supply and Sanitation* exhibit statistically significant immediate effects, while those in *Production Sectors* display a delayed impact. Moreover, we find notable heterogeneity in the direction and magnitude of effects across sectors over time. Some sectors demonstrate an increasing impact, others a decreasing trend, and a few exhibit a quadratic evolution of effects. Although the sign of significant effects remains consistent within sectors over time, we observe both positive and negative impacts across different sectors. Importantly, only two sectors show a significant negative effect overall.

In conclusion, our analysis reveals substantial heterogeneity in the effects of foreign aid on local economic development across countries, sectors, and time. Future research should focus on uncovering the underlying drivers of this variability, which could provide valuable insights into the interconnected dimensions of heterogeneity and inform more effective aid allocation strategies.

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Appendix

A Regression Tables

Table A1: Differences-in-Differences Estimates of Foreign Aid on Lights Activity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Foreign Aid Treatment Variable						
	Treatment Status					Project Counts	Aid Disbursements
	No Controls	Grid Cell FE	Climatic Controls	Socioeconomic Controls	Country-by-Year FE	Country-by-Year FE	Country-by-Year FE
	Dependent Variable: Log of Satellite-measured Night-Time Light Activity						
Foreign Aid	0.1120***	0.0807***	0.0633***	0.0586***	0.0199***	0.0051***	0.0022***
	(0.0080)	(0.0015)	(0.0040)	(0.0052)	(0.0014)	(0.0006)	(0.0003)
Number of Cells	60,677	60,677	60,677	60,677	60,677	60,677	60,677
Number of Treated Cells	8,847	8,847	8,847	8,847	8847	8,847	4,180
Mean of Dependent Variable	9.609	9.609	9.609	9.609	9.609	9.609	9.609
Observations	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633
Adjusted $R-squared$	0.004	0.222	0.228	0.230	0.458	0.458	0.458
Grid Cell FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Country $\times$ Year FE	No	No	No	No	Yes	Yes	Yes
Climatic Controls	No	No	Yes	Yes	Yes	Yes	Yes
Socioeconomic Controls	No	No	No	Yes	Yes	Yes	Yes

Notes: If not otherwise stated, the spatial unit of investigation refers to 0.5 decimal degrees latitude $\times$ longitude grid cells. The dependent variable refers to the log of satellite-measured night-time lights activity at the cell-year level. *Foreign Aid* refers to either a dichotomous treatment status variable that increases accordingly by one unit with the initiation of any foreign aid project in a given cell and year (columns 1-5), the count of active projects (6), or the total disbursements (7). *Climatic Controls* include mean of total monthly precipitation (in millimeters per year) and mean annual temperature value (in degrees Celsius). *Socioeconomic Controls* include log of population size, and a conflict incidence indicator. Constant term included but not shown. Clustered standard errors, robust to serial correlation within grid cells and spatial correlation across grid cells by region-year, are reported in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table A2: Differences-in-Differences Estimates of Foreign Aid on Lights Activity – Main Sector Analysis

	(1) Education	(2) Health	(3) Water Supply and Sanitation	(4) Government and Civil Society	(5) Other Social Infrastructure and Services	(6) Economic Infrastructure and Services	(7) Production Sectors	(8) Industry, Mining, and Construction	(9) Multi-Sector/ Cross-Cutting	(10) Full Model
	Dependent Variable: Log of Satellite-measured Night-Time Light Activity									
Education	0.0008									0.0015**
	(0.0009)									(0.0007)
Health		0.0025*								0.0034***
		(0.0013)								(0.0011)
Water Supply and Sanitation			0.0015							0.0012
			(0.0021)							(0.0014)
Government and Civil Society				-0.0005						-0.0015
				(0.0013)						(0.0010)
Other Social Infrastructure and Services					-0.0001					-0.0000
					(0.0022)					(0.0017)
Economic Infrastructure and Services						0.0024**				0.0043***
						(0.0011)				(0.0007)
Production Sectors							0.0039***			0.0050***
							(0.0010)			(0.0010)
Industry, Mining, and Construction								-0.0002		-0.0015
								(0.0019)		(0.0015)
Multi-Sector/Cross-Cutting									0.0105***	0.0103***
									(0.0031)	(0.0031)
Other Foreign Aid Sectors	0.0019***	0.0018***	0.0019***	0.0026***	0.0020***	0.0016***	0.0016***	0.0019***	0.0016***	
	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	
Number of Cells	60,677	60,677	60,677	60,677	60,677	60,677	60,677	60,677	60,677	60,677
Number of Treated Cells	2,604	2,794	4,180	7,067	3,732	6,914	4,433	2,190	943	8,847
Mean of Dependent Variable	9.609	9.609	9.609	9.609	9.609	9.609	9.609	9.609	9.609	9.609
Observations	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633	1,759,633
Adjusted $R-squared$	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458	0.458
Grid Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climatic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: If not otherwise stated, the spatial unit of investigation refers to 0.5 decimal degrees latitude × longitude grid cells. The dependent variable refers to the log of satellite-measured night-time lights activity at the cell-year level. *Foreign Aid* is a count variable that increases accordingly by one unit with the initiation of foreign aid projects in the main sectors *ma = (1) Education, (2) Health, (3) Water Supply and Sanitation, (4) Government and Civil Society, (5) Other Social Infrastructure and Services, (6) Economic Infrastructure and Services, (7) Production Sectors, (8) Industry, Mining, and Construction, (9) Multi-Sector/Cross-Cutting.* in a given cell and year. All regressions include treatment status controls for the presence of foreign aid projects in the remaining main sectors. *Climatic Controls* include mean of total monthly precipitation (in millimeters per year) and mean annual temperature value (in degrees Celsius). *Socioeconomic Controls* include log of population size, and a conflict incidence indicator. Constant term included but not shown. Clustered standard errors, robust to serial correlation within grid cells and spatial correlation across grid cells by region-year, are reported in parentheses. *: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

B Figures

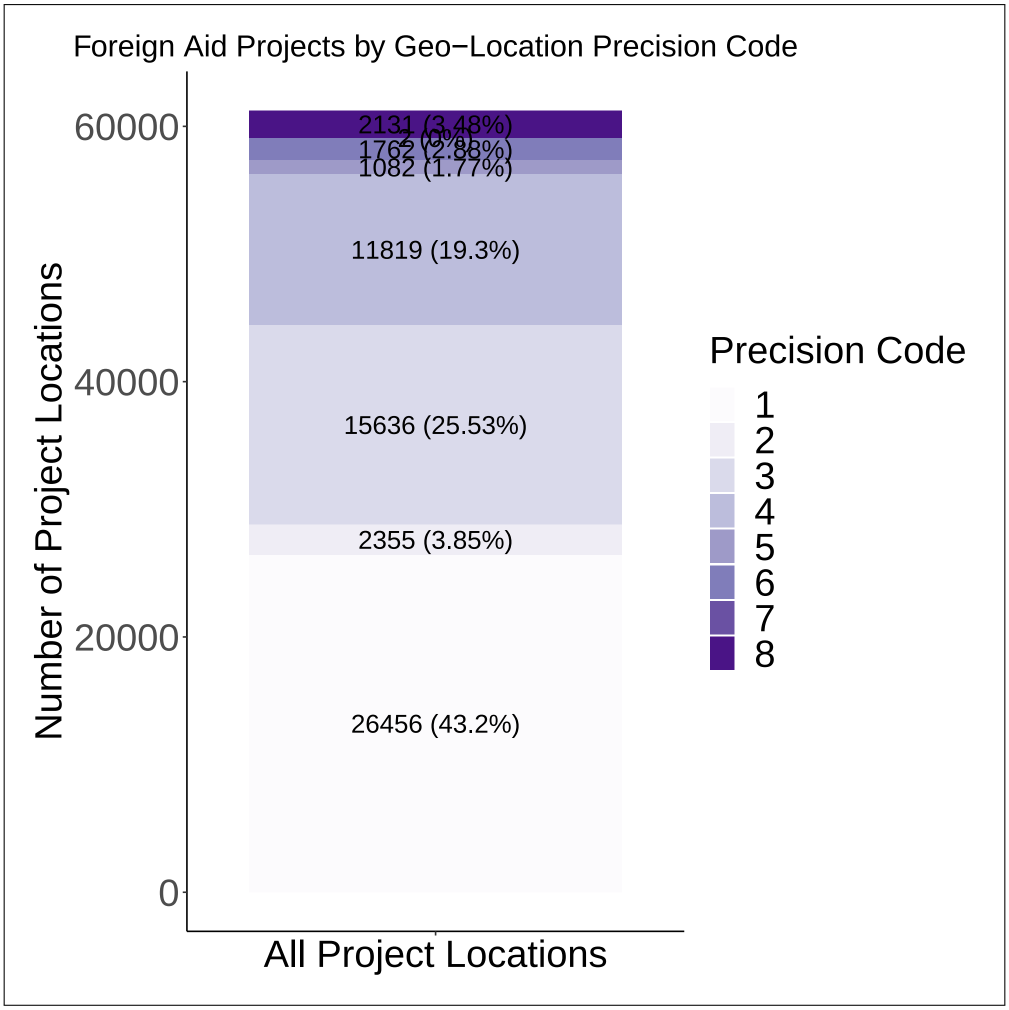

Figure 1: Bar Chart of Foreign Aid Projects by Geo-Location Precision Code

Notes: This figure shows the frequencies of all foreign aid projects by geo-location precision code. The data originate from AidData (2016) and cover the period from 1995 to 2014. The precision codes correspond to the level of detail in the geographic coordinates of the project location, as described in Section 2.1.

