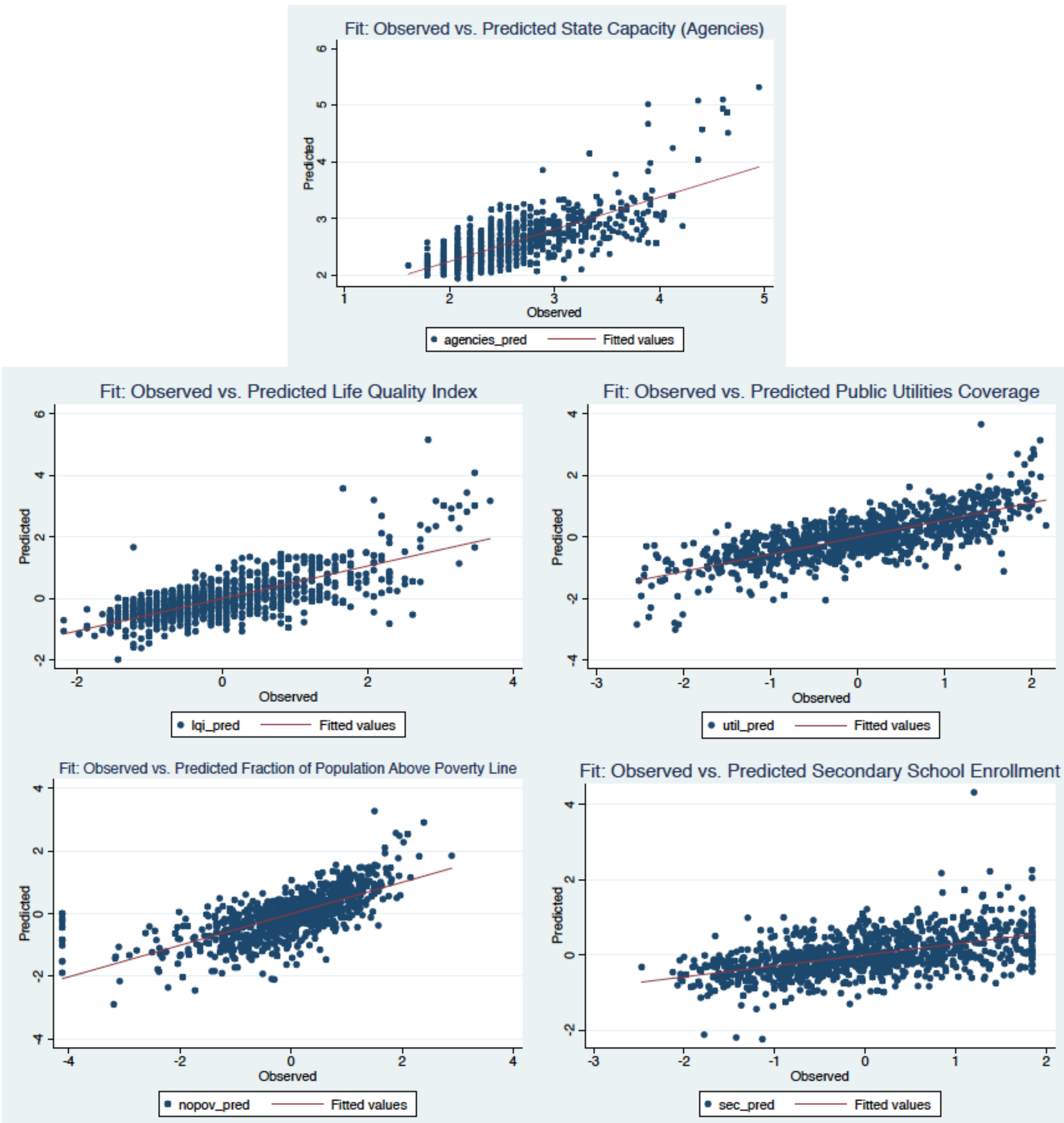
Online Appendix for State Capacity and Economic Development: A Network Approach by Acemoglu, Garcia-Jimeno and Robinson, *American Economic Review*

Additional Tables and Figures

Appendix Figure 1: Fit Scatterplots Linear Model (System GMM estimates)



The figure plots the observed (x-axis) and predicted (y-axis) local state capacity (measured as the number of local agencies) and prosperity outcomes together with a linear fit line. The predicted values are based on the model with linear best responses with the parameter estimated using system GMM. The predicted local state capacity vector is obtained by inverting the system of linear best responses at the estimated parameters. The predicted prosperity outcomes are obtained using the predicted state capacity and estimated parameters on the prosperity equations.

