Target at the Right Level: Aid, Spillovers and Growth in Sub-Saharan Africa

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This project uses spatial analytical skills to investigate aid effectiveness and aid spillovers at the sub-national level in sub-Saharan Africa over the period 1995-2013.

Contributions:
aid effectiveness at sub-national level; aid spillovers.

Model Specification:

$$growth_{i,t} = \alpha_0 + \alpha_1 * \ln(1 + lightspc_{i-1,t}) + \beta_1 * \ln(1 + aid_{i,t-1}^{ADM2}) + \beta_2 * \ln(1 + aid_{-i,t-1}^{ADM2}) + \beta_3 * \ln(1 + aid_{i,t-1}^{ADM1}) + \beta_4 * \ln(1 + aid_{i,t-1}^{country}) + \gamma' X_{i,t-1} + \delta_i + \delta_t + \varepsilon_{i,t}$$

$growth_{i,t}$ is the growth rate of income per capita (measured as growth of night lights per capita) in ADM2 i at t-1.
$\ln(1 + lightspc_{i-1,t})$ represents the logarithm of lagged income per capita level (measured as night lights per capital) in ADM2 i. $aid_{i,t-1}^{ADM2}$ is the amount of aid received by ADM2 i at t-1. $aid_{-i,t-1}^{ADM2}$ is the total amount of aid received by i's neighbors. $aid_{i,t-1}^{ADM1}$ is the fair share (total amount divided by the number of ADM2s) of total amount of aid received by the ADM1 where ADM2 i locates at t-1, excluding the amount of aid received at ADM2 level. $aid_{i,t-1}^{country}$ is the fair share of total amount of aid received by the country where ADM2 i locates at t-1, excluding the amount of aid received at ADM2 and ADM1 levels. All the aid variables are measured in current US dollars. $X_{i,t-1}$ is a matrix of lagged control variables, including general government final consumption expenditure, inflation rate, openness to trade, ICRG institutional score and conflicts intensity.

However, there exists simultaneity problem: countries with faster growth may systematically receive more or less aid, so the direction is from growth to aid. Use the method of Brückner (2013), to solve this problem:

$$\ln(1 + aid_{t-1}) = a_i + b_t + c * growth_{i,t} + \epsilon_{i,t}$$

where $\ln(1 + aid_{t-1})$ is the general form of logged level of aid received at t-1, and includes $aid_{i,t-1}^{ADM2}, aid_{-i,t-1}^{ADM2}, aid_{i,t-1}^{ADM1}$, and $aid_{i,t-1}^{country}$; $growth_{i,t}$ is the growth of income per capita in i at t. a_i and b_t are ADM2 fixed effects and time fixed effects. I use air temperature and precipitation in region i at time t as instruments for $growth_{i,t}$, since African economy is heavily based on agriculture and these weather conditions are assumed to affect agricultural output contemporaneously. The exclusion restriction is that current weather conditions should not affect any lagged aid flows.

$$\ln(1 + aid_{t-1}^*) = \ln(1 + aid_{t-1}) - c * growth_{i,t}$$

This adjusted aid series is assumed to be exogenous to $growth_{i,t}$ and is used as instruments for $\ln(1 + aid_{t-1})$ in equation (1).

Baseline Conclusions:
Aid targeted at the local level tends to promote local economic growth, while aid received at more aggregate levels depresses local economic activities.

One possibility is that more specifically targeted aid tends to be less fungible compared to "general" aid, while aid generally given to a more aggregated level is more likely to be misappropriated for other purposes, thus creating rent-seeking opportunities to cause corruption and hurt institutional environment.

Table 1: Data Sources for the Main Variables

	Data Sources
Aid	AidData (2015)
Night lights	NOAA (2015)
Population	CIESIN and CIAT (2015)
Administrative boundary	Global Administrative Areas Database (2015)
Conflicts	ACLED (2016), UCDP (2016)
Air temperature	University of Delaware (2016)
Precipitation	University of Delaware (2016)
Government expenditure as a share of GDP	WDI (2016)
Inflation rate	WDI (2016)
Money supply as a share of GDP	WDI (2016)
Openness as a share of GDP	WDI (2016)
Fiscal surplus as a share of GDP	WDI (2016)
ICRG score	ICRG (2013)

