Separate Online Appendices with Supplemental Material for: Trade and Institutions, Explaining Urban Giants

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Abstract

This document contains a set of appendices with supplemental material. Section 1 presents the time lag before which an income gap approximated by satellite pictures affects the size of urban primacy. Section 2 describes how our indicator of historical network has been computed. Section 3 provides the microeconomic foundations for our specification of market access. Section 4 provides an alternative measure of democracy in the first step of our IV strategy. In Section 5 we wonder what happens whether the market access is determined by historical institutions. In Section 6 we find that our result are robust to a change in the indicator of democracy. In Section 7 we go beyond our binary version of democracy. In section 8 we verify that our result are also found with non parametric estimations.

1 Light nights and urban primacy

Table (1) presents our baseline estimation using the FE estimator with different lag of the income gap approximated by the differential of night lights between the biggest city and the rest of the country. The current differential seems to have no effect (Column 1), while the differential of light intensity in the night observed five (Column 2) or ten years ago (Column 3) explains the current population growth of the biggest city.

Table 1: Effect of the constructed light night gap on urban primacy

	(1)	(2)	(3)
Light gap (level)	0.029		
	(0.021)		
Light gap (Lag = 5)		0.074	
		(0.032)^b	
Light gap (lag = 10)			0.085
			(0.024)^a
Temperature	0.193	0.553	0.848
	(0.186)	(0.256)^b	(0.277)^a
Humidity	-0.022	-0.027	-0.020
	(0.019)	(0.028)	(0.017)
Constant	1.241	0.425	-0.067
	(0.541)^b	(0.733)	(0.802)
R-squared	0.983	0.982	0.989
Observations	686	505	322

FE estimator. All variables are in Log. a: significant at 1%, b: at 5%. The income gap (Light gap) between the biggest city and other cities is approximated by the differential between the intensity of night lights in the biggest city and the intensity of lights in other cities obtained from satellite pictures (1992-2010). All estimations include a full set of year and country fixed effects.

2 Outdegree Indicator of Network

Historical data on trade comes from Fouquin and Hugot (2016). Working with historical data obviously lead to deal with entities that does not exist in 1900 (e.g. colonial empires). To compute a network indicator at the level of countries (as they are known today), we assume that a country trading to a group of countries is connected to all of these countries. For instance when Italy traded with "Italian East Africa" we consider that Italy was connected to Eritrea, Somalia and Ethiopia. In the reverse case where "Italian East Africa" traded with Italy, we assume that Eritrea, Somalie and Ethiopia were connected with Italy. The nature of this database explains why we have not go beyond an indicator of network based on "links", indeed building the network of trade flows would lead to make critical assumptions on the distribution of trade between countries. Figure below presents this network.

The size of vertices is proportional to the number of outcoming arcs: a large circle indicate that the corresponding country exports to a large number of exporting countries. Considering a dummy variable taking, L_{ij} taking one when country i and j are trade connected, and zero otherwise, the outdegree measure is computed as follows:

$$o_{ij} = \frac{\sum_{j \neq i} L_{ij}}{N-1}$$

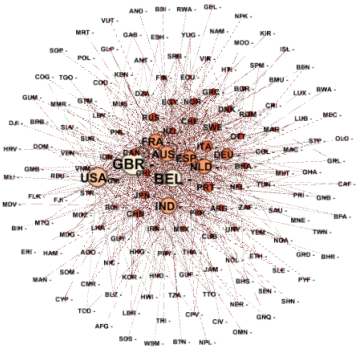

Figure 1: World Trade Network in 1900

where i is the exporter and where N represents the number of node/country in this network.

3 Theoretical foundation of the market access

Here we briefly present the theory behind the Redding and Venables (2004) methodology to build the market access variable.