Appendix Table 1. Robustness Exercises: Prosperity and Public Goods Outcomes Structural Equation

Panel I	**Without controlling for distance to current highway**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.436	0.648	0.400	0.304	0.270	0.395	0.337	0.286
	(0.140)	(0.133)	(0.148)	(0.182)	(0.086)	(0.105)	(0.115)	(0.131)
dp_i/ds_j	0.025	0.020	0.022	0.035	0.021	0.015	0.013	0.020
	(0.006)	(0.006)	(0.006)	(0.007)	(0.005)	(0.005)	(0.005)	(0.006)
Slope from the best response (IV):	0.019				0.022			
	(0.003)				(0.004)			
Observations	973	975	975	965	1014	1017	1017	1006

Panel II	**Controlling by additional geographic covariates**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.288	0.443	0.198	0.189	0.189	0.259	0.210	0.096
	(0.146)	(0.143)	(0.155)	(0.192)	(0.097)	(0.106)	(0.115)	(0.138)
dp_i/ds_j	0.021	0.019	0.023	0.028	0.018	0.017	0.015	0.022
	(0.007)	(0.006)	(0.006)	(0.008)	(0.005)	(0.005)	(0.005)	(0.006)
Slope from the best response (IV):	0.019				0.025			
	(0.004)				(0.004)			
Observations	960	962	962	952	999	1002	1002	991

All reported estimates are instrumental variables average marginal effects of the prosperity equation for each of the four outcomes. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, and a department capital dummy. Panel I reports the estimates of models that do not control for the distance to a current highway. Panel II reports the estimates of models that include the following as additional covariates: density of primary, secondary, and tertiary rivers, and the full distribution of land qualities (qualities 1-8), and types (under water, valley, mountain, hill, and plain). Columns 1-4 use the log number of municipality state agencies as the measure of local state capacity, and columns 5-8 use the log number of municipality employees as the measure of local state capacity. Estimates of the first stages for the IV models are omitted. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. All prosperity outcomes are standardized. In all models log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 2. Robustness Exercises: Prosperity and Public Goods Outcomes Structural Equation

Panel I	Using neighbors of neighbors of neighbors as instruments							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.617	0.763	0.479	0.318	0.411	0.423	0.330	0.222
	(0.111)	(0.115)	(0.126)	(0.161)	(0.066)	(0.079)	(0.088)	(0.102)
dp_i/ds_j	0.024	0.028	0.026	0.038	0.017	0.021	0.018	0.027
	(0.007)	(0.007)	(0.007)	(0.009)	(0.005)	(0.005)	(0.005)	(0.007)
Slope from the best response (IV):	0.009				0.013			
	(0.002)				(0.002)			
Observations	973	975	975	965	1014	1017	1017	1006

Panel II	Defining links to include neighbors and neighbors of neighbors							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.519	0.693	0.375	0.365	0.374	0.331	0.296	0.226
	(0.114)	(0.115)	(0.129)	(0.164)	(0.069)	(0.080)	(0.095)	(0.107)
dp_i/ds_j	0.007	0.007	0.007	0.011	0.005	0.006	0.005	0.008
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)
Slope from the best response (IV):	0.006				0.008			
	(0.001)				(0.001)			
Observations	973	975	975	965	1014	1017	1017	1006

Panel III	All municipalities linked to each other with decaying link strength							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.375	0.487	0.196	0.155	0.380	0.339	0.216	0.276
	(0.114)	(0.107)	(0.111)	(0.142)	(0.070)	(0.079)	(0.079)	(0.100)
dp_i/ds_j	0.039	0.051	0.063	0.052	0.021	0.038	0.041	0.028
	(0.011)	(0.012)	(0.012)	(0.015)	(0.009)	(0.010)	(0.010)	(0.012)
Slope from the best response (IV):	0.013				0.041			
	(0.006)				(0.007)			
Observations	973	975	975	965	1014	1017	1017	1006