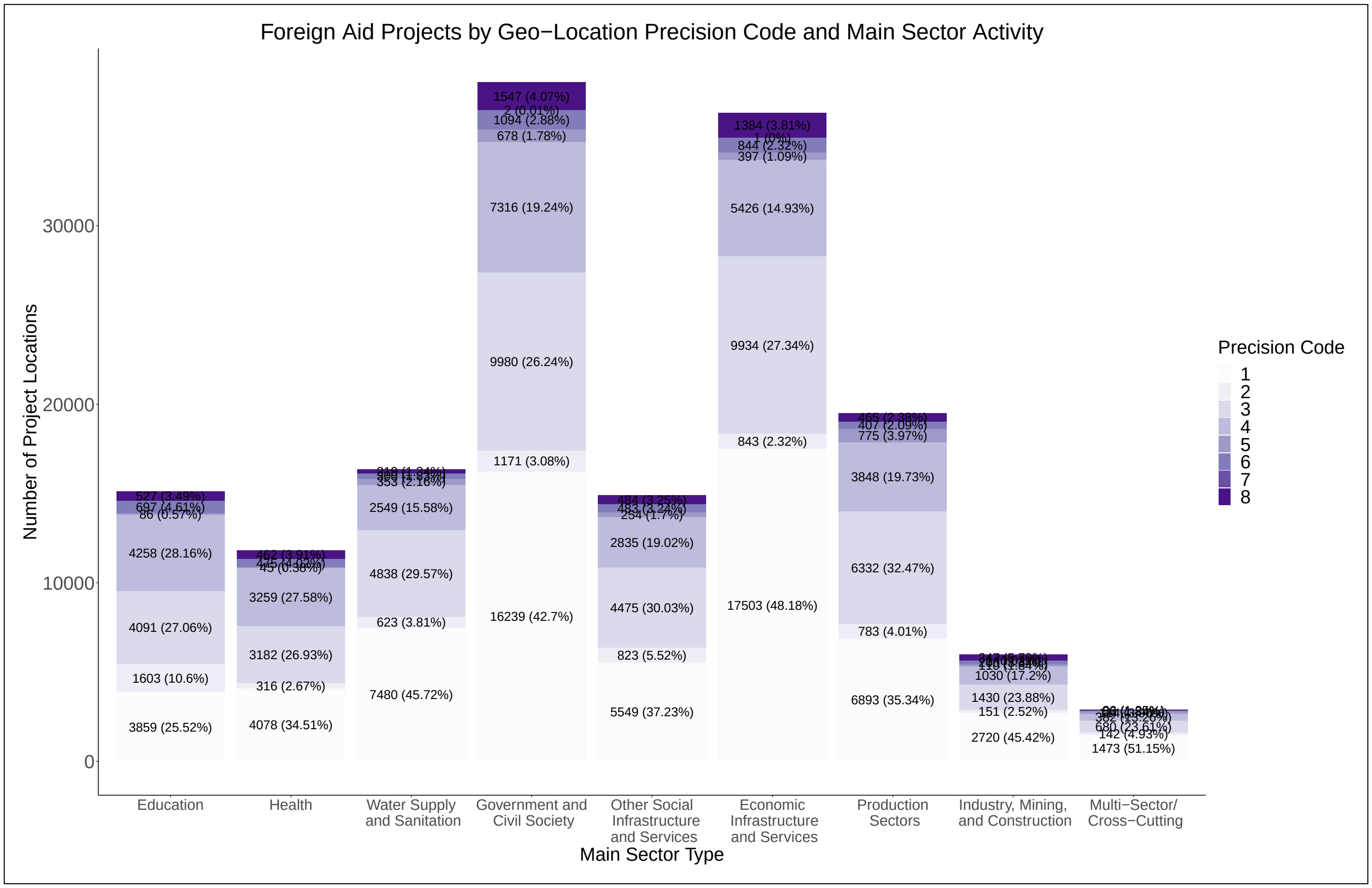

Figure 2: Bar Chart of Foreign Aid Projects by Geo-Location Precision Code and Main Sector Activity

Notes: This figure shows the frequencies of foreign aid projects by main sector activity and geo-location precision code. The data originate from AidData (2016) and cover the period from 1995 to 2014. The precision codes correspond to the level of detail in the geographic coordinates of the project location, as described in Section 2.1.

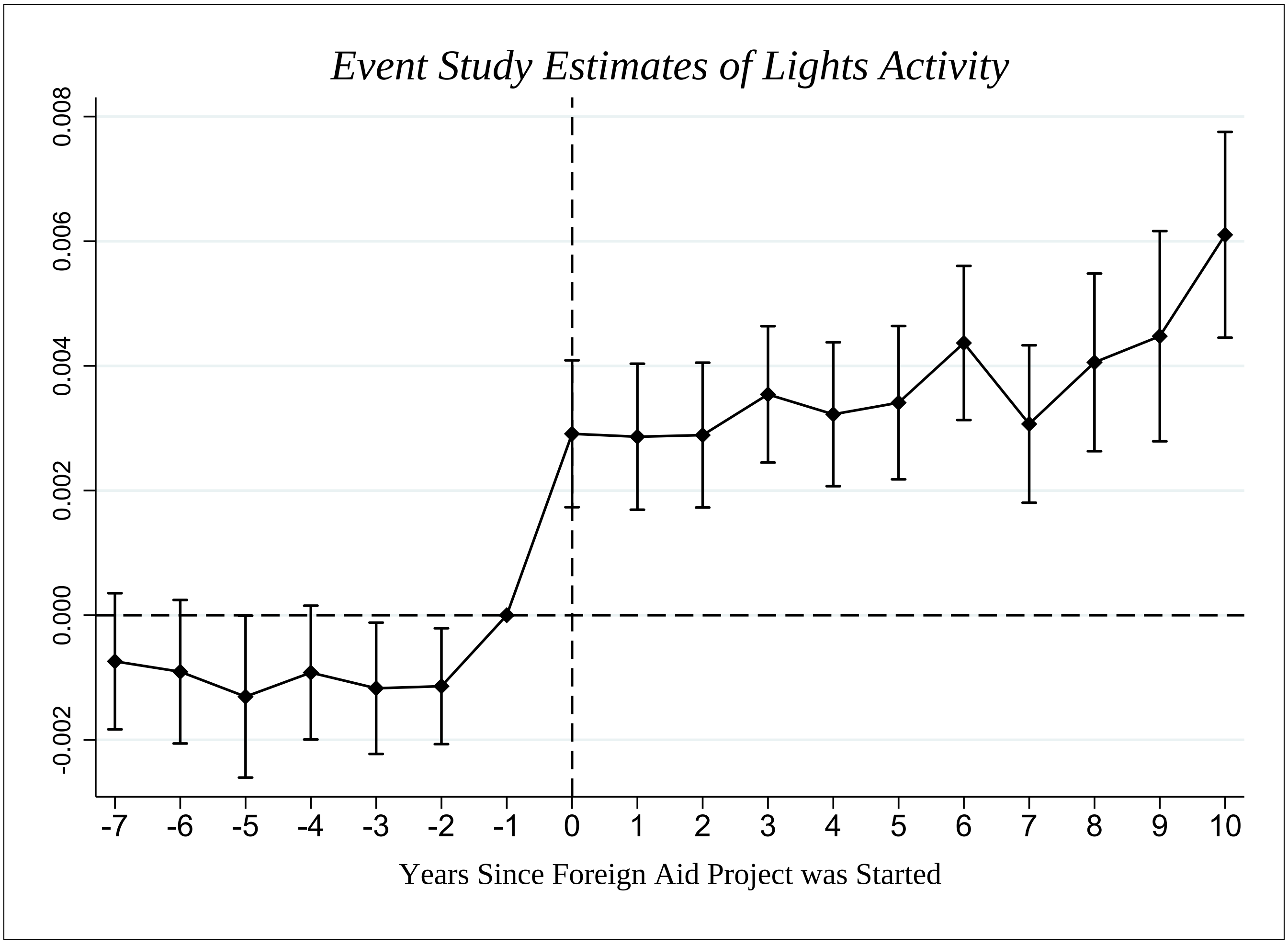

Figure 3: Event Study Estimates of Lights Activity

Notes: This figure plots OLS coefficient estimates and the corresponding 90% confidence intervals from the event study specification in equation (2). The dependent variable is the log of nighttime lights activity in grid cell g and year t. The controls include climate, population, conflict, grid cell and country-year fixed effects. The treatment adoption count variable does account for multiple foreign aid treatments. Binned endpoints, i.e. dynamic treatment effects are assumed to stay constant outside the effect window. The data cover the period from 2000 to 2014. Number of grid-by-year obs.: 909,045.

