Renewable Resources, Ethnic Institutions and Regional Economic Activity:

The Case of Maritime Fishery in Africa

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May 30, 2014

Abstract

Maritime fisheries in African coastal regions play an important role as a driver of economic and social development. Africa is also a highly fractionalized country and deeply-rooted ethnic institutions play a major role on how natural resources are managed. This paper constructs a novel panel dataset, which combines information on fish production with regional variation in economic activity. We use satellite data on nighttime light intensity to analyse the impact of shocks to fish production on subnational economic activity in 812 coastal regions from 31 African countries for 1992 to 2007. We address endogeneity by instrumenting fish production with yearly variation in sea-surface temperature. We find that a 10 % increase in fish production leads to a 3 % increase in contemporary regional economic activity. Further, we present evidence of the importance of pre-colonial political centralization on a regions vulnerability to contemporary negative shocks to fisheries. In particular, we find that a decrease in regional economic activity due to a negative shock to fish production is mitigated by up to 80 % in societies with strong pre-colonial political centralization.

Keywords: African fisheries, regional economic activity, ethnic institutions.
JEL: Q22, Q56, R11, P48

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1 Introduction

Next to human and physical capital, access to and use of natural resource deposits play an important role in countries' economic development and growth. As nutritional sources they support the livelihood of human beings, as input factors they facilitate the production of physical capital. The impact of primary goods production on economic growth depends on various institutional factors formed by historic cultural and biological traits (e.g., Acemoglu, Johnson & Robinson 2005, Spolaore & Wacziarg 2013). The increasing size of human population, growing economic activities, a severe overexploitation of natural resources in the past and changing climatic conditions in the future will make the constant supply of these resources unassured and, therefore, will challenge the future development of economies, especially resource based economies in developing countries. In light of these upcoming challenges it is important to know about the potential impacts of changes in natural resource availability on economic development. Further, insights how different institutional settings can handle these changes help to make economic and social efficient policy decisions.

In this paper we are going to answer two research questions. First, we will determine the impact of maritime fisheries on regional economic activity. And second, we are going to explore the role of institutions, especially subnational deeply rooted ethnic institutions, in shaping the relationship between fish production and regional economic activity. The geographic focus is on maritime fisheries in African coastal regions. Due to the fact, that these regions and countries are mainly resource based economies, the direct and indirect effects of fish production are essential for their economic and social development (Dyck & Sumalia 2010, Jacobsen, Lester & Halpern 2013). Further, the relevance of fisheries on regional employment levels is high. The employment rate in labor intensive small-scale fisheries in developing countries reaches up to 17% of the total workforce in coastal populations (Teh & Sumaila 2013). Additionally, fish is the cheapest source of animal protein and accounts for about 21% of daily intake in Africa.[1] Due to the high employment effect, high contribution on regional economic performance, high nutritional contribution and lack of adaptive capacities African economies are especially vulnerable to shocks to their primary fish production. In a recent study Allison, Perry, Badjeck, Adger, Brown, Conway, Halls, Pilling, Reynolds, Andrew & Dulvy (2009) localized two

[1] State of World Fisheries Report, United Nations Food and Agriculture Organization of the UN (2008).

thirds of the 33 most vulnerable countries to an production shock to fisheries in tropical Africa.

Institutions, formed by historical European colonization[2], matter in explaining contemporary economic development (e.g., Acemoglu, Johnson & Robinson 2001, Acemoglu, Johnson & Robinson 2002, Acemoglu et al. 2005, Acemoglu & Johnson 2005, Glaeser, La Porta, Lopez-De-Silanes & Shleifer 2004, Rodrik, Subramanian & Trebbi 2004). Recent literature has turned to an alternative causal interpretation of how institutions form current economic development. They state that historical institutions are an important causal factor but should not be abstracted from the ancestral structure of the population to explain contemporary differences in economic growth. Putterman & Weil (2010), Easterly & Levine (2012) and Comin, Easterly & Gong (2010) suggest that persistent cultural and biological traits transmitted across generations in a population are one of the key factors in explaining the impact of historical experience with settled agriculture, political institution and frontier technologies on contemporary economic development. Cultural transmitted traits can play an important role in forming generalized trust and individualism, moral norms and formal rules (Greif & Tabellini 2010, Tabellini 2008, Spolaore & Wacziarg 2009, Tabellini 2010, Ashraf & Galor 2013).