All reported estimates are instrumental variables average marginal effects of the prosperity equation for each of the four outcomes. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and a department capital dummy. Panel I reports the estimates of models that use neighbors of neighbors' colonial state presence as instruments following Bramoulle et al. (2009). Panel II reports the estimates of models where the network structure defines a link as existing between both neighbors and neighbors of neighbors. Panel III reports estimates of models where the network structure allows for links between all municipalities and decaying link strength. Columns 1-4 use the log number of municipality state agencies as the measure of local state capacity, and columns 5-8 use the log number of municipality employees as the measure of local state capacity. Estimates of the first stages for the instrumental variables models are omitted. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. All prosperity outcomes are standardized. In all models log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 3. Robustness Exercises: Prosperity and Public Goods Outcomes Structural Equation

Panel I	**Excluding neighbors' distance to royal roads as instruments**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.429	0.763	0.441	0.367	0.258	0.415	0.293	0.196
	(0.148)	(0.144)	(0.154)	(0.198)	(0.095)	(0.112)	(0.113)	(0.144)
dp_i/ds_j	0.019	0.018	0.024	0.033	0.018	0.015	0.016	0.025
	(0.007)	(0.006)	(0.007)	(0.008)	(0.005)	(0.005)	(0.005)	(0.006)
Slope from the best response (IV):	0.018				0.024			
	(0.003)				(0.004)			
Observations	973	975	975	965	1014	1017	1017	1006

Panel II	**Including only neighbors' distance to royal roads as instruments**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.371	0.638	0.493	0.180	0.195	0.333	0.295	0.231
	(0.162)	(0.155)	(0.173)	(0.210)	(0.101)	(0.116)	(0.125)	(0.145)
dp_i/ds_j	0.028	0.020	0.017	0.037	0.024	0.017	0.013	0.021
	(0.008)	(0.007)	(0.007)	(0.009)	(0.005)	(0.005)	(0.005)	(0.007)
Slope from the best response (IV):	0.022				0.023			
	(0.005)				(0.005)			
Observations	973	975	975	965	1014	1017	1017	1006

Panel II	**Including only first and second powers of instruments**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.583	0.710	0.433	0.538	0.255	0.295	0.395	0.318
	(0.193)	(0.183)	(0.190)	(0.286)	(0.143)	(0.154)	(0.182)	(0.198)
dp_i/ds_j	0.020	0.019	0.020	0.031	0.021	0.019	0.011	0.021
	(0.007)	(0.007)	(0.006)	(0.009)	(0.006)	(0.006)	(0.007)	(0.008)
Slope from the best response (IV):	0.019				0.022			
	(0.003)				(0.004)			
Observations	973	975	975	965	1014	1017	1017	1006

All reported estimates are instrumental variables average marginal effects of the prosperity equation for each of the four outcomes. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and a department capital dummy. Panel I reports the estimates of models that exclude neighbors' distance to royal roads from the instrument set. Panel II reports the estimates of models that only include neighbors' distance to royal roads in the instrument set. Panel II reports the estimates of models including only first and second powers of our three instruments. Columns 1-4 use the log number of municipality state agencies as the measure of local state capacity, and columns 5-8 use the log number of municipality employees as the measure of local state capacity. Estimates of the first stages for the instrumental variables models are omitted. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. All prosperity outcomes are standardized. In all models log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 4. Prosperity and Public Goods Quadratic Equation

State capacity measured as:	log of number of municipality state agencies				log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation: $p_i^j = \theta s_i^2 + \Upsilon^j \mathbf{N}_i(\boldsymbol{\delta})\mathbf{s} + \lambda(\mathbf{N}_i(\boldsymbol{\delta})\mathbf{s})^2 + \varepsilon_i^j$							
dp_i/ds_i	0.456	0.477	0.295	0.143	0.236	0.215	0.231	0.162
	(0.145)	(0.137)	(0.145)	(0.206)	(0.090)	(0.103)	(0.111)	(0.136)
dp_i/ds_j	0.017	0.031	0.028	0.042	0.019	0.032	0.021	0.031
	(0.008)	(0.007)	(0.008)	(0.011)	(0.006)	(0.006)	(0.007)	(0.008)
Coefficient on $(\mathbf{N}_i(\boldsymbol{\delta})\mathbf{s})^2$	0.613	-0.816	-0.521	-0.590	0.102	-0.674	-0.310	-0.424
	(0.416)	(0.351)	(0.428)	(0.654)	(0.170)	(0.183)	(0.206)	(0.269)
Slope from the best response (IV):	0.019				0.022			
	(0.003)				(0.004)			
Observations	973	975	975	965	1014	1017	1017	1006