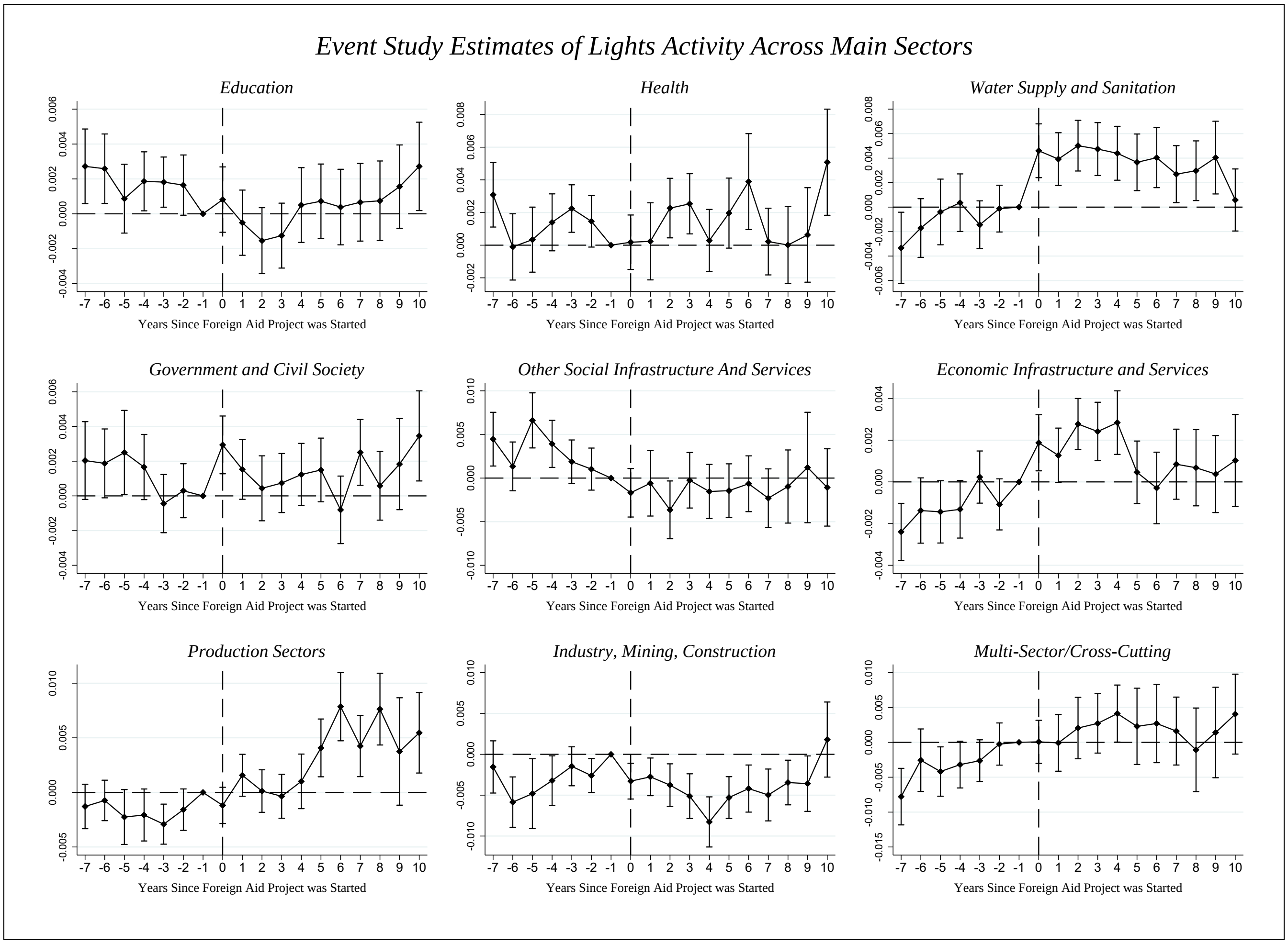

Figure 4: Event Study Estimates of Lights Activity - Main Sector Analysis

Notes: This figure plots OLS coefficient estimates and the corresponding 90% confidence intervals from the event study specification in equation (2) across the main foreign aid sector classifications. The dependent variable is the log of nighttime lights activity in grid cell g and year t. The controls include climate, population, conflict, grid cell and country-year fixed effects. The treatment adoption variable does account for multiple foreign aid treatments. All regressions control for the presence of foreign aid projects in the remaining main sectors. Binned endpoints, i.e. dynamic treatment effects are assumed to stay constant outside the effect window. The data cover the period from 2000 to 2014. Number of grid-by-year obs.: 909,045.

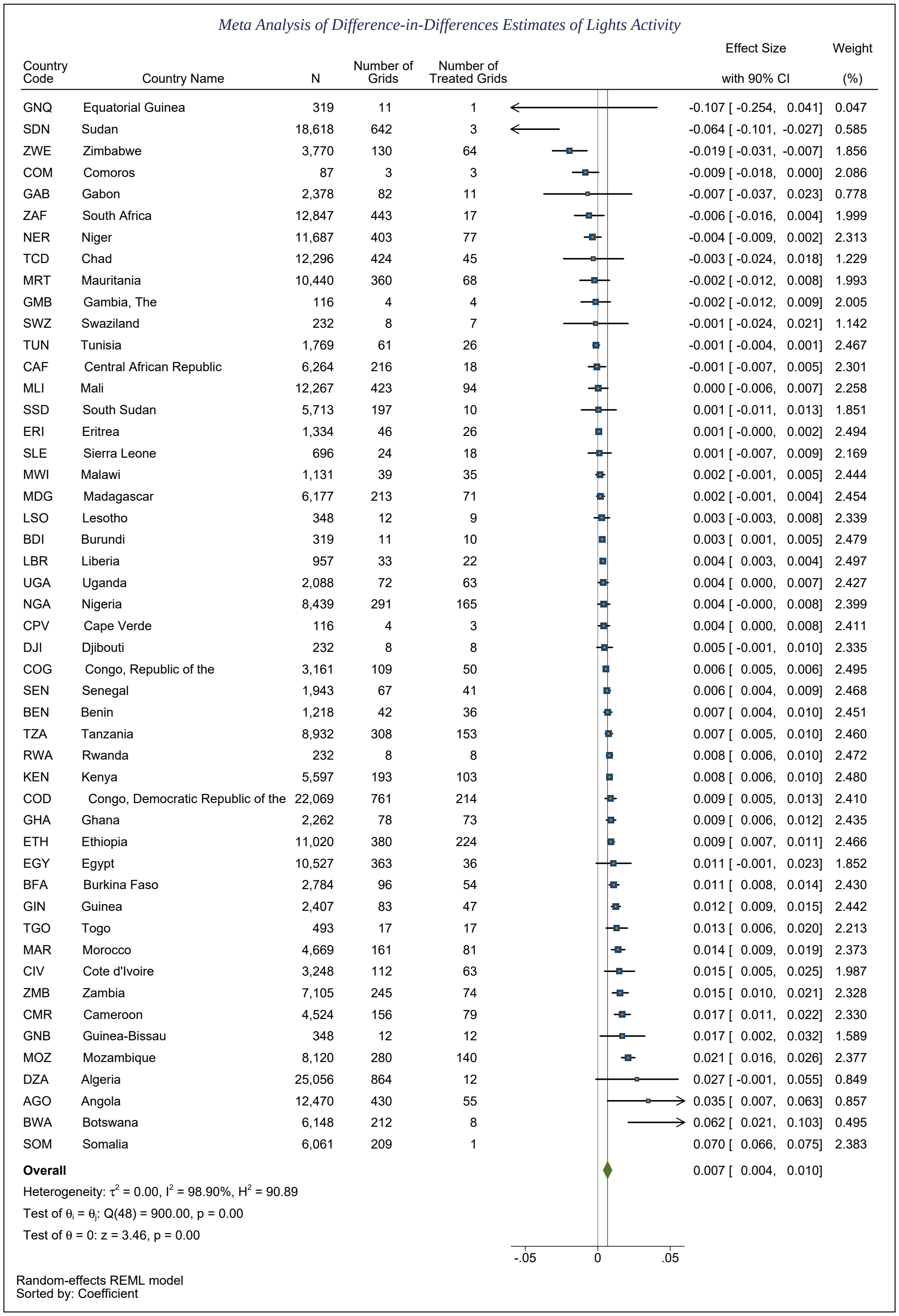

Figure 5: Meta Analysis of Foreign Aid on Lights Activity - Africa

Notes: This figure shows the meta-analysis of the effect of foreign aid on lights activity across countries. The point estimates and corresponding standard errors for each country sample are derived from the DID regression equation (1). The foreign aid measure corresponds to the number of project counts. All regressions include grid cell and country-by-year fixed effects, as well as climate and socioeconomic controls. Standard errors are clustered at the grid cell level. The square boxes correspond to the point estimates. The size of the box corresponds to the associated weight of the study in the calculation of the overall effect, while the whiskers represent the 90% confidence interval, with arrows at the end if truncated. The diamond at the bottom and the red vertical line represent the overall effect, with its center indicating the point estimate and its stretching corresponding to the 90% confidence interval. The point estimates for Botswana, Somalia, Sudan, and Equatorial Guinea lie outside the axis range.