In standard urban economics model of the NEG (e.g. Krugman and Livas, 1998), individuals consume a composite basket of different varieties produced under increasing returns and sold under monopolistic competition. These goods are exchanged between cities and with the rest of the world under iceberg trade costs denoted τ. Agents lives in monocentric cities and have to commute to work in the central business district where jobs are located. Market clearing on the goods market gives the following export equation (denoted X_{ij}, expressed in value) from city i to j:

$$X_{ij} = \tau_{ij}^{-\varepsilon} \frac{Y_j}{P_j} s_i \tag{1}$$

where ε is the relative elasticity of export with respect to bilateral trade costs i.e. $\varepsilon = \partial \ln(X_{ij}/X_{jj})/\partial \ln \tau_{ij}$, Y_j is the nominal income of each importing partner j that depends on wage, commuting costs and land rent. The term s_i takes into account the exporting capacity of firms located in i (mainly the number of firms and the factory price that depends on wage and markup). Lastly, P_j is a reversed measure of the price index in j that depends on trade costs and prices, called supplier access of importer j (since it is a weighted sum of the supplier market capacities):

$$P_j = s_j \tau_{jj}^{-\varepsilon} + \sum_{i \neq j} s_i \tau_{ij}^{-\varepsilon} \tag{2}$$

Now considering the gravity equation (1), one can remark that the term $\tau_{ij}^{-\varepsilon} Y_j / P_j$ is a measure of the real income of consumers/importers located in j

net of transportation costs, in other words it represents the market access of firms that exports from i to j. The aggregate market access obtained from the location i is thus given by:

$$\Omega_i = \tau_{ii}^{-\varepsilon} \frac{Y_i}{P_i} + \sum_{j \neq i} \tau_{ij}^{-\varepsilon} \frac{Y_j}{P_j} \tag{3}$$

4 Alternative measures of democracy in the first step IV strategy

In the main document the impact of the mortality rate of settlers on the current institution, measured by the indicator of democracy of ANRR, in only verified for ten years (between 1962-1972).[1] Since this result is potentially interesting regarding the debate about this instrumentation (see Albouy, 2012), we check whether the AJR thesis is also invalidating by using other measures of democracy: the polity 2 score of democracy, the Freedom House indices of political rights (PR) and civil liberty (CL). Using these three indicators, the thesis of AJR is verified. These estimations confirm a negative and significant effect of colonizers mortality rate on these different measures of democracy and a positive and still highly significant impact of waves of democratization.

Table (2) presents this first stage for some years and confirms the negative sign of colonizers mortality rate on democracy and the positive impact of waves of democratization on the polity2 score of democracy.

Table 2: Democracy (Polity 2 score), first step

	1962	1972	1982	1992	2002	2010
Waves of democratization	10.228	12.025	11.301	14.209	12.446	10.616
Z_i	$(1.605)^a$	$(2.757)^a$	$(2.586)^a$	$(1.347)^a$	$(2.284)^a$	$(2.215)^a$
Mortality rate of colonizers	-2.560	-2.777	-2.559	-1.756	-1.013	-1.297
M_i	$(1.203)^b$	$(1.406)^c$	$(1.199)^b$	$(0.843)^b$	(0.705)	$(0.760)^c$
Constant	7.693	6.939	5.660	2.288	0.346	3.074
	(5.613)	(6.467)	(5.648)	(3.872)	(3.320)	(3.185)
R-square	0.659	0.632	0.424	0.669	0.642	0.515
Observations	35	36	36	36	36	36

OLS estimator. a: significant at 1%, b: at 5%. The mortality rate of colonizers (in log) comes from Albouy (2012). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2016) and instrumented with their instrument based on waves of democratization.

Countries where colonizers face high mortality rate have now a lower level of democracy than other countries. This result is significant over a large part of the period (excepted four years around the end). Notice also the erosion of

[1] This have led us to verify whether our results are robust to the exclusion of this variable (they are, see Footnote 23).

this historical heritage, the coefficient of the mortality rate declines from -2.5 in 1962 to -1.3 in 2010.

The results are similar when using the Freedom House indices of political rights (PR) and civil liberty (CL). Indeed higher score of PR and CL indicate less freedom, explaining the now positive sign of the coefficient of mortality.