All reported estimates are average marginal effects. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and a department capital dummy.The Table reports estimates of a quadratic-in-state-capacity prosperity equation for each of the four outcomes. Models in columns 1-4 use the log number of state agencies as the measure of state capacity. Models in columns 5-8 use the log number of municipality employees as the measure of state capacity. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. All prosperity outcomes are standardized. In all models reported, log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 5. Contemporary State Equilibrium Best Response with Contextual Effects

State capacity measured as log of number of:	Municipality state Agencies	Municipality employees
	(1)	(2)
	IV	IV
	Equilibrium best response equation: $s_i = (\phi/\theta)\mathbf{N}_i(\boldsymbol{\delta})\mathbf{s} + \mathbf{c}_i\boldsymbol{\varphi}_1 + \mathbf{x}_i\boldsymbol{\beta}_1 + \mathbf{N}_i(\boldsymbol{\delta})\mathbf{c}\boldsymbol{\phi}_2 + \mathbf{N}_i(\boldsymbol{\delta})\mathbf{x}\boldsymbol{\beta}_2 + \xi_i$	
ds_i/ds_j	0.020	0.021
	(0.007)	(0.008)
ds_i/dcolonial state officials$_i$	0.101	0.092
	(0.031)	(0.047)
ds_i/dcolonial state agencies$_i$	-0.021	0.004
	(0.033)	(0.060)
ds_i/ddistance to royal roads$_i$	0.017	-0.060
	(0.033)	(0.056)
Observations	975	1017

All reported estimates are average marginal effects of the best response equation. All models include department fixed effects, and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, contextual effects of all these covariates, and a department capital dummy. Given that the contextual effects include neighbors' colonial state and neighors royal roads, neighbors of neighbors' colonial state and neighbors of neighbors' royal roads are used as instruments for neighbors' state capacity. Column 1 uses the log number of local state agencies as the measure of state capacity, and column 2 uses the log number of municipality employees as the measure of state capacity. The first stages of the instrumental variables models are omitted. Log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 6. Prosperity and Public Goods Outcomes Structural Equation with Contextual Effects

State capacity measured as:	**Log of number of municipality state agencies**			
Dependent Variable:	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)
	IV	IV	IV	IV
	Prosperity equation: $p_i^j = \theta s_i^2 + \Upsilon^j \mathbf{N}_i(\boldsymbol{\delta})\mathbf{s} + \mathbf{x}_i\boldsymbol{\beta}_1 + \mathbf{N}_i(\boldsymbol{\delta})\mathbf{x}\boldsymbol{\beta}_2 + \varepsilon_i^j$			
dp_i/ds_i	0.705	0.845	0.520	0.292
	(0.021)	(0.023)	(0.024)	(0.031)
dp_i/ds_j	0.004	0.006	0.013	0.042
	(0.002)	(0.002)	(0.003)	(0.003)
Observations	973	975	975	965

State capacity measured as:	**Log of number of municipality employees**			
Dependent Variable:	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)
	IV	IV	IV	IV
	Prosperity equation: $p_i^j = \theta s_i^2 + \Upsilon^j \mathbf{N}_i(\boldsymbol{\delta})\mathbf{s} + \mathbf{x}_i\boldsymbol{\beta}_1 + \mathbf{N}_i(\boldsymbol{\delta})\mathbf{x}\boldsymbol{\beta}_2 + \varepsilon_i^j$			
dp_i/ds_i	0.441	0.501	0.347	0.221
	(0.014)	(0.016)	(0.016)	(0.020)
dp_i/ds_j	0.008	0.002	0.012	0.027
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	1014	1017	1017	1006

All reported estimates are average marginal effects. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, contextual effects of all these covariates, and a department capital dummy. Columns 1-4 use the log number of local state agencies as the measure of state capacity, and columns 5-8 use the log number of municipality employees as the measure of state capacity. The first stages of the instrumental variables models are omitted. Log population is instrumented using 1843 population. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 7. Robustness Exercises: Prosperity and Public Goods Outcomes Structural Equation