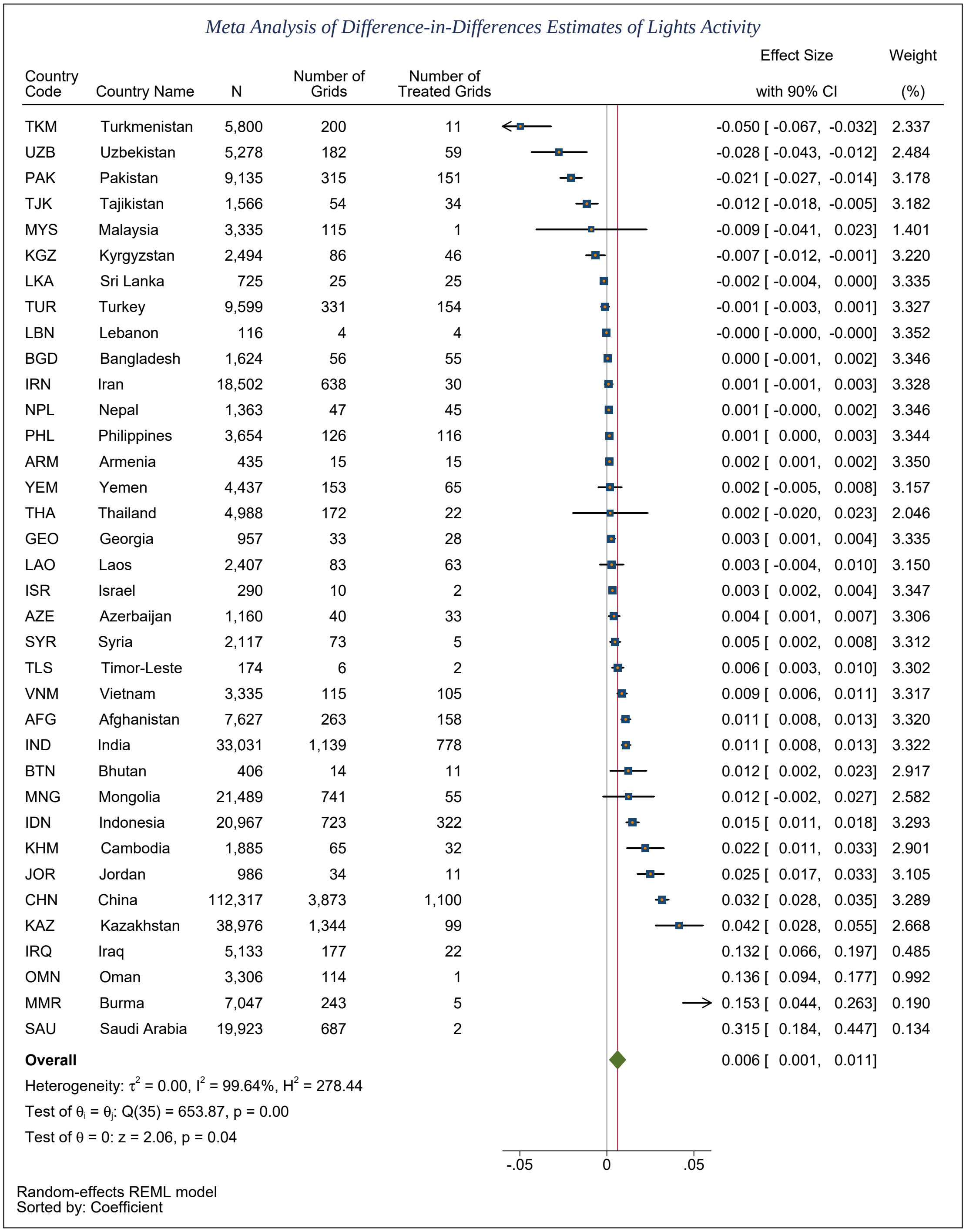

Figure 6: Meta Analysis of Foreign Aid on Lights Activity - Asia

Notes: This figure shows the meta-analysis of the effect of foreign aid on lights activity across countries. The point estimates and corresponding standard errors for each country sample are derived from the DID regression equation (1). The foreign aid measure corresponds to the number of project counts. All regressions include grid cell and country-by-year fixed effects, as well as climate and socioeconomic controls. Standard errors are clustered at the grid cell level. The square boxes correspond to the point estimates. The size of the box corresponds to the associated weight of the study in the calculation of the overall effect, while the whiskers represent the 90% confidence interval, with arrows at the end if truncated. The diamond at the bottom and the red vertical line represent the overall effect, with its center indicating the point estimate and its stretching corresponding to the 90% confidence interval. The point estimates for Oman, Iraq, Burma, and Saudi Arabia lie outside the axis range.

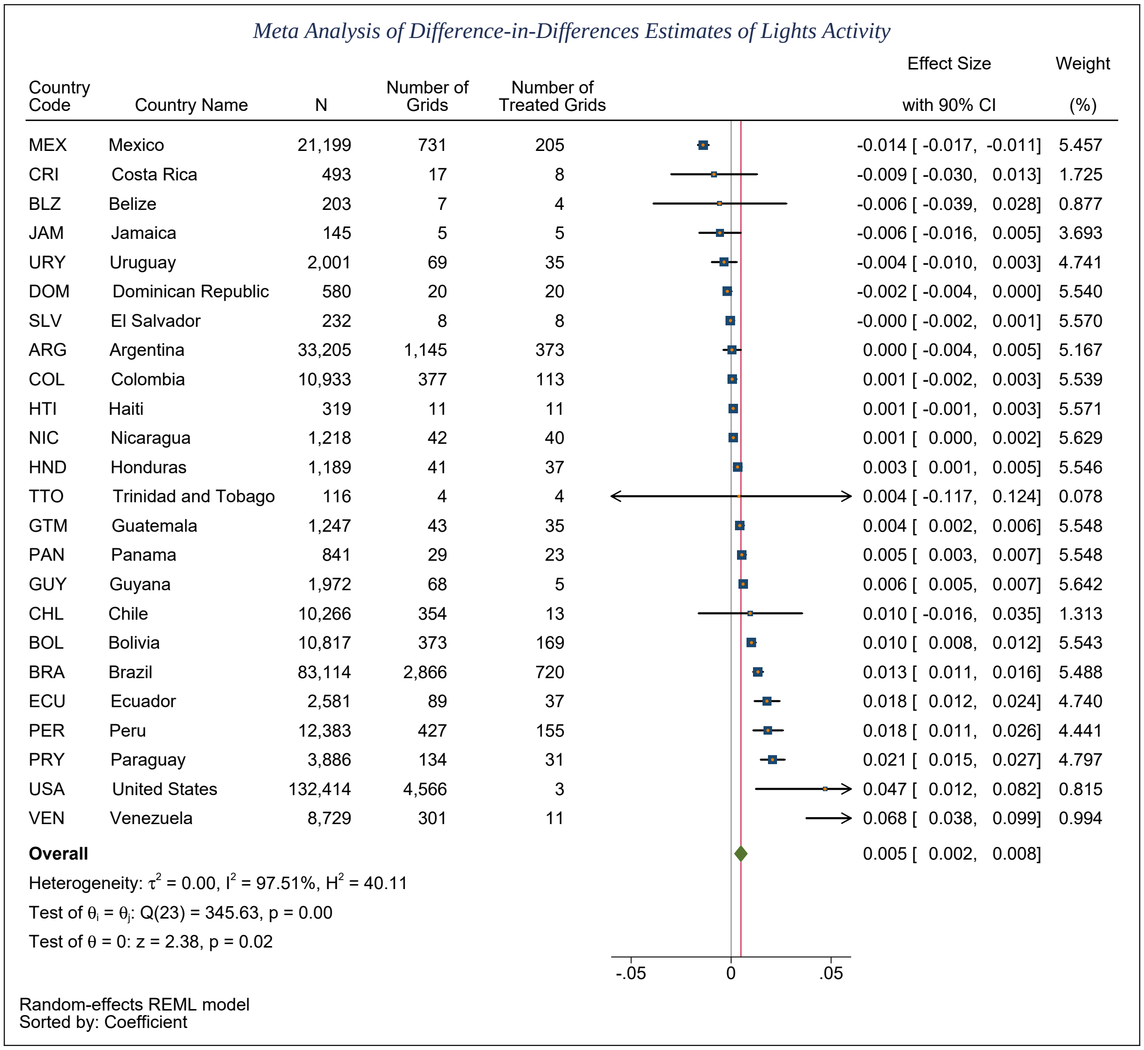

Figure 7: Meta Analysis of Foreign Aid on Lights Activity - Americas

Notes: This figure shows the meta-analysis of the effect of foreign aid on lights activity across countries. The point estimates and corresponding standard errors for each country sample are derived from the DID regression equation (1). The foreign aid measure corresponds to the number of project counts. All regressions include grid cell and country-by-year fixed effects, as well as climate and socioeconomic controls. Standard errors are clustered at the grid cell level. The square boxes correspond to the point estimates. The size of the box corresponds to the associated weight of the study in the calculation of the overall effect, while the whiskers represent the 90% confidence interval, with arrows at the end if truncated. The diamond at the bottom and the red vertical line represent the overall effect, with its center indicating the point estimate and its stretching corresponding to the 90% confidence interval. The point estimates for United States and Venezuela lie outside the axis range.