Table 3: Democracy (PR, CL), first step

CL							
	1995	2000	2002	2004	2006	2008	2010
Waves of democratization	-3.181	-2.684	-2.918	-2.670	-2.522	-2.597	-2.259
Z_i	$(0.460)^a$	$(0.519)^a$	$(0.500)^a$	$(0.473)^a$	$(0.436)^a$	$(0.476)^a$	$(0.491)^a$
Mortality rate of colonizers	0.931	0.675	0.660	0.722	0.601	0.617	0.658
M_i	$(0.161)^a$	$(0.237)^a$	$(0.228)^a$	$(0.200)^a$	$(0.194)^a$	$(0.198)^a$	$(0.222)^a$
Constant	2.206	2.593	2.676	2.073	2.465	2.537	2.112
	$(0.857)^b$	(1.129)	(1.100)	$(0.932)^b$	$(0.830)^a$	$(0.868)^a$	$(1.005)^b$
R-square	0.719	0.574	0.588	0.568	0.548	0.520	0.427
Observations	36	36	36	36	36	36	36
PR							
	1995	2000	2002	2004	2006	2008	2010
Waves of democratization	-3.663	-4.098	-3.848	-3.778	-3.815	-4.047	-3.754
Z_i	$(0.456)^a$	$(0.627)^a$	$(0.619)^a$	$(0.632)^a$	$(0.609)^a$	$(0.650)^a$	$(0.684)^a$
Mortality rate of colonizers	0.982	0.449	0.499	0.602	0.441	0.561	0.518
M_i	$(0.155)^a$	$(0.246)^c$	$(0.262)^c$	$(0.274)^b$	$(0.248)^c$	$(0.240)^b$	$(0.253)^b$
Constant	2.039	4.414	3.911	3.373	4.080	3.836	3.778
	$(0.731)^a$	$(1.222)^a$	$(1.148)^a$	$(1.190)^a$	$(0.909)^a$	$(0.791)^a$	$(0.966)^a$
R-square	0.695	0.573	0.604	0.577	0.616	0.640	0.530
Observations	36	36	36	36	36	36	36

OLS estimator. a: significant at 1%, b: at 5%. The mortality rate of colonizers (in log) comes from Albouy (2012). Data on democracy, the political rights (PR) and civil liberties (CL) indices, are from Freedom House dataset. Waves of democratization is from ANRR (2017).

5 Market access determined by historical institutions

To deepen our understanding on the channels from which institutions play on the biggest city, we also consider that the market access is determined by historical institutions. Table (4) estimate the zero-stage described in the text by regressing the market access on the mortality rates of colonizers in 1500. The difficulty to settle have influenced the market potential of countries; individuals extracting rents typically viewed these economies as peripheral, while individual in inclusive institution were fighting to bring their economy at the core of the trading system. Results confirm this hypothesis, the difficulty of settlement explains the current low level of market access. A 1% increases in the mortality rates of colonizers

in 1500 decreases the market access between 0.167% and -0.392.

Table 4: Market Access, zero-stage

	1962	1972	1982	1992	2002	2010
Mortality	-0.177	-0.295	-0.379	-0.392	-0.373	-0.167
	$(0.084)^b$	$(0.129)^b$	$(0.167)^b$	$(0.181)^b$	$(0.177)^b$	$(0.085)^c$
Constant	2.820	2.193	3.554	3.791	4.184	3.208
	$(0.098)^a$	$(0.434)^a$	$(0.362)^a$	$(0.425)^a$	$(0.328)^a$	$(0.296)^a$
R-Square	0.873	0.568	0.356	0.427	0.558	0.538
Observation	35	36	36	36	36	36

OLS estimator. All variables are in Log. a: significant at 1%, b: at 5%. The mortality rate of colonizers (in log) comes from Albouy (2012). The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII.

Consequently, we use the predicted value of this mortality rate as an instrument of the market access in the first step. Table (5) presents these results where, as expected, the instrument explains the variable of interest.