Panel I	**Excluding from the estimating sample municipalities above the 90th percentile of violence**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.401	0.569	0.307	0.322	0.184	0.284	0.212	0.240
	(0.139)	(0.132)	(0.140)	(0.189)	(0.099)	(0.117)	(0.114)	(0.141)
dp_i/ds_j	0.026	0.021	0.023	0.032	0.024	0.018	0.016	0.020
	(0.007)	(0.006)	(0.006)	(0.008)	(0.005)	(0.005)	(0.005)	(0.006)
Slope from the best response (IV):	0.020				0.026			
	(0.004)				(0.005)			
Observations	850	852	852	842	887	890	890	879

Panel II	**Excluding from the network municipalities above the 90th percentile of violence**							
State capacity measured as:	Log of number of municipality state agencies				Log of number of municipality employees			
	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment	Life quality index	Public utilities coverage	Not in poverty	Secondary enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV	IV	IV	IV	IV	IV	IV	IV
	Prosperity equation							
dp_i/ds_i	0.663	0.778	0.386	0.772	0.355	0.379	0.266	0.400
	(0.145)	(0.148)	(0.151)	(0.210)	(0.107)	(0.125)	(0.125)	(0.157)
dp_i/ds_j	0.021	0.017	0.022	0.024	0.019	0.016	0.014	0.017
	(0.007)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)	(0.006)	(0.008)
Slope from the best response (IV):	0.019				0.025			
	(0.004)				(0.004)			
Observations	850	852	852	842	887	890	890	879

All reported estimates are instrumental variables average marginal effects of the prosperity equation for each of the four outcomes. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and a department capital dummy. Panel I reports the estimates of models excluding from the estimating sample all municipalities in the top 10th percentile of violence as measured by 1988-2004 paramilitary attacks. Panel II reports the estimates of models excluding from the network all municipalities in the top 10th percentile of violence as measured by 1988-2004 paramilitary attacks. Columns 1-4 use the log number of municipality state agencies as the measure of local state capacity, and columns 5-8 use the log number of municipality employees as the measure of local state capacity. Estimates of the first stages for the instrumental variables models are omitted. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. All prosperity outcomes are standardized. In all models log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 8. Robustness Exercises: Prosperity and Public Goods Outcomes Structural Equation

Excluding capital cities from the network

State capacity measured as: log of number of municipality state agencies

Panel I	Life quality index		Public util. coverage		Not in poverty		Secondary enrollment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	Prosperity equation							
dp_i/ds_i	0.848	0.833	0.737	1.096	0.590	0.646	0.844	0.429
	(0.078)	(0.179)	(0.070)	(0.165)	(0.072)	(0.183)	(0.087)	(0.235)
dp_i/ds_j	0.015	0.014	0.020	0.007	0.019	0.015	0.014	0.027
	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)	(0.005)	(0.008)
Slope from the best response (IV):	0.019							
	(0.003)							
Observations	947	947	949	949	949	949	939	939

State capacity measured as: log of number of municipality employees

Panel II	Life quality index		Public util. coverage		Not in poverty		Secondary enrollment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	Prosperity equation							
dp_i/ds_i	0.396	0.394	0.191	0.292	0.155	0.283	0.227	0.253
	(0.029)	(0.123)	(0.029)	(0.138)	(0.028)	(0.137)	(0.035)	(0.199)
dp_i/ds_j	0.018	0.016	0.024	0.018	0.022	0.014	0.021	0.019
	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.007)
Slope from the best response (IV):	0.024							
	(0.004)							
Observations	988	988	991	991	991	991	980	980

All reported estimates are instrumental variables average marginal effects of the prosperity equation for each of the four outcomes. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and a department capital dummy. Panel I reports the estimates usingthe log number of municipality state agencies as the measure of local state capacity. Panel II reports the estimatesusing the log number of municipality employees as the measure of local state capacity. Estimates of the first stages for the instrumental variables models are omitted. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average. All prosperity outcomes are standardized. In all models log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 9. Contemporary State Equilibrium Best Response