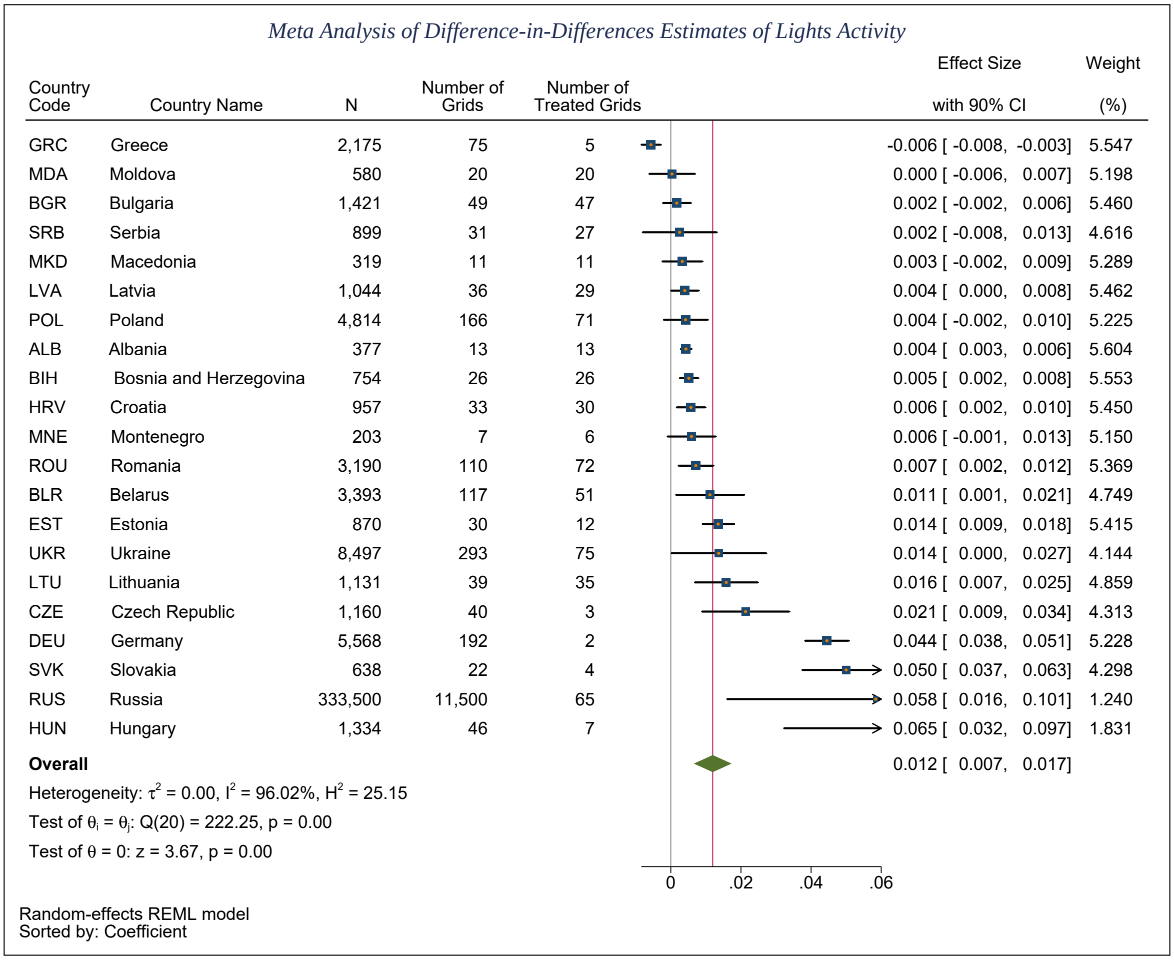

Figure 8: Meta Analysis of Foreign Aid on Lights Activity - Europe

Notes: This figure shows the meta-analysis of the effect of foreign aid on lights activity across countries. The point estimates and corresponding standard errors for each country sample are derived from the DID regression equation (1). The foreign aid measure corresponds to the number of project counts. All regressions include grid cell and country-by-year fixed effects, as well as climate and socioeconomic controls. Standard errors are clustered at the grid cell level. The square boxes correspond to the point estimates. The size of the box corresponds to the associated weight of the study in the calculation of the overall effect, while the whiskers represent the 90% confidence interval, with arrows at the end if truncated. The diamond at the bottom and the red vertical line represent the overall effect, with its center indicating the point estimate and its stretching corresponding to the 90% confidence interval. The point estimates for Russia and Hungary lie outside the axis range.

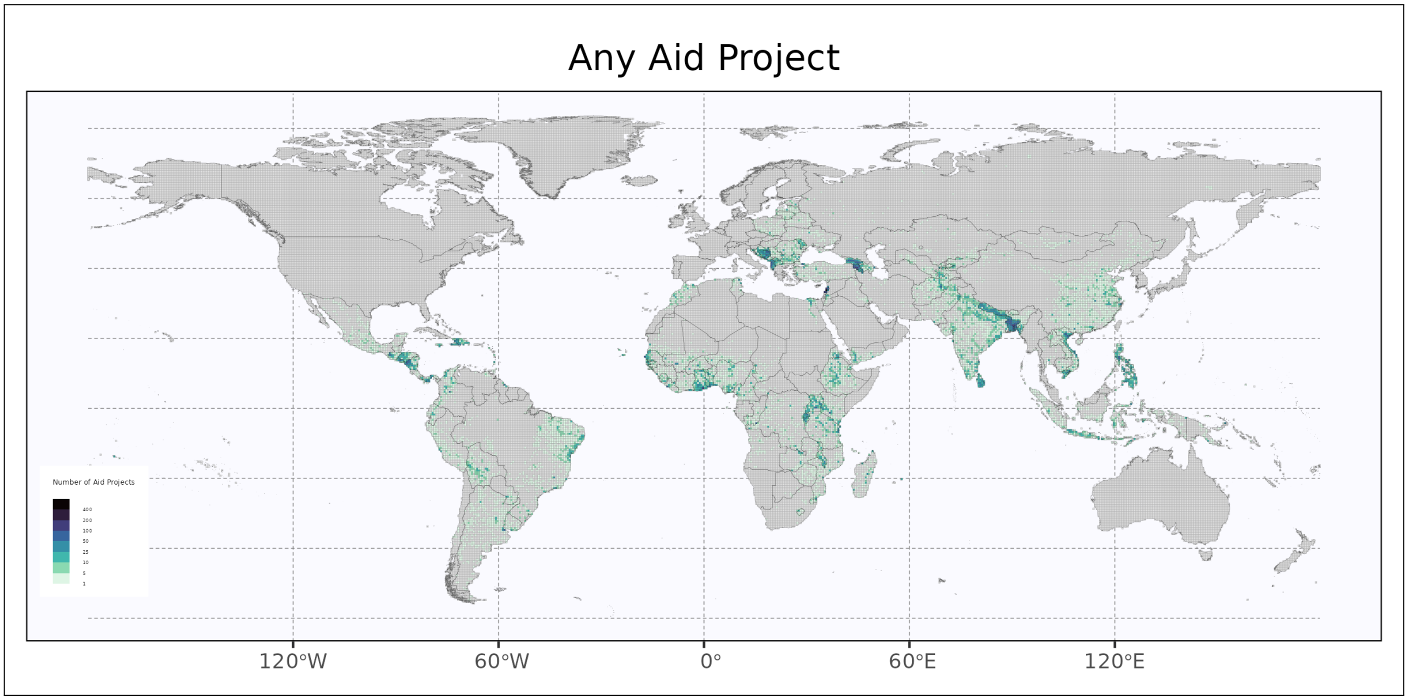

Figure 9: Distribution of Aid Projects Across Grid Cells

Notes: This figure plots the distribution of foreign aid projects (precision code 1, 2, or 3) across grid cells (see Section 2). The color indicates the number of any projects in a given cell. The data originate from AidData (2016) and cover the period from 1995 to 2014.