Table 5: First stage

	Market Access Eq. (??)
Market Access ($\widehat{D^g_{it}}$)	0.974
Instru: Mortality	$(0.103)^a$
Temperature	0.552
	$(0.103)^a$
Precipitation	0.001
	(0.016)
Constant	-1.685
	$(0.543)^a$
R-square	0.98
Observations	1579
F-test	89.68

2SLS procedure, a: significant at 1%, b: at 5%. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using the mortality rate of colonizers provided by Albouy (2012). This estimation includes time effects and individual fixed effects.

To alleviate potential multicolinearity problems between our instrument of political institutions and this new instrument of market access, we exclude the mortality rate in the zero stage concerning institutions. In other terms, the

instrument of institution used in the first stage is only based on waves of democratization $\widehat{H_i^g} \equiv \widehat{\gamma} G_i$. We finally use the predicted value of these two instruments in the second stage. Table (6, Column 1) report this result. In Column 2, we exclude the variable of institutions to see how the multicolinearity can biased the significance of this result and in Column 3 we use the instrument of institution described in the text (i.e. that takes into account mortality rates). The market access is never significant.

Table 6: Trade, Institutions and Urban Primacy

dep:	Democracy ANRR Eq. (??)		
Market Access	0.136	0.083	0.113
Instru: Mortality	(0.133)	(0.106)	(0.131)
Democracy $(\widehat{\varsigma G_{it}})$	0.087		
Instru: Waves only	$(0.034)^b$		
Democracy $(\widehat{\varsigma H_{it}^g})$			0.091
Instru: Waves + Mortality			$(0.035)^a$
Light	0.080	0.042	0.080
	$(0.020)^a$	$(0.012)^a$	$(0.020)^a$
Temperature	0.045	0.064	0.050
	(0.154)	(0.143)	(0.152)
Precipitation	-0.009	-0.006	-0.007
	(0.012)	(0.012)	(0.012)
Constant	-1.975	-1.666	-1.947
	$(0.358)^a$	$(0.341)^a$	$(0.358)^a$
R-square	0.99	0.99	0.99
Observations	306	313	306

2SLS procedure, a: significant at 1%, b: at 5%., c: at 10% The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using genetic distance in 1500 from Spolaore and Wacziarg (2017). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2016) and instrumented with their instrument, denoted ANRR, based on waves of democratization and with the mortality rate of colonizers provided by Albouy (2012). All estimations include time effects and individual fixed effects.

6 Another indicator of democracy

As a robustness check, this Appendix reports results based on Polity2 score of democracy. Table (7) presents the same structure than the Table presented in the text. Although the coefficient of the Polity2 score of democracy are significant at only 5%, results are similar to the ones reported in the text.

Table 7: First and Second Nature of Urban Giants (Robustness check with polity2 score)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Market Access	-0.146	-0.316			-0.321		
Instru: Genetic	(0.156)	(0.165)^{c}			(0.159)^{b}		
Market Access			0.081	0.091		0.081	0.068
Instru: Mortality			(0.103)	(0.110)		(0.103)	(0.108)
Democracy		0.007		0.006			
Instru: Mort+ANRR		(0.003)^{b}		(0.003)^{b}			
Democracy					0.007		0.006
Instru: ANRR					(0.003)^{b}		(0.003)^{b}
Democracy							
Instru: Mortality							
Light	0.046	0.083	0.042	0.077	0.084	0.042	0.077
	(0.012)^{a}	(0.021)^{a}	(0.012)^{a}	(0.019)	(0.021)^{a}	(0.012)^{a}	(0.019)^{a}
Temperature	0.132	0.053	0.110	0.017	0.052	0.110	0.018
	(0.114)	(0.108)	(0.122)	(0.117)	(0.109)	(0.122)	(0.118)
Precipitation	-0.007	-0.006	-0.006	-0.007	-0.006	-0.006	-0.007
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Constant	-2.122	-1.562	-2.670	-2.538	-1.546	-2.670	-2.483
	(0.555)^{a}	(0.542)^{a}	(0.426)^{a}	(0.407)^{a}	(0.534)^{a}	(0.426)^{a}	(0.406)^{a}
R-square	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Observations	322	306	313	306	315	313	306

2SLS procedure, all variables are in Log. a: significant at 1%, b: at 5%, c at 10%. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using genetic distance in 1500 from Spolaore and Wacziarg (2017) and the mortality rate of colonizers from Albouy (2012). Data on democracy are from PolityIV database; it is instrumented with Acemoglu, Naidu, Restrepo, Robinson (2016) instrument, denoted ANRR, based on waves of democratization and with the mortality rate of colonizers provided by Albouy (2012). All estimations include a full set of year and country fixed effects.