	Subsets of municipality agencies				
State capacity measured as log of the number of municipality:	All agencies	Health agencies	Regulation agencies	Services agencies	Education agencies
Panel I	(1)	(1)	(2)	(3)	(4)
	IV	IV	IV	IV	IV
	Equilibrium best response				
ds_i/ds_j	0.019	0.050	0.029	0.024	0.020
	(0.003)	(0.010)	(0.009)	(0.005)	(0.005)
Colonial state officials$_i$	0.108	0.151	0.040	0.060	0.130
	(0.033)	(0.045)	(0.035)	(0.048)	(0.042)
Colonial state agencies$_i$	-0.016	-0.054	0.0381	-0.072	0.006
	(0.033)	(0.044)	(0.039)	(0.034)	(0.043)
Distance to royal roads$_i$	0.007	0.012	-0.037	0.024	0.007
	(0.021)	(0.021)	(0.029)	(0.016)	(0.026)
Panel II	First stage for neighbors' state agencies				
Neighbors' colonial state officials	0.338	0.235	0.278	0.183	0.437
	(0.100)	(0.051)	(0.054)	(0.060)	(0.098)
Neighbors' colonial state agencies	1.242	0.363	0.517	0.596	0.887
	(0.131)	(0.054)	(0.066)	(0.067)	(0.115)
Neighbors' distance to royal roads	-0.992	-0.347	-0.460	-0.507	-0.743
	(0.223)	(0.077)	(0.083)	(0.109)	(0.184)
Neighbors' of neighbors colonial state officials	0.269	0.033	0.122	0.098	0.259
	(0.177)	(0.066)	(0.080)	(0.079)	(0.168)
Neighbors' of neighbors colonial state agencies	0.568	0.259	0.214	0.311	0.379
	(0.190)	(0.074)	(0.090)	(0.094)	(0.169)
Neighbors' of neighbors distance to royal roads	0.172	0.041	0.091	0.099	0.149
	(0.173)	(0.060)	(0.070)	(0.085)	(0.143)
First-stage R^2:	0.671	0.644	0.684	0.675	0.626
Observations	975	975	975	975	975

All reported estimates are instrumental variables average marginal effects of the best response equation. All models include department fixed effects and the following vector of controls: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and a department capital dummy. Column 1 reproduces column 3 of Table 3 for comparison. Column 2 measures local state capacity as the log number of health agencies and health posts. Column 3 measures local state capacity as the log number of notary offices, jails, deeds registry offices, and tax collection offices. Column 4 measures local state capacity as the log number of Telecom offices, post offices, and fire stations. Column 5 measures local state capacity as the log number of public schools and libraries. Panel I reports the estimates of the best response equation, and Panel II reports the first stage for the instrumental variables models. In all models log population is instrumented using 1843 population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Appendix Table 10. Experiment: Implications of Moving All Municipalities below Median National State Capacity to Median

Nonlinear model (under SMM parameter estimates)											
General equilibrium change in median of:											
State capacity				Life quality index		Utilities coverage		% not in poverty		Secondary enrollment	
National:		Local:									
From	To	From	To	From	To	From	To	From	To	From	To
220	275.3	10	12.1	48	49.7	53.3	54.7	57.1	58.6	56.6	57.5
Percent change:											
25.1%		21.3%		3.5%		2.6%		2.6%		1.7%	

This table reports results from an experiment which takes all municipalities below median national state capacity (**b**) to the median, using the estimated parameters of the model. Local state capacity is measured as the number of local state agencies. National state capacity is measured as the number of national public employees. The table reports the medians of the empirical and counterfactual distributions using the structural parameters of the nonlinear model estimated with SMM, in the general equilibrium exercise where both municipalities and the national level have best responded to the shock. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average.

Appendix Table 11. Experiment: Implications of Moving the National-Level Weights of Municipalities below Median to Median

General equilibrium change in median of:											
State capacity				Life quality index		Utilities coverage		% not in poverty		Secondary enrollment	
National:		Local:									
From	To	From	To	From	To	From	To	From	To	From	To
220	261.6	10	12.0	48	49.1	53.3	54.6	57.1	59.0	56.6	57.6
Percent change:											
18.9%		20.0%		2.3%		2.5%		3.3%		1.9%	

This table reports results from an experiment which takes all municipalities below median national state weights to the median, using the estimated parameters of the model. Local state capacity is measured as the number of local state agencies. National-level state capacity is measured as the number of national-level public employees. The table reports the medians of the empirical and counterfactual distributions using the structural parameters of the nonlinear model estimated with SMM, in the general equilibrium exercise where both municipalities and the national level have best responded to the shock. The life quality index is for 1998, the public utilities coverage (aqueduct, electricity, and sewage) is for 2002, the fraction of the population above the poverty line is for 2005, and the secondary enrollment rate is the 1992-2002 average.