Precision Code Table

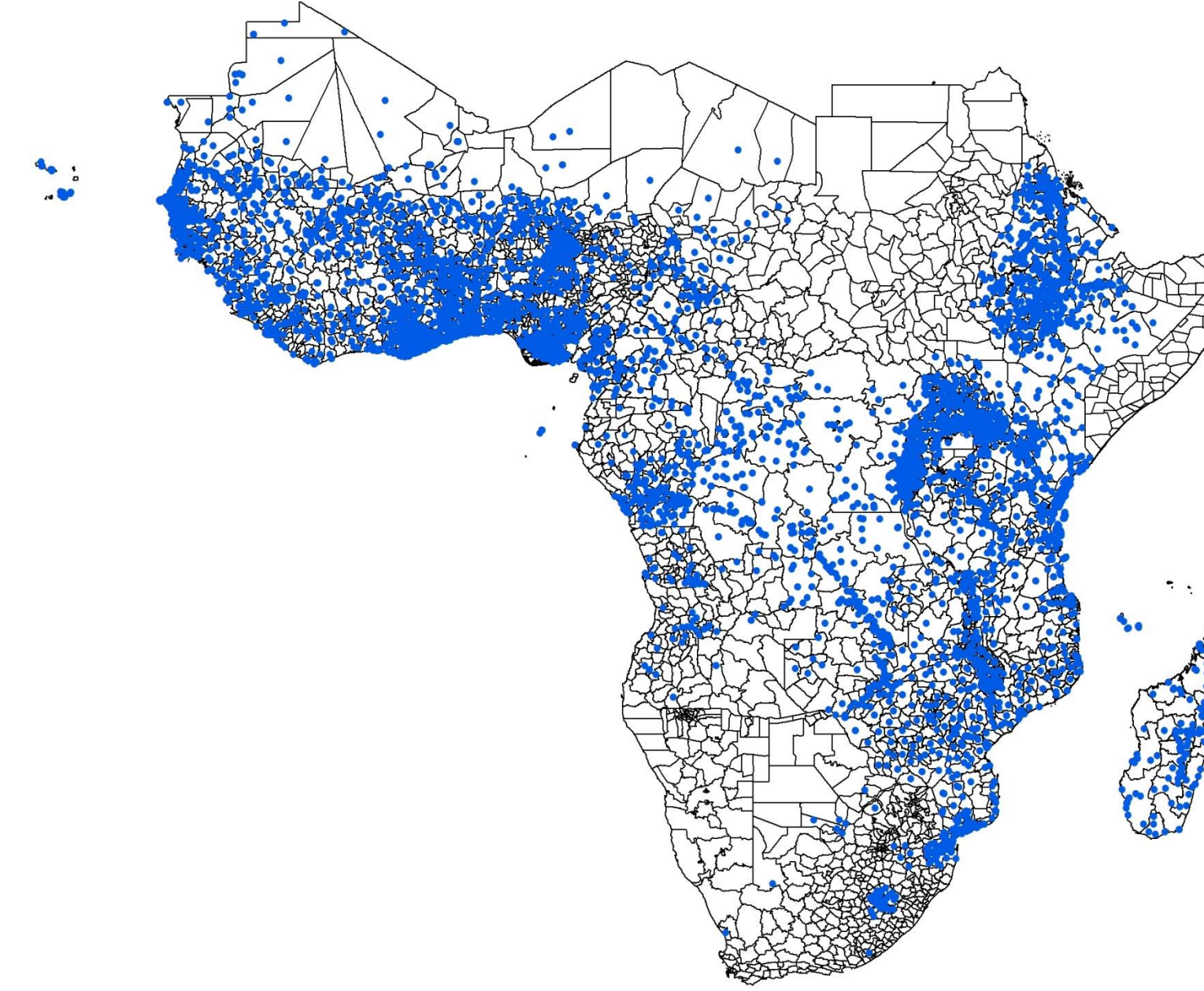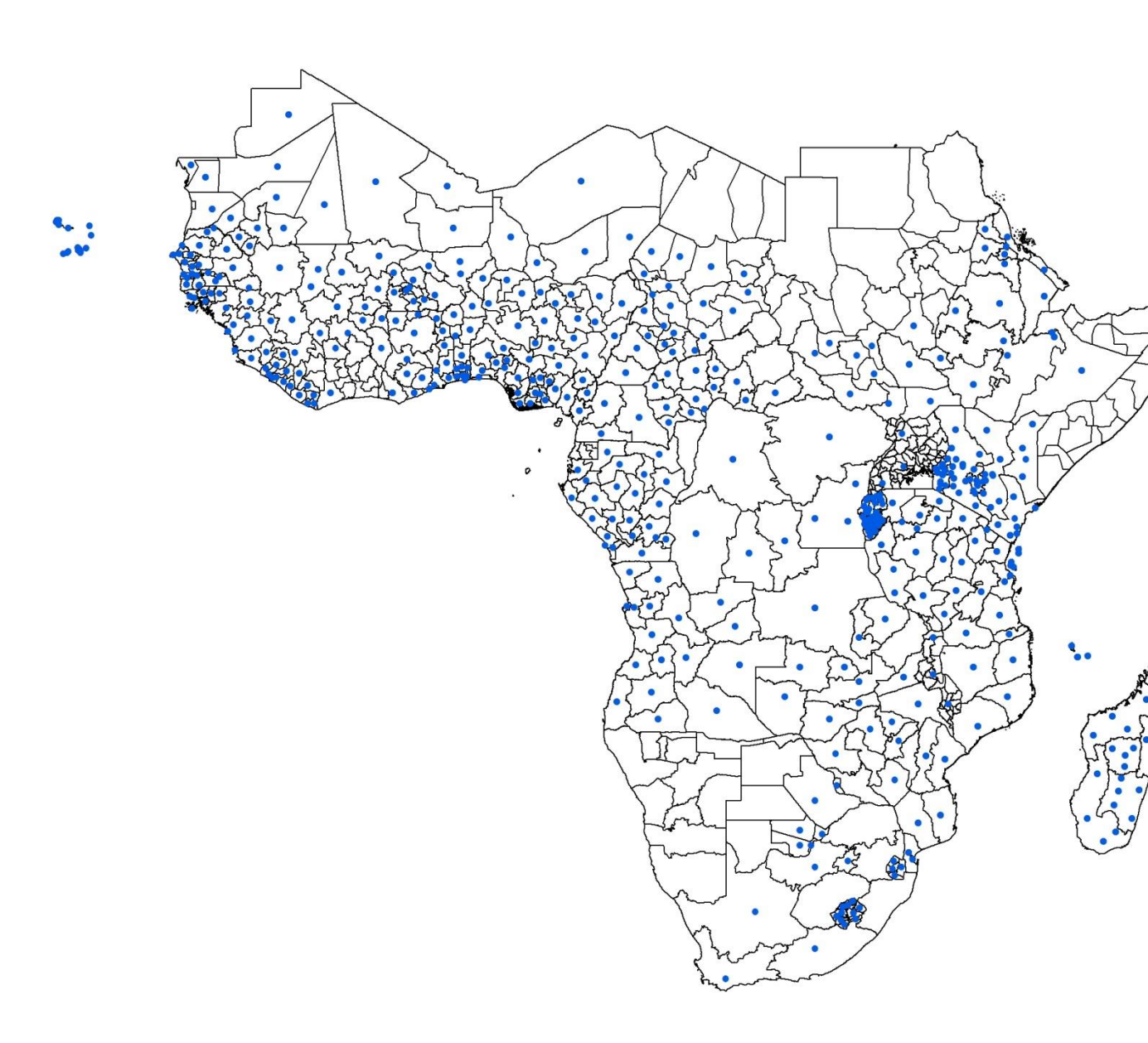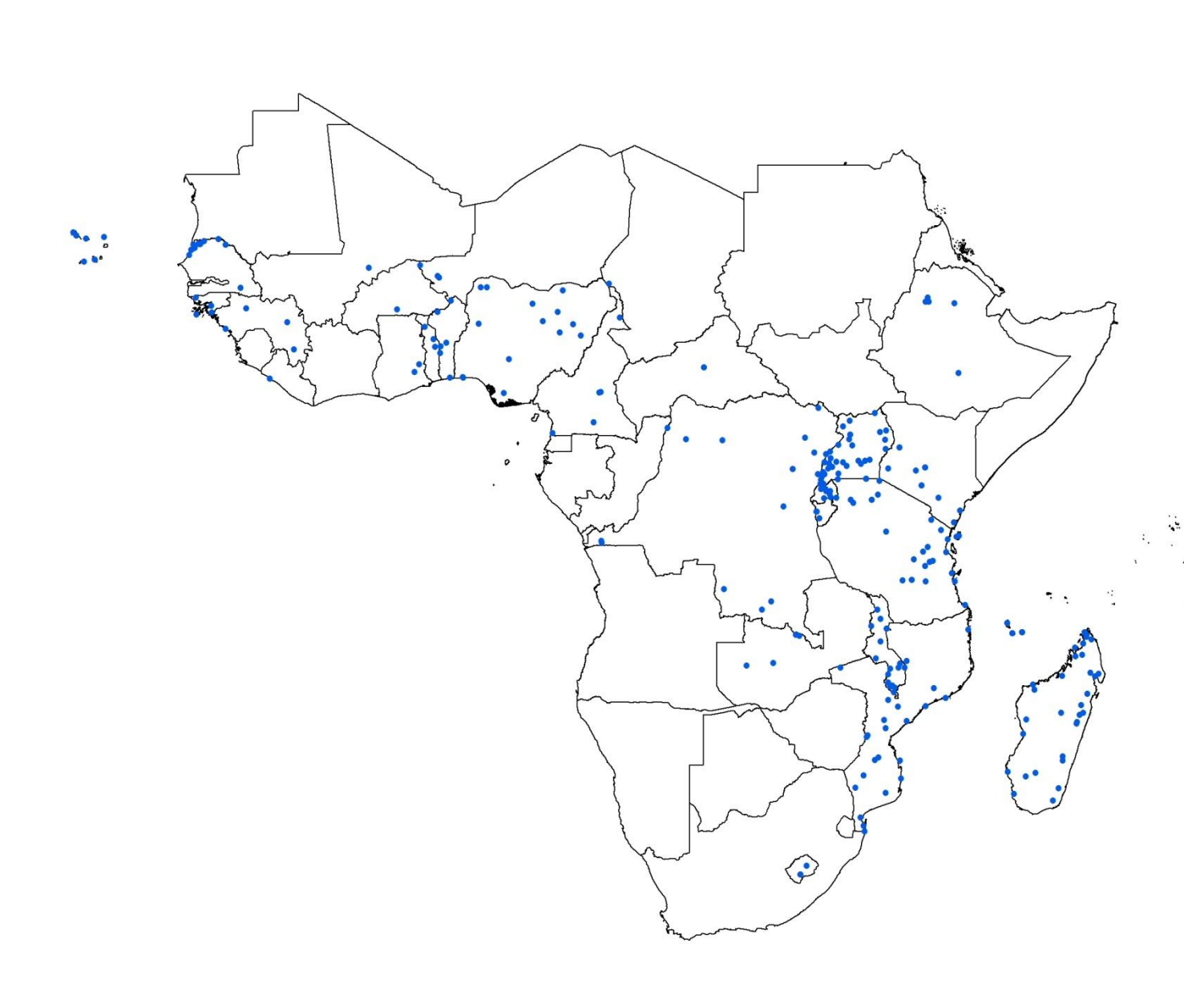| Precision Code	Precision Code Description
1	coordinates correspond to an exact location or populated place
2	coordinates correspond to a location that is known to be within 25km of the coordinates or a division smaller than ADM2
3	coordinates correspond to an ADM2 division (as defined by GAUL)
4	coordinates correspond to an ADM1 division (as defined by GAUL)
5	estimated coordinates of a large feature, such as rivers or national parks
6	coordinates correspond to the entire country, project operates in sub-national locales but they are not known
8	coordinates correspond to the entire country, it is likely that the funding goes to a government ministry or financial institution