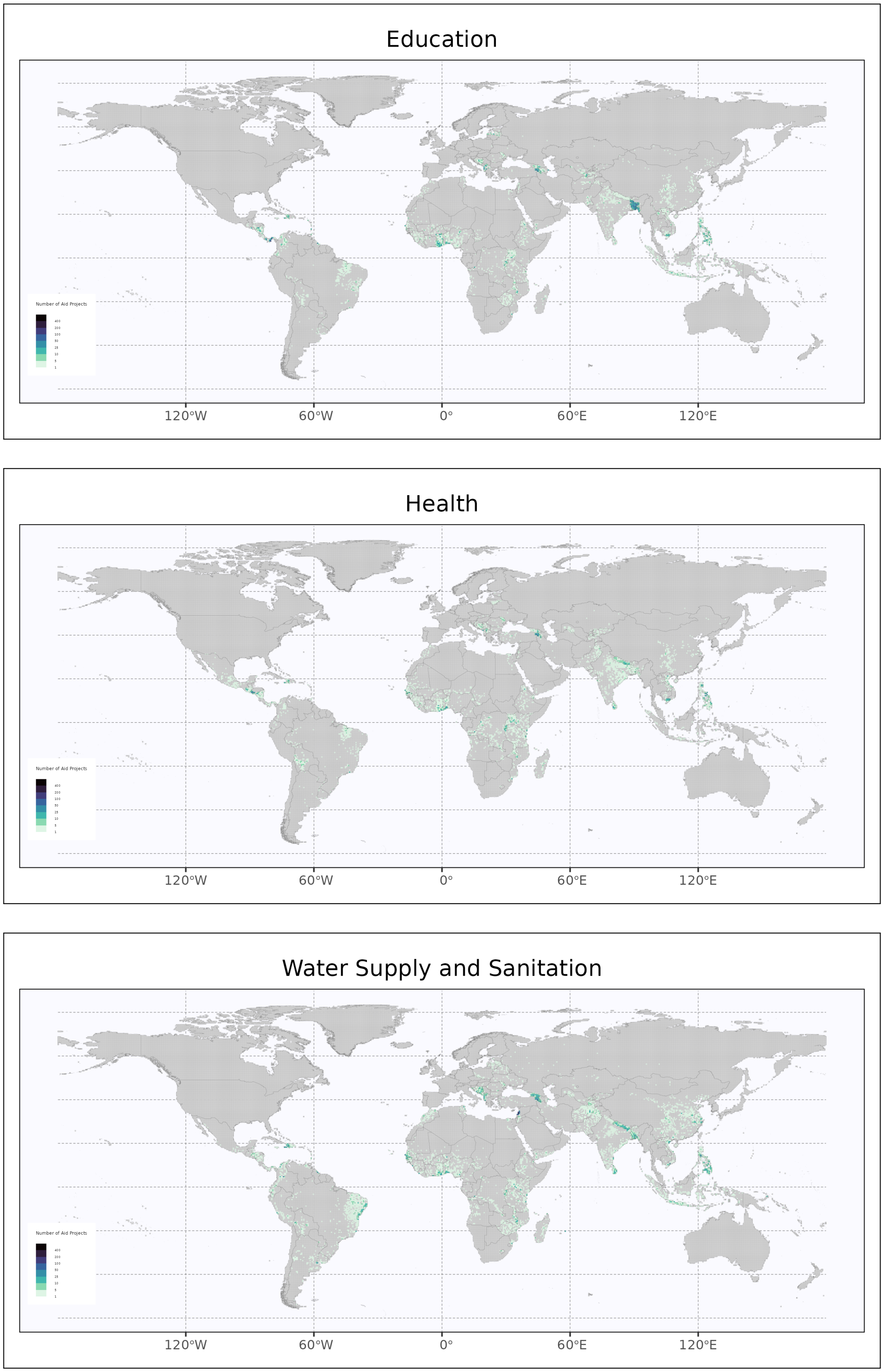

Figure 10: Geographic Distribution of Aid Projects Across Grid Cells and Main Sectors

Notes: This figure plots the distribution of foreign aid projects (precision code 1, 2, or 3) across grid cells (see Section 2). The color indicates the number of projects in the respective sector and in a given cell. The data originate from AidData (2016) and cover the period from 1995 to 2014.

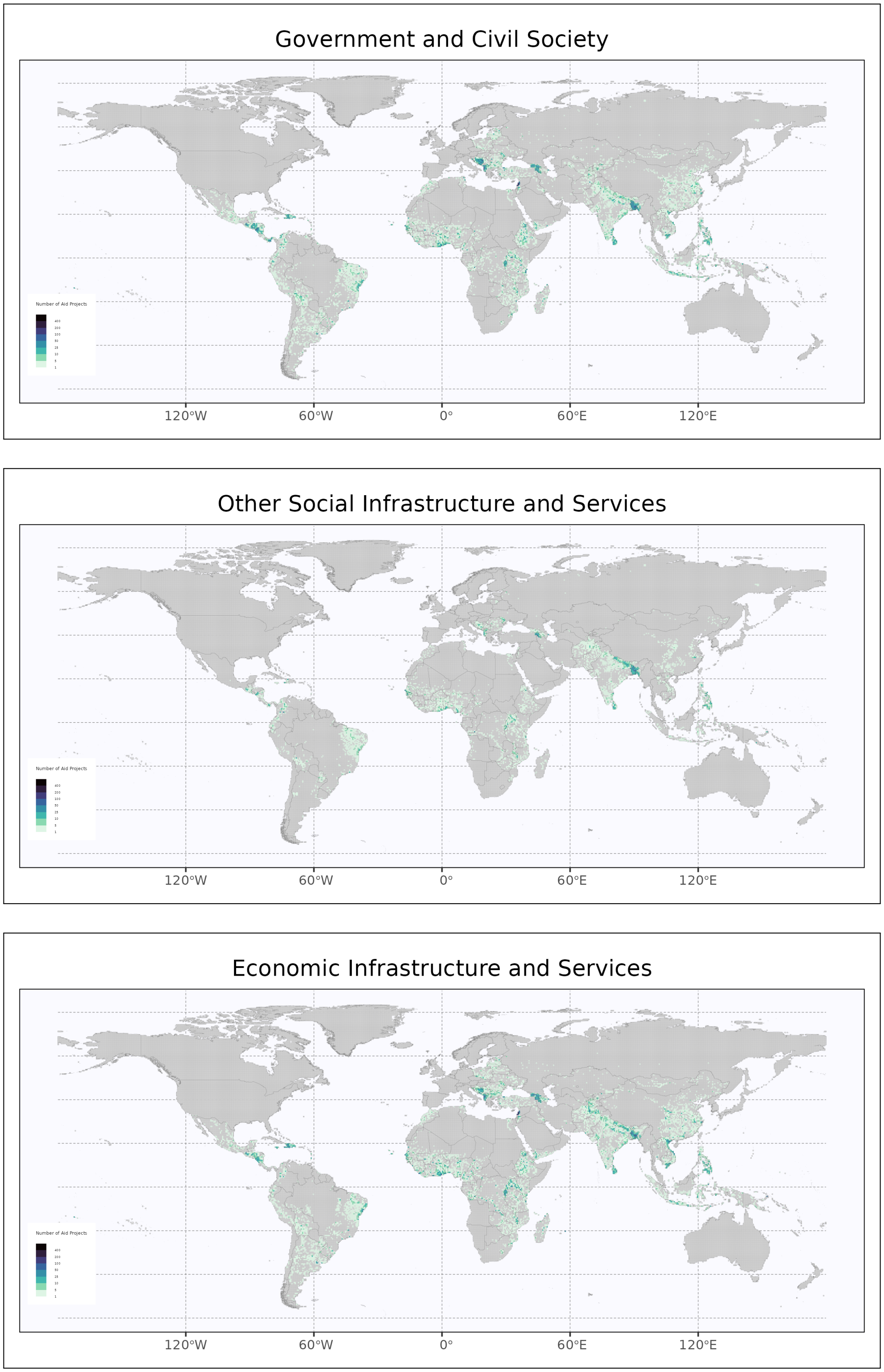

Figure 11: Geographic Distribution of Aid Projects Across Grid Cells and Main Sectors

Notes: This figure plots the distribution of foreign aid projects (precision code 1, 2, or 3) across grid cells (see Section 2). The color indicates the number of projects in the respective sector and in a given cell. The data originate from AidData (2016) and cover the period from 1995 to 2014.