Turning to Africa, recent literature stresses the importantance of deeply rooted ethnic institutions in forming contemporary African development. Goldstein & Udry (2008) and Logan (2013) show that informal ethnic institutions and local chiefs have an important role in dispute settlement and a significant impact in distributing and controlling property rights. Further, their results suggest that these locally and deeply-rooted institutions have a positive influence on the investment of the population in secured tenure rights. Additionally, Baldwin (2013) shows that local chiefs and ethnic leaders enjoy a strong support and popularity across local communities and have a significant influence in current political turnouts. In a recent paper Michalopoulos & Papaioannou (2013) investigate the role of deeply rooted pre-colonial ethnic institutions on the development of current African economies. They show that deeply rooted long-term features of populations rather than current national institutions are instrumental in explaining contemporary economic outcomes. By combining information on the spatial distribution of ethnicities across Africa and satellite nighttime light density data as a proxy for contemporary local economic development they demonstrate that regional development is significantly higher in regions with centralized, hierarchical, pre-colonial ethnic institutions.

[2] which was partly influenced by the prevailing geographical conditions

We contribute to this literature by determining one potential causal mechanism through which ethnical institutions influence current economic performance - their capacity of dealing with economic disruptions. On a national level, several papers have shown that the quality of institutions matters when dealing with external shocks, like natural disasters, commodity price fluctuations and changes in international interest rates. Raddatz (2007), Noy (2009) and Collier & Goderis (2012) show that low-income countries with weaker institutional quality face higher reductions in real per-capita GDP when facing a shock in commodity prices, natural disaster or real interest rate, respectively. Based on local community level case study evidence suggests that strategies dealing with negative primary production shocks are predominantly based on historical practices and existing resources and depend on the strength of social networks and customary systems of governance (Nakashima & Roué 2002, Agrawal, Mearns, Perrin & Kononen 2011).

In our empirical exercise we make use of a rich dataset on Afican regions, which is based on Murdock (1967) "Ethnographic Atlas" and combines information on pre-colonial spatial distribution of 490 ethnic African homelands with a large variety of variables capturing cultural, geographic, economic and political characteristics. Further, as a proxy for economic activity in a region we use nighttime light data based on satellite images provided by the National Oceanic and Atmospheric Adminstration (NOAA). The advantage of nighttime light data is that it is available at the same high quality for all countries and at the local level, making it "uniquely suited to spatial analysis of economic activity" (Henderson, Storeygard & Weil 2012). For fish production we use data on a country's annual fish catch provided by the *Sea Around Us* Project, which is a scientific collaboration of the University of British Columbia and the Pew Environment Group.

We construct a panel dataset for 812 subnational regions in 31 African countries for the period 1992 to 2007 that combines information about nighttime light intensity, fish production and pre-colonial political centralization. Due to the potential endogenous relationship between regional income and fish production, e.g. unobserved structural or technological changes, measurement error in official data on fish production, we use exogenous variation in sea-surface temperature as an instrument for fish production. The identifying assumption is that sea-surface temperature should have no effect on nighttime-light activity on land other than through fish production. We provide a set of evidence that is supportive for the validity of this assumption.