Aid at Different Levels

ADM2 (Second Order Administrative Division)

ADM1 (First Order Administrative Division)

Country

Table 3: Simultaneity Regression

VARIABLES	(1) $growth_{i,t}$	(2) $aid_{i,t-1}^{ADM2}$	(3) $aid_{-i,t-1}^{ADM2}$	(4) $aid_{i,t-1}^{ADM1}$	(5) $aid_{i,t-1}^{country}$
air temperature$_{i,t}$	0.0568***				
	(0.0214)				
precipitation$_{i,t}$	-0.00169***				
	(0.000562)				
growth$_{i,t}$		-21.18*	-14.68*	23.19*	11.85*
		(12.04)	(8.592)	(13.07)	(6.843)
Constant	-1.320**				
	(0.541)				
Observations	22,584	15,056	15,056	15,056	15,056
R-squared	0.034	-22.038	-9.793	-23.974	-9.627
Number of ADM2	3,764	3,764	3,764	3,764	3,764
ADM2 FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
p-value of FF statistic	0.0000	0.0000	0.0000	0.0000	0.0000
Hansen J	-	0.5178	0.1666	0.1301	0.8781

Table 4: Baseline Regression Results

VARIABLES	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) OLS
$aid_{i,t-1}^{ADM2}$	0.979***	0.861***			0.667***	0.649***	-0.000416
	(0.116)	(0.107)			(0.0768)	(0.0738)	(0.00133)
$aid_{i,t-1}^{ADM1}$		0.405***			0.611***	0.606***	-0.000313
		(0.0518)			(0.0705)	(0.0689)	(0.00146)
$aid_{i,t-1}^{country}$			-0.790***	-1.042***	-0.945***	-0.945***	-0.00199
			(0.0814)	(0.115)	(0.104)	(0.104)	(0.00225)
$aid_{-i,t-1}^{ADM2}$				-0.680***	-0.234***	-0.234***	-0.00550***
				(0.0671)	(0.0313)	(0.0313)	(0.00204)
$\ln(1 + lightspc_{i,t})$	-17.66***	-16.43***	-28.01***	-28.91***	-25.54***	-30.38***	-18.28***
	(3.519)	(3.866)	(3.314)	(3.477)	(2.991)	(3.482)	(2.425)
government expenditure$_{i,t-1}$	-0.233***	-0.283***	-0.0499***	-0.342***	-0.159***	-0.386***	-0.00199
	(0.032?)	(0.0409)	(0.0150)	(0.0448)	(0.0179)	(0.0479)	(0.00191)
inflation$_{i,t-1}$	-0.0435***	-0.0586***	-0.0195***	-0.0889***	0.0484***	-0.0694***	0.00256***
	(0.00684)	(0.00808)	(0.00403)	(0.0115)	(0.00525)	(0.00968)	(0.000807)
openness$_{i,t-1}$	0.0199***	0.0273***	-0.00923***	0.0177***	-0.00954***	0.0154***	-0.00150***
	(0.00363)	(0.00485)	(0.00310)	(0.00404)	(0.00234)	(0.00409)	(0.000254)
ICRG score$_{i,t-1}$	-0.0613***	-0.0769***	0.0806***	0.0195	0.0637***	0.0311**	0.0100***
	(0.0133)	(0.0157)	(0.0114)	(0.0143)	(0.00730)	(0.0142)	(0.00107)
conflict$_{i,t-1}$	0.000293*	0.000220	9.83e-06	0.000178	3.67e-05	0.000189	-1.85e-05
	(0.000155)	(0.000156)	(0.000144)	(0.000190)	(6.80e-05)	(0.000177)	(2.09e-05)
Constant	1.991***	0.769	2.933***	3.801***	2.336***	4.231***	0.0209
	(0.524)	(0.604)	(0.443)	(0.725)	(0.317)	(0.731)	(0.0716)
Observations	11,386	11,386	11,386	11,386	11,386	11,386	11,619
R-squared	-15.523	-18.662	-10.263	-27.472	-4.912	-27.047	0.270
Number of ADM2	2,863	2,863	2,863	2,863	2,863	2,863	3,096
ADM2 FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
p-value of F statistic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cragg-Donald Wald F	394.924	164.658	590.419	74.705	1201.773	56.872	-
Kleibergen-Paap rk Wald F	78.642	35.205	104.665	27.981	129.458	21.681	-