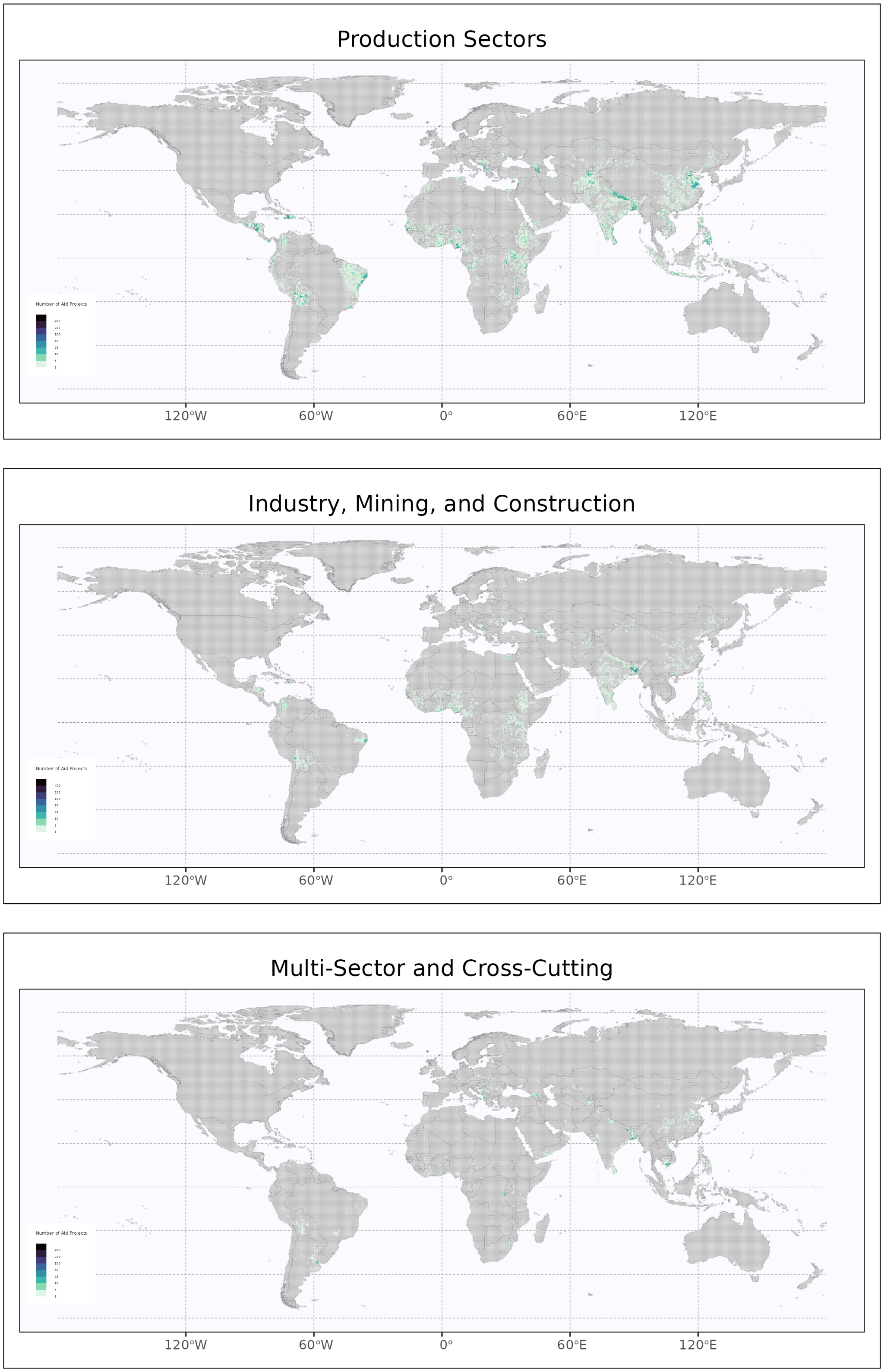

Figure 12: Geographic Distribution of Aid Projects Across Grid Cells and Main Sectors

Notes: This figure plots the distribution of foreign aid projects (precision code 1, 2, or 3) across grid cells (see Section 2). The color indicates the number of projects in the respective sector and in a given cell. The data originate from AidData (2016) and cover the period from 1995 to 2014.

C Descriptive Statistics

Table C1: Summary Statistics for the Main Regression Variables

Variable	N	Mean	SD	Minimum	Maximum
Dependent Variable					
Night-Time Light Activity: $\ln(0.01 + Light_{gt})$	1,759,633	9.6092	1.5905	-4.6052	12.3246
Foreign Aid Measure: Treatment Status					
Any Foreign Aid	1,759,633	0.2132	0.8966	0	17
Foreign Aid Main Sector Coding 1: *Education*	1,759,633	0.0389	0.2797	0	10
Foreign Aid Main Sector Coding 2: *Health*	1,759,633	0.0379	0.2450	0	7
Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	1,759,633	0.0624	0.3573	0	11
Foreign Aid Main Sector Coding 4: *Government and Civil Society*	1,759,633	0.1505	0.6681	0	14
Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	1,759,633	0.0577	0.3517	0	11
Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	1,759,633	0.1257	0.5732	0	13
Foreign Aid Main Sector Coding 7: *Production Sectors*	1,759,633	0.0615	0.3394	0	8
Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	1,759,633	0.0228	0.1747	0	7
Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	1,759,633	0.0096	0.1150	0	5
Foreign Aid Measure: Treatment Counts					
Any Foreign Aid	1,759,633	0.4174	2.9795	0	401
Foreign Aid Main Sector Coding 1: *Education*	1,759,633	0.0884	1.1366	0	126
Foreign Aid Main Sector Coding 2: *Health*	1,759,633	0.0719	0.6860	0	53
Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	1,759,633	0.1167	1.4951	0	296
Foreign Aid Main Sector Coding 4: *Government and Civil Society*	1,759,633	0.2844	2.2643	0	364
Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	1,759,633	0.1047	0.8993	0	72
Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	1,759,633	0.2688	2.2502	0	378
Foreign Aid Main Sector Coding 7: *Production Sectors*	1,759,633	0.1272	0.9148	0	37
Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	1,759,633	0.0387	0.4695	0	56
Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	1,759,633	0.0184	0.3277	0	35
Foreign Aid Measure: $\ln(0.01 + Aid\ Disbursements)$					
Any Foreign Aid	1,759,633	-3.8844	3.4202	-4.6052	20.1399
Foreign Aid Main Sector Coding 1: *Education*	1,759,633	-4.4126	1.709	-4.6052	18.7526
Foreign Aid Main Sector Coding 2: *Health*	1,759,633	-4.4332	1.5901	-4.6052	18.7526
Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	1,759,633	-4.3744	1.8589	-4.6052	16.4037
Foreign Aid Main Sector Coding 4: *Government and Civil Society*	1,759,633	-4.0679	2.864	-4.6052	18.7526
Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	1,759,633	-4.359	1.9346	-4.6052	18.7526
Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	1,759,633	-4.1831	2.5807	-4.6052	18.7424
Foreign Aid Main Sector Coding 7: *Production Sectors*	1,759,633	-4.341	1.9965	-4.6052	16.8068
Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	1,759,633	-4.4887	1.335	-4.6052	17.1875
Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	1,759,633	-4.5596	0.8517	-4.6052	17.9788
Climate Controls					
Annual Mean Precipitation Rate (mm/month)	1,759,633	62.6194	60.0761	0	1120.175
Annual Mean Temperature (degree Celsius)	1,759,633	12.5906	12.1430	-24.075	33.5417
Socioeconomic Controls					
Population Size: $\ln(0.01 + Pouplulation_{gt})$	1,759,633	7.2925	5.3571	-4.6052	17.2106
Indicator: Any Conflicts	1,759,633	0.0169	0.1288	0	1

Notes: This table shows basic summary statistics for the main variables employed in the regression analysis. The data cover the period from 1992 to 2020 across 60,677 grid cells with a spatial resolution of 0.5 decimal degrees latitude × longitude. See the main text for additional details on data construction and sources.