Using an instrumental-variables strategy, we find that a 10 % increase in maritime fish production increases regional economic activity by 3 %. This is a large

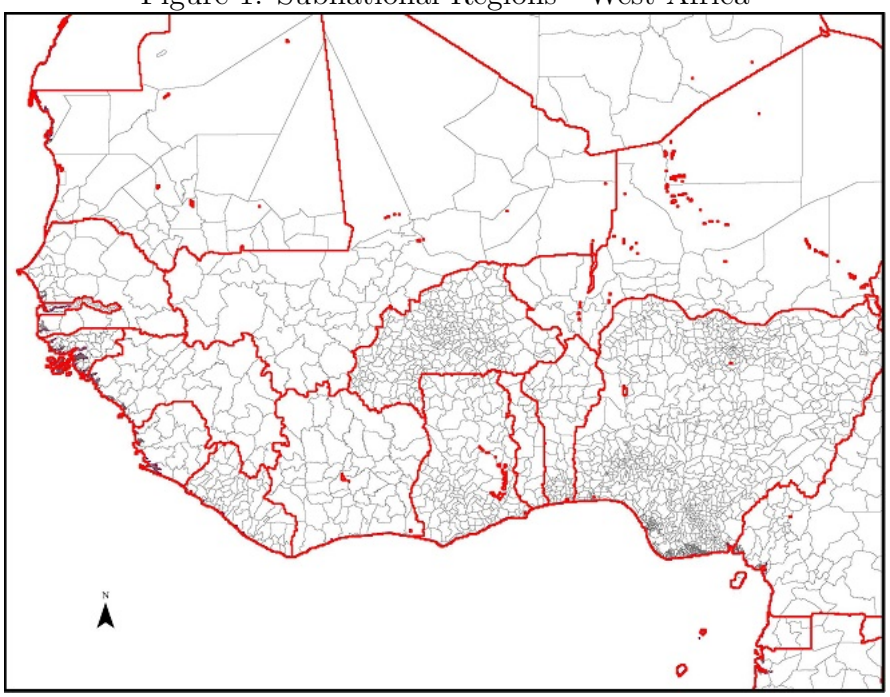
effect and pictures the social and economic importance of this primary industry on regional level for Africa. Further, we show that subnational ethnic institutions matter in dealing with shocks to fish production. A decrease in regional economic activity due to a negative shock to fish production is dampened by around 80 % in societies with pre-colonial ethnic political centralization. A reason for this large dampening effect can be that, based on advanced regulative setting, a stricter setting of property rights and other forms of public goods provision, centralized ethnic societies developed a higher degree of capability in dealing with shocks. And finally, taking a measure of quality of national institutions into account our results indicate that on a disaggregated subnational level deeply rooted local institutions do matter whereas national institution do not matter in dealing with a disruptive production shock. These findings extend the literature on the impact of deeply rooted ethnical characteristics on contemporary economic development by showing one causal mechanism how ethnic institutional and cultural traits influence current economic performance (e.g., Michalopoulos & Papaioannou 2013, Spolaore & Wacziarg 2013).

This paper is structured in the following way. In the next chapter data on pre-colonial ethnic institutions and luminosity is presented and discussed. In Chapter 3 our empirical strategy is being presented. Further, we discuss the validity of our instrument for a shock to fish production - sea surface temperature. Chapter 4 presents our main findings and the results of various robustness tests, exploring the sensitivity of our econometric specification and instrumental variable strategy. Finally, in Chapter 5 we discuss the policy implications of our results and conclude.

2 Data

We construct a panel dataset for 812 subnational coastal regions in 31 African countries from 1992 to 2007. To define the geographic boundaries of our subnational regions we relied on GIS-data from the Center for International Earth Science Information Network (CIESIN) at Columbia University and its project. We use the second subnational federal level, which corresponds for example to local government areas (LGAs) in Nigeria or districts in Ghana. Figure 1 provides an illustration of the subnational units for a set of countries in West Africa. It presents subnational boundaries for all regions in the pictured countries. However, for this study, we only use regions that are on the coast. All other regions (in Figure 1) are not part of the sample.