7 Institutions with and without urban primates

In this appendix we analyze whether our results can be generalized inside our categorization of democracy *versus* dictatorship and whether the existence of urban giant can shape our result. We conjecture that for a democratic regime, the existing urban pattern has no role. To win a election, politicians need to win in different regions and cities and thus the degree of democratization *in these countries* may not be a determinant of urban bias and of urban primacy. Considering now an unstable dictatorship, such a regime may have a too weak power to reverse the spatial pattern of a country where activities are dispersed;

but the situation can be different in these regimes if there is already an urban giant. In a weak dictatorship, it can be efficient to concentrate the governmental policy in the biggest city.

How to define a "weak dictatorship" or the "existence" of an urban primacy? We consider that dictatorship (as defined by ANRR) with weak military power are weak dictatorship. We calculate the average "military personal on labor force ratio" over the period 1992-2010 and each country is labeled as "high military power country" ("low military power country") when its associated group mean ratio is equal or above (below) the 75 percentile of its density. While this computation is certainly not exhaustive, it undoubtedly covers cases of weak dictatorships. Concerning democracy, based on ANRR, we create a dummy variable taking one when the country has never experienced a period of dictatorship during all the period and zero when it had experienced at least one year of dictatorship.

Finally based on the Zipf's law, establishing that within a country, the size of the largest cities is inversely proportional to their rank, a dichotomous measure of the current existence of urban primacy is built. A country is considered as exhibiting urban primacy if its most populous city has more than twice the population of the second city. On the contrary, this variable takes zero when the second city in the urban hierarchy has more than half of the population of the biggest city.

In Table (8, col 1&2) we study how the share of the population in the biggest city evolves in countries with democratic rules and where the level of urban primacy is low. In that case, there is no evidence that institutions influence the relative growth of the biggest city. Similar results are obtained in democratic countries with urban giants. The hypothesis that an urban bias can be beneficial to democratic regime (for instance to win election) in countries where an urban giant dominates the landscape is not obvious; there is no apparent relationship between political institutions and urban primacy in countries already democratized whatever the urban pattern. On the opposite in countries with weak dictatorship and urban primacy, more democracies foster the development of the largest city (see Table (8), col 3). The same result is obtained concerning countries that already host an urban giant, i.e. in countries where the biggest city is higher that the size predicted by the Zipf's law, democracies favors the agglomeration of the population there.

Table 8: First and Second Nature of Urban Giants

	(1)	(2)	(3)	(4)
Market Access	-0.928	-3.840	0.404	-0.317
Instru: Genetic	(0.281)[a]	(5.101)	(0.359)	(0.175)[c]
Democracy	0.096	-0.131	0.930	0.229
Instru: Mort+ANRR	(0.106)	(0.147)	(0.394)[b]	(0.051)[a]
Light	-0.046	-0.020	0.268	0.127
	(0.018)[b]	(0.054)	(0.105)[b]	(0.032)[a]
Temperature	-2.111	0.846	-2.734	0.385
	(0.686)[a]	(0.821)	(1.958)	(0.175)[b]
Precipitation	-0.086	0.120	-0.043	-0.023
	(0.043)[b]	(0.190)	(0.059)	(0.015)
Constant	-2.807	-8.821	-12.916	-2.316
	(1.480)[c]	(11.737)[a]	(6.226)[c]	(0.578)
R-square	0.999	0.995	0.998	0.998
Observations	81	99	36	180

Column (1): Democracy without urban primacy, Column (2): Democracy with urban primacy, Column (3): Weak dictatorship with urban primacy, Column (4): All with urban primacy. Estimation: 2SLS procedure, all variables are in Log. a: significant at 1%, b: at 5%. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. This market access is instrumented using genetic distance in 1500 from Spolaore and Wacziarg (2017) and the mortality rate of colonizers from Albouy (2012). Data on democracy are from Acemoglu, Naidu, Restrepo, Robinson (2016) and instrumented with their instrument, denoted ANRR, based on waves of democratization and with the mortality rate of colonizers provided by Albouy (2012). All estimations include a full set of year and country fixed effects.