Appendix Table 12. Regressions of Optimal Reallocation of State Capacity on Network Centrality Statistics

	Dependent Variable: Optimal reallocation of state capacity							
State capacity measured as:	log of number of municipality agencies				log of number of municipality public employees			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Betweenness Centrality$_i$	5.99			5.13	9.58			8.16
	(0.956)			(1.376)	(1.438)			(1.971)
Bonacich Centrality$_i$		2.10		0.29		3.57		0.59
		(1.314)		(1.487)		(1.943)		(2.195)
Local Clustering$_i$			0.35	0.28			0.56	0.43
			(0.091)	(0.090)			(0.129)	(0.133)
log population$_i$	-12.24	-12.05	-12.01	-12.13	-18.51	-18.19	-18.10	-18.32
	(1.462)	(1.458)	(1.442)	(1.409)	(2.094)	(2.086)	(2.050)	(2.013)
R^2	0.80	0.80	0.80	0.81	0.81	0.80	0.81	0.81
Observations	962	962	962	962	988	988	988	988

All reported estimates are from OLS regressions. All models include a constant, department fixed effects, a department capital dummy, and the following vector of controls and their quadratics: longitude, latitutde, surface area, elevation, annual rainfall, distance to a current highway, and log population. Standard errors reported in parenthesis are robust to arbitrary heteroskedasticity and allow for arbitrary spatial correlation within the network following Conley (1996) adapted to the network structure as described in the text.

Likelihood Function on the Network

In this section we suggest an approach for MLE estimation of a network model with nonlinear best responses like ours, taking the national state's choices as predetermined. Since the difficulty in writing the likelihood lays on the cross municipality choice dependencies, we abstract from the prosperity outcomes and focus on the likelihood for the vector of state capacity choices. In particular, we show how to express the likelihood of the data on a network game with nonlinear best responses, and suggest an estimation procedure.

We begin establishing some notation. Recall that $N(i)$ is the set of neighbors of i, and denote $L(i)$ to be the set of i's neighbors' local state capacity choices. Thus, $L(i) = \{l_j : j \in N(i)\}$. Assume $\xi_i \sim f(\xi)$. This and the best response in equation (14) imply that we can express the coditional likelihood for l_i as (conditional on i's neighbors' choices):

$$\mathcal{L}_i(l_i|L(i);\boldsymbol{\psi}) \equiv f\left(h_\xi(l_i|\mathbf{p}_i, b_i;\boldsymbol{\psi})\right)|J_i|,$$

where $|J_i|$ is the Jacobian of the transformation. Notice that the network structure implies that conditional on $L(i)$, $l_i \perp l_k$ for any $k \notin L(i)$. In other words, once we condition on i's neighbors' choices, choices of all other municipalities provide us no further information. Thus, $\mathcal{L}_i(l_i|L(i);\boldsymbol{\psi}) = \mathcal{L}_i(l_i|\boldsymbol{l}_{-i};\boldsymbol{\psi})$, where $\boldsymbol{l}_{-i}$ denotes all local state capacity choices except i's. Now index (order) the set of all observations in an arbitrary way from $i = 1$ to n. The joint likelihood of $\boldsymbol{l} = (l_1, l_2, ..., l_n)$ can be expressed as the product of conditionals and marginals:

$$\mathcal{L}(\boldsymbol{l};\boldsymbol{\psi}) = \mathcal{L}_1(l_1|l_2,...,l_n;\boldsymbol{\psi})\mathcal{L}_2(l_2,...,l_n;\boldsymbol{\psi})$$

$$= \mathcal{L}_1(l_1|l_2,...,l_n;\boldsymbol{\psi})\mathcal{L}_2(l_2|l_3,...,l_n;\boldsymbol{\psi})\mathcal{L}(l_3,...,l_n;\boldsymbol{\psi})$$

$$= \prod_{j=1} \mathcal{L}_j(l_j|l_{j+1},...,l_n;\boldsymbol{\psi})\mathcal{L}(l_n)$$