Figure 1: Subnational Regions - West Africa



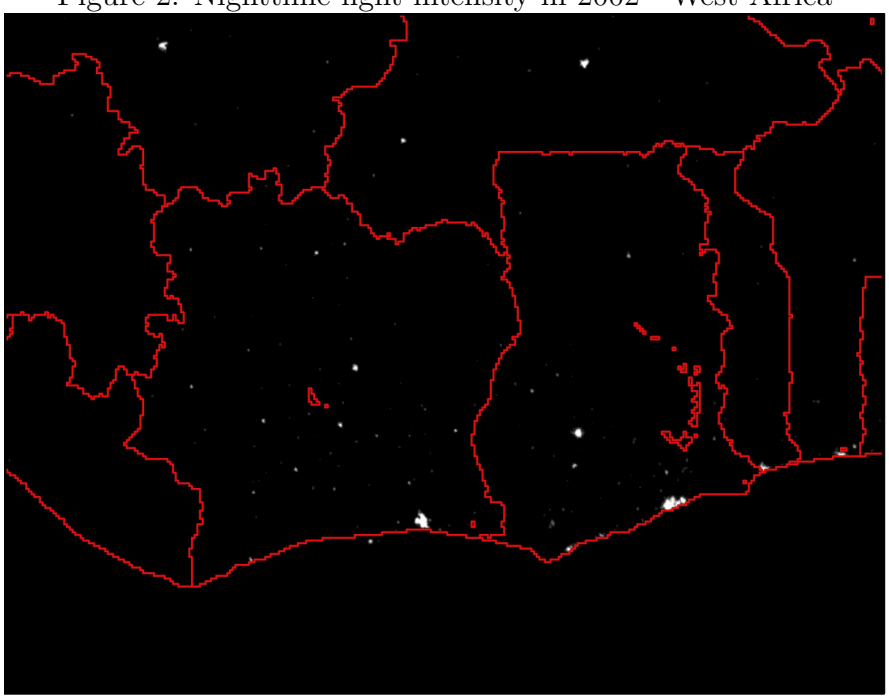
2.1 Satellite data on nighttime luminosity

Our dependent variable is satellite data on nighttime light intensity, which we use as a proxy for regional economic activity in coastal regions in Africa. The data stems from satellite imagery provided by the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (NGDC). This imagery comes from United States Air Force meteorological satellites, which circle the earth 14 times each day and record light intensity. Readings of light intensity for every location happen every evening (8.30-10.00pm) in the dark half of the lunar cycle in seasons when the sun sets early.[3] The final data is a simple average across satellites within pixel-year and varies between 0 (no light) and 63 for pixels of about 1 km^2. Figure 2 presents graphically the nighttime light intensity for a sub-sample of West African countries for the year 2002. Like GDP, nighttime light is a proxy for economic activities. Most forms of consumption and production in the evening require light, and public infrastructure is often lit at night. The advantage of nighttime light data is that it is available at the same high quality and at a very disaggregated level for all countries and every year from 1992-2011. Chen & Nordhaus (2011) and

[3] In combination with the substraction of auroral lights and forest fires this removes all sources of natural light, which leaves mostly human-made light. Observation with cloud covers are also excluded.

Henderson et al. (2012) both emphasis the applicability of nighttime light data for data-poor countries, e.g., war-prone countries.[4]

Figure 2: Nighttime light intensity in 2002 - West Africa



Within the economics literature there are already some empirical studies using nighttime light data as a proxy for economic activity on national (e.g. Chen & Nordhaus 2011, Henderson et al. 2012) and subnational level (e.g. Michalopoulos & Papaioannou 2013, Hodler & Raschky 2014). Henderson et al. (2012) and Hodler & Raschky (2014) examine the relationship between nighttime luminosity and GDP at the country level and subnational level, respectively. Both studies find a linear relationship with an estimated elasticity of about 0.3.