Table 7: Further Explorations

VARIABLES	(1) total lights	(2) population	(3) quad aid	(4) policy	(5) institutions
$aid_{i,t-1}^{ADM2}$	0.0517***	-4.78e-05	-2.662***	0.812*	-4.061*
	(0.00871)	(4.38e-05)	(1.029)	(0.465)	(4.616)
$aid_{i,t-1}^{ADM1}$	0.0664***	-0.000140***	-2.035	0.759***	-5.905*
	(0.00829)	(4.14e-05)	(2.029)	(0.277)	(3.257)
$aid_{i,t-1}^{ADM2}$	-0.0633***	0.000228***	5.136*	-1.870***	10.56*
	(0.0120)	(6.51e-05)	(2.752)	(0.394)	(5.618)
$aid_{i,t-1}^{country}$	-0.0373***	0.000120***	1.603	-0.493	13.08**
	(0.00458)	(2.08e-05)	(2.874)	(2.301)	(6.293)
$(aid_{i,t-1}^{ADM2})^2$			-0.185**		
			(0.0782)		
$(aid_{-i,t-1}^{ADM2})^2$			0.182		
			(0.151)		
$(aid_{i,t-1}^{ADM1})^2$			-0.501**		
			(0.236)		
$(aid_{i,t-1}^{country})^2$			-0.122		
			(0.262)		
$\ln(1 + level_{i,t-1})$	-0.778***	0.0108***	1.357	-20.79***	-30.02***
	(0.0185)	(0.000931)	(17.84)	(4.105)	(15.98)
government expenditure$_{i,t-1}$	-0.0349***	2.63e-05	0.445		1.277
	(0.00464)	(2.96e-05)	(0.343)		(0.785)
inflation$_{i,t-1}$	-0.00522***	-2.05e-05***	0.0553		0.411*
	(0.00148)	(6.386e-06)	(0.105)		(0.221)
openness$_{i,t-1}$	0.000389	-4.50e-05***	-0.0235**		0.0904**
	(0.000627)	(2.22e-06)	(0.0103)		(0.0399)
ICRG score$_{i,t-1}$	0.0295***	2.15e-05***	-0.0769*	-0.0763	0.0294
	(0.0253)	(9.46e-06)	(0.0348)	(0.0959)	(0.0957)
conflict$_{i,t-1}$	-4.03e-05	3.64e-08	-0.000145	(8.29e-05)	0.00168
	(4.00e-05)	(1.30e-07)	(0.000394)	-79.54***	(0.00115)
policy$_{i,t-1}$				(26.41)	
$aid_{i,t-1}^{ADM2} * policy_{i,t-1}$				3.526	
				(11.33)	
$aid_{-i,t-1}^{ADM2} * policy_{i,t-1}$				0.434	
				(6.127)	
$aid_{i,t-1}^{ADM1} * policy_{i,t-1}$				4.253	
				(12.83)	
$aid_{i,t-1}^{country} * policy_{i,t-1}$				-13.93	
				(55.71)	
$aid_{i,t-1}^{ADM2} * ICRG score_{i,t-1}$					0.165*
					(0.0885)
$aid_{-i,t-1}^{ADM2} * ICRG score_{i,t-1}$					0.123*
					(0.0656)
$aid_{i,t-1}^{ADM1} * ICRG score_{i,t-1}$					-0.221**
					(0.110)
$aid_{i,t-1}^{country} * ICRG score_{i,t-1}$					0.268**
					(0.127)
constant	5.215***	-0.034***	-91.933	108.047	312.634**
	(0.381)	(0.006)	(256.415)	(347.632)	(132.134)
Observations	11,386	11,386	11,386	6,404	11,386
R-squared	0.286	0.409	-66.765	-31.332	-250.554
Number of ADM2	2,863	2,863	2,863	2,298	2,863
ADM2 FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
p-value of F statistic	0.0000	0.0000	0.0000	0.0000	0.0087
Cragg-Donald Wald F	32.908	30.434	0.598	1.741	0.805
Kleibergen-Paap rk Wald F	10.714	9.856	1.128	0.598	0.556

Policy Implications:
The findings have very profound policy implications that to promote local economic growth, we should focus more on specifically targeted and less-fungible aid projects rather than aid generally given to governments at more aggregate levels; also we should reduce barriers to these activities within the country to promote positive spillover effects.

Data Processing Details:

Spatial Data Procession Details

Descriptions	GIS Programs and Commands
Country boundary merge	QGIS: MMQGIS
Neighbor weights matrix building	R: poly2nb ("spdep" package)
Aid calculation	R
Night lights calculation	ArcGIS: Model Builder, Zonal Statistics as Table
Population calculation	ArcGIS: Model Builder, Zonal Statistics as Table
Conflicts Intensity calculation	ArcGIS: Kernel Density
Air temperature calculation	R: extract ("raster" package)
Precipitation Calculation	R: extract ("raster" package)

Non-Spatial Data Procession Details

Descriptions	Computer Programs and Commands
Population liner interpolation	Stata: ipolate
Regression	Stata: xtivreg2

Extensions:
Aid at the local level promotes total economic flourish and slows down population growth, while aid at more aggregate levels depresses total economic activities but stimulates population growth. Aid directly received at all levels exhibits diminishing returns, which is consistent with the theory that aid directly stimulates investment and adds capital accumulation. While aid spillovers show weak increasing returns, which suggests the spillover effects partly function through technology and knowledge dissemination. As to the conditional aid effectiveness, no systematic story is found that aid is effective conditional on policy or institutions, probably due to data limitations that local policy and institutions data are unavailable in Sub-Saharan Africa.

Note:
This project is based on my job market paper "*Target at the Right Level: Aid, Spillovers and Growth in Sub-Saharan Africa*". Further information is available upon request.

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