Notice that for a given j, if $\forall k < j$, $k \notin N(j)$, put differently, if no neighbor of j has an index below j, then

$$\mathcal{L}_j(l_j|l_{j+1},...,l_n;\boldsymbol{\psi}) = \mathcal{L}_j(l_j|L(j);\boldsymbol{\psi})$$

This condition cannot hold for all municipalities. In particular, there will exist municipalities j such that $\exists k_1, k_2, ..., k_t < j$ and $(k_1, k_2, ..., k_t) \in N(j)$, in which case

$$\mathcal{L}_j(l_j|l_{j+1},...,l_n;\boldsymbol{\psi}) \neq \mathcal{L}_j(l_j|L(j);\boldsymbol{\psi})$$

However, for a sparse network, with an appropriately chosen order of municipalities, it will be true for a significant subset of municipalities. Let us next denote the set of municipalities for which this equality holds by A. Similarly, denote the set of municipalities for which the equality does not hold as B.

Although we do not have a known expression for the conditional likelihood of the observations $j \in B$, we can observe that

$$\mathcal{L}_j(l_j|l_{j+1},...,l_n;\boldsymbol{\psi}) = \int \mathcal{L}_j(l_j|l_{k_1},l_{k_2},...,l_{k_t},l_{j+1},...,l_n;\boldsymbol{\psi})\mathcal{L}(l_{k_1},l_{k_2},...,l_{k_t})dl_{k_1}dl_{k_2}...dl_{k_t}$$

$$= \int \mathcal{L}_j(l_j|L(j) \cup \{l_s : s > j\};\boldsymbol{\psi})\mathcal{L}(l_{k_1},l_{k_2},...,l_{k_t})dl_{k_1}dl_{k_2}...dl_{k_t}$$

Here we condition on the “missing neighbors," (with orders lower than j), and then integrate them out assuming we knew the marginal density for them. This is convenient since $\mathcal{L}_j(l_j|L(j) \cup \{l_s : s > j\};\boldsymbol{\psi}) = \mathcal{L}_j(l_j|L(j);\boldsymbol{\psi})$, that is, after conditioning for all of j's neighbors, l_j is independent of all other observations. Thus we have

$$\mathcal{L}_j(l_j|l_{j+1},...,l_n;\boldsymbol{\psi}) = \int \mathcal{L}_j(l_j|L(j);\boldsymbol{\psi})\mathcal{L}(l_{k_1},l_{k_2},...,l_{k_t})dl_{k_1}dl_{k_2}...dl_{k_t}.$$

As a result, the joint likelihood can be expressed as a function of all of the conditionals, which are simply given by the best responses:

$$\mathcal{L}(l_1,...,l_n;\boldsymbol{\psi}) = \left[\prod_{j\in A}\mathcal{L}_j(l_j|L(j);\boldsymbol{\psi})\right]\left[\prod_{j\in B}\int \mathcal{L}(l_j|L(j);\boldsymbol{\psi})\mathcal{L}(L(j)\cap\{l_s : s<j\};\boldsymbol{\psi})d(L(j)\cap\{l_s : s<j\})\right].$$

In the above expression, for each $j \in B$, we are integrating out the state capacity choices of neighbors of j with indices lower than j. Once again, notice that for a relatively sparse network, the above integral will not be too high-dimensional. In the expression for the joint likelihood above, the issue is that we do not know the marginals in the second bracket. One feasible strategy would be to posit a prior joint density $\mathcal{L}^0(l_1,l_2,...,l_n)$, and to use this prior to compute a “Bayesian” MLE of $\boldsymbol{\psi}$:

$$\hat{\boldsymbol{\psi}}^0 = argmax_{\boldsymbol{\psi}}\sum_{j\in A} ln\mathcal{L}_j(l_j|L(j);\boldsymbol{\psi})+\sum_{j\in B} ln\int \mathcal{L}(l_j|L(j);\boldsymbol{\psi})\{\mathcal{L}^0(L(j)\cap\{l_s : s<j\};\boldsymbol{\psi})d(L(j)\cap\{l_s : s<j\}).$$