8 Non parametric estimation: matching estimator approach

The previous results are based on a linear functional relationship and on strong assumptions regarding the IV strategy. The combination of non-random selection into the process of democratization and the omission of non-linear relationships, can biased estimates. By finding for each observation in the treatment group, a statistical "twins" in the control group with the same characteristics, and by using these observations to compute a counterfactual outcome without treatment for the observations at hand, matching estimators potentially address these problems without specifying any parametric assumption, and are thus used here as an alternative strategy.

For any observation, we observe the treatment I_{it} (democratic regime or not) and the outcome for this treatment: the relative size of the largest city under a democracy, denoted $u_{it}(1)$, or under another regime, denoted $u_{it}(0)$.

We use the Average Treatment Effect on the entire sample (ATE) and the Average Treatment effect for the Treated (ATT) by performing the nearest neighbor matching (Abadie and Imbens, 2006). At least two assumptions are crucial. The first one is the "conditional mean independence" leading to assume that the political regime I_{it} is independent of urban primacy $u_{it}(1)$ and $u_{it}(0)$, conditional on a set of covariates. The second is the stable-unit-treatment-value assumption (SUTVA) or the "non-interference" assumption, leading in our case to consider on the one hand that the treatment I_{it} is identical for each treated observation and on the second hand that being under a democratic regime in a given country does not influence untreated urban primacy.

We retain covariates used in the previous section apart from temperature and precipitation, to which we add country-year GDP per capita and the rural population growth. Using these covariates for the five nearest neighbors, Table (9, Row 1 and 3) presents the ATEs and ATTs. Since the nearest-neighbor matching estimators may not be consistent when matching on more than one variable,[2] Table (9, Row 2 and 4) also presents bias-corrected estimator results. Reported ATEs and ATTs are positive, statistically significant and then confirm results obtained in the previous section. Democracy causes an increase in the relative size of the biggest city by an average of 1.39 (i.e., $e^{0.332}$) point. The sensitivity analysis based on different nearest neighbors (1 to 4) confirms this conclusion.

Table 9: Average effect of democracy on log urban primacy

		Outcome: log_Prim_pop
	# of observation (# of Democracies)	703 (532)
(1)	A-I ATEs	0.514
		$(0.053)^a$
(2)	A-I ATEs (Bias adjusted)	0.285
		$(0.059)^a$
(3)	A-I ATTs	0.645
		$(0.060)^a$
(4)	A-I ATTs (Bias adjusted)	0.332
		$(0.066)^a$
(5)	ATT (Propensity score matching)	0.25
		$(0.121)^b$

Matching procedure, all variables are in Log. a: significant at 1%, b: at 5%. The market access is computed from the estimation of a gravity equation using bilateral exportation from COMTRADE, distance and geographical variables from the CEPII. Data on democracy, the treatment, is from Acemoglu, Naidu, Restrepo, Robinson (2016).

As a robustness check, in particular regarding the selection bias, we also use the propensity-score estimator. In contrast with the previous matching procedure, propensity-score matching relies on only one characteristic which is

[2] see Abadie and Imbens (2006)

the probability of being in democracy conditionally on covariates, therefore, the matching procedure can be less precise. We adopt a logit model to estimate these propensity scores. The covariates are the same ones used for matching earlier. In practice, we take into account the fact that the propensity scores are estimated rather than known when calculating standard errors.[3] Table (9) presents this PSM-ATT which is computed by calculating the average of the difference between the observed and potential outcome for each observation in the treated group. This last analysis confirms the results obtained so far, the urban primacy has been promoted by democratic regimes.

[3]The newest command in Stata allows this.