Table C2: Pairwise Correlations for the Main Regression Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Night-Time Light Activity: $\ln(0.01+Light_{gt})$	1.0000																
(2) Any Foreign Aid	0.0631	1.0000															
(3) Foreign Aid Main Sector Coding 1: *Education*	0.0301	0.6988	1.0000														
(4) Foreign Aid Main Sector Coding 2: *Health*	0.0326	0.6892	0.6071	1.0000													
(5) Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	0.0448	0.7747	0.5913	0.5608	1.0000												
(6) Foreign Aid Main Sector Coding 4: *Government and Civil Society*	0.0585	0.9396	0.6855	0.6453	0.7232	1.0000											
(7) Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	0.0352	0.7566	0.6550	0.6203	0.6794	0.7112	1.0000										
(8) Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	0.0570	0.9094	0.5930	0.5667	0.7077	0.8501	0.6514	1.0000									
(9) Foreign Aid Main Sector Coding 7: *Production Sectors*	0.0380	0.7615	0.5661	0.5176	0.6632	0.6993	0.6878	0.6552	1.0000								
(10) Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	0.0301	0.5874	0.4108	0.3871	0.4328	0.5224	0.4950	0.5230	0.5764	1.0000							
(11) Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	0.0307	0.4155	0.2721	0.2671	0.4174	0.4039	0.2857	0.4111	0.3270	0.2218	1.0000						
(12) Any Foreign Aid	0.0466	0.7197	0.5610	0.5082	0.6053	0.6933	0.5853	0.6770	0.5477	0.4440	0.3563	1.0000					
(13) Foreign Aid Main Sector Coding 1: *Education*	0.0204	0.4539	0.6429	0.3772	0.3653	0.4468	0.4491	0.3662	0.3480	0.2810	0.2032	0.5198	1.0000				
(14) Foreign Aid Main Sector Coding 2: *Health*	0.0236	0.5300	0.4741	0.7472	0.4565	0.4840	0.5010	0.4505	0.4192	0.3059	0.2222	0.5315	0.3870	1.0000			
(15) Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	0.0285	0.4002	0.3109	0.2865	0.5090	0.3796	0.3350	0.3793	0.3258	0.2285	0.2204	0.8012	0.2462	0.3001	1.0000		
(16) Foreign Aid Main Sector Coding 4: *Government and Civil Society*	0.0414	0.6127	0.4721	0.4192	0.5080	0.6539	0.4751	0.5758	0.4534	0.3540	0.3145	0.9368	0.4399	0.4239	0.8138	1.0000	
(17) Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	0.0294	0.6111	0.5768	0.5047	0.5484	0.5857	0.7940	0.5433	0.5451	0.4256	0.2620	0.6662	0.5161	0.5499	0.4025	0.5248	1.0000
(18) Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	0.0400	0.5889	0.4250	0.3799	0.5033	0.5681	0.4435	0.6339	0.4238	0.3501	0.3071	0.9215	0.3217	0.3594	0.8273	0.9155	0.4949
(19) Foreign Aid Main Sector Coding 7: *Production Sectors*	0.0352	0.5962	0.4327	0.3957	0.5309	0.5466	0.5292	0.5117	0.7802	0.4605	0.2819	0.5682	0.3258	0.4001	0.3795	0.4880	0.5379
(20) Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	0.0234	0.4442	0.3770	0.2782	0.3281	0.4149	0.4267	0.3946	0.4100	0.7003	0.1895	0.4864	0.3351	0.2225	0.2169	0.3704	0.5185
(21) Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	0.0231	0.3385	0.2476	0.2330	0.3154	0.3310	0.2292	0.3362	0.2270	0.1710	0.7323	0.3480	0.2068	0.2258	0.2176	0.3152	0.2315
(22) Any Foreign Aid	0.0544	0.7188	0.5014	0.5014	0.5567	0.6788	0.5472	0.6454	0.5763	0.4297	0.2946	0.4766	0.3046	0.3520	0.2728	0.4151	0.4065
(23) Foreign Aid Main Sector Coding 1: *Education*	0.0251	0.5402	0.7225	0.4591	0.4862	0.5293	0.5008	0.4686	0.4637	0.3113	0.2100	0.4386	0.4636	0.3443	0.2730	0.3830	0.4072
(24) Foreign Aid Main Sector Coding 2: *Health*	0.0243	0.4875	0.4592	0.6469	0.3696	0.4647	0.4234	0.3960	0.3498	0.2662	0.1700	0.3485	0.2986	0.4389	0.1936	0.2897	0.3552
(25) Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	0.0322	0.4756	0.3825	0.3467	0.6137	0.4475	0.3853	0.4239	0.3951	0.2814	0.2445	0.3065	0.1982	0.2517	0.2696	0.2555	0.2930
(26) Foreign Aid Main Sector Coding 4: *Government and Civil Society*	0.0484	0.6939	0.5119	0.4847	0.5363	0.7135	0.5527	0.6199	0.5333	0.4037	0.2752	0.4625	0.3194	0.3424	0.2468	0.4223	0.4214
(27) Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	0.0281	0.5437	0.4636	0.4228	0.4474	0.5146	0.6798	0.4643	0.4944	0.3792	0.2150	0.3831	0.2813	0.3198	0.2134	0.3139	0.5015
(28) Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	0.0449	0.6009	0.3987	0.3971	0.4623	0.5541	0.4249	0.6492	0.4538	0.3635	0.2897	0.4075	0.2281	0.3044	0.2221	0.3399	0.3340
(29) Foreign Aid Main Sector Coding 7: *Production Sectors*	0.0269	0.5118	0.4156	0.3308	0.4113	0.4747	0.4139	0.4455	0.6427	0.4171	0.2491	0.3346	0.2385	0.2436	0.1885	0.2804	0.3180
(30) Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	0.0219	0.3706	0.2071	0.2310	0.2610	0.3452	0.3057	0.3434	0.3511	0.6361	0.1601	0.2563	0.1270	0.1764	0.1266	0.2225	0.2315
(31) Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	0.0188	0.2106	0.0993	0.1298	0.1886	0.2040	0.1338	0.2163	0.1962	0.1201	0.5712	0.1619	0.0644	0.1087	0.0941	0.1540	0.1041
(32) Annual Mean Precipitation Rate (mm/month)	0.0714	0.1817	0.1557	0.1469	0.1277	0.1724	0.1388	0.1672	0.1382	0.1063	0.0685	0.1226	0.1009	0.1106	0.0554	0.1065	0.1170
(33) Annual Mean Temperature (degree Celsius)	0.1667	0.1812	0.1243	0.1353	0.1370	0.1714	0.1407	0.1661	0.1444	0.1007	0.0555	0.1073	0.0709	0.0896	0.0599	0.0962	0.1016
(34) Population Size: $\ln(0.01+Pouplulation_{gt})$	0.2840	0.2416	0.1455	0.1565	0.1775	0.2257	0.1678	0.2213	0.1810	0.1361	0.0906	0.1519	0.0848	0.1103	0.0845	0.1336	0.1251
(35) Indicator: Any Conflicts	0.0185	0.1207	0.0811	0.0905	0.1035	0.0979	0.1120	0.1226	0.0981	0.0788	0.0327	0.0935	0.0497	0.0671	0.0695	0.0728	0.1016

Notes: This table shows basic pairwise correlations for the main variables used in the empirical analysis. The data cover the period from 1992 to 2020 across 60,677 grid cells with a spatial resolution of 0.5 decimal degrees latitude × longitude. See the main text for additional details on data construction and sources.

Table C2: Pairwise Correlations for the Main Regression Variables

Variables	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Night-Time Light Activity: $\ln(0.01 + Light_{gt})$																		
(2) Any Foreign Aid																		
(3) Foreign Aid Main Sector Coding 1: *Education*																		
(4) Foreign Aid Main Sector Coding 2: *Health*																		
(5) Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*																		
(6) Foreign Aid Main Sector Coding 4: *Government and Civil Society*																		
(7) Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*																		
(8) Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*																		
(9) Foreign Aid Main Sector Coding 7: *Production Sectors*																		
(10) Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*																		
(11) Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*																		
(12) Any Foreign Aid																		
(13) Foreign Aid Main Sector Coding 1: *Education*																		
(14) Foreign Aid Main Sector Coding 2: *Health*																		
(15) Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*																		
(16) Foreign Aid Main Sector Coding 4: *Government and Civil Society*																		
(17) Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*																		
(18) Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	1.0000																	
(19) Foreign Aid Main Sector Coding 7: *Production Sectors*	0.4439	1.0000																
(20) Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	0.4022	0.4242	1.0000															
(21) Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	0.3142	0.2135	0.1443	1.0000														
(22) Any Foreign Aid	0.3940	0.4354	0.3014	0.2143	1.0000													
(23) Foreign Aid Main Sector Coding 1: *Education*	0.3460	0.3435	0.2613	0.1797	0.5417	1.0000												
(24) Foreign Aid Main Sector Coding 2: *Health*	0.2706	0.2644	0.2164	0.1566	0.5119	0.4337	1.0000											
(25) Foreign Aid Main Sector Coding 3: *Water Supply and Sanitation*	0.2632	0.3096	0.1932	0.1924	0.5912	0.4005	0.3789	1.0000										
(26) Foreign Aid Main Sector Coding 4: *Government and Civil Society*	0.3724	0.4045	0.2975	0.2090	0.8946	0.5479	0.4850	0.5285	1.0000									
(27) Foreign Aid Main Sector Coding 5: *Other Social Infrastructure and Services*	0.2967	0.3675	0.3008	0.1741	0.6168	0.4949	0.3954	0.4544	0.5997	1.0000								
(28) Foreign Aid Main Sector Coding 6: *Economic Infrastructure and Services*	0.3778	0.3434	0.2454	0.2142	0.7980	0.4207	0.3639	0.4707	0.7170	0.4608	1.0000							
(29) Foreign Aid Main Sector Coding 7: *Production Sectors*	0.2644	0.4712	0.3035	0.1631	0.6320	0.4167	0.3202	0.4452	0.5232	0.5117	0.4813	1.0000						
(30) Foreign Aid Main Sector Coding 8: *Industry, Mining and Services*	0.2076	0.2763	0.4157	0.1181	0.4246	0.2118	0.1891	0.2437	0.3697	0.3628	0.3605	0.4793	1.0000					
(31) Foreign Aid Main Sector Coding 9: *Multi-Sector/Cross-Cutting*	0.1478	0.1579	0.0763	0.3756	0.2666	0.1313	0.0858	0.2346	0.2350	0.1691	0.2804	0.2731	0.1415	1.0000				
(32) Annual Mean Precipitation Rate (mm/month)	0.0980	0.1078	0.0805	0.0542	0.1499	0.1171	0.0989	0.0861	0.1397	0.1037	0.1189	0.1043	0.0443	0.0377	1.0000			
(33) Annual Mean Temperature (degree Celsius)	0.0914	0.1085	0.0675	0.0399	0.1566	0.0928	0.0932	0.1025	0.1417	0.1055	0.1217	0.1047	0.0569	0.0381	0.3212	1.0000		
(34) Population Size: $\ln(0.01 + Pouplulation_{gt})$	0.1290	0.1438	0.0917	0.0646	0.2144	0.1191	0.1127	0.1282	0.1908	0.1322	0.1689	0.1357	0.0906	0.0610	0.2841	0.5695	1.0000	
(35) Indicator: Any Conflicts	0.0874	0.0762	0.0629	0.0289	0.0974	0.0710	0.0673	0.0736	0.0886	0.0815	0.0821	0.0649	0.0338	0.0141	0.0771	0.1087	0.1167	1.0000

Notes: This table shows basic pairwise correlations for the main variables used in the empirical analysis. The data cover the period from 1992 to 2020 across 60,677 grid cells with a spatial resolution of 0.5 decimal degrees latitude × longitude. See the main text for additional details on data construction and sources.

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