In addition, a number of recent papers apply nighttime luminosity data specifically to empirical questions regarding subnational growth in Africa. Michalopoulos & Papaioannou (2013) use nighttime light data as proxy for economic activity in Africa. They cross validated the data using micro-level data from the Demographic and Health Surveys and find a significant correlation of around 70 %. Shortland, Makatsoris & Christopoulou (2013) combines disaggregated nighttime light data and geo-located conflict event data to estimate the impact of local fighting activity on income in Somalia.

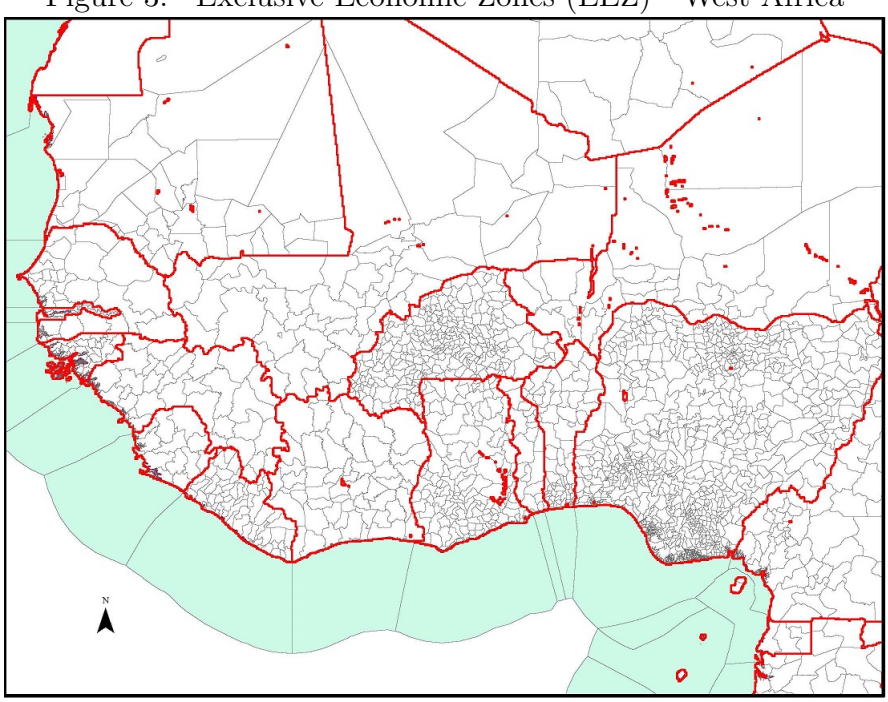
[4] Two features that fit to earlier or current situations in a number of coastal African countries.

In this study, we use yearly pixel level luminosity data and aggregate at the subnational level using the geo-referenced information of subnational boundaries. This results in our final dependent variable, $Light_{ict}$, which is the log of average nighttime light in region i in country c in year t.[5]

2.2 Fish production

Our data on fish production refers to a country's total annual fish catches in their exclusive economic zone (EEZ) for each year until 2006.

Figure 3: Exclusive Economic Zones (EEZ) - West Africa



Based on the Third United Nations Conference on the Law of the Sea, which came into force in 1994, the area out to 200 nautical miles from a state's coast line is declared as a country's exclusive economic zone. Figure 3 shows the boundaries of the EEZs again for a subsample of West African countries. Within this area, the coastal nation has sole exploitation rights over all natural resources. We attain this data from the database on global fish production of the *Sea Around Us* Project,

[5]In order to deal with 0 when log transforming the data we follow Hodler & Raschky (2014) and Michalopoulos & Papaioannou (2013) and take the logarithm of average nighttime light intensity plus 0.01.

which is a scientific collaboration of the University of British Columbia and the Pew Environment Group. Reliable and comparable data at a more disaggregated level that would match the subnational regions i are not available for fish production. We therefore construct the variable FP_{ct} as log of a country c's total fish catches in tonnes ('000) in year t. In our econometric specification itself, we will be using the first lag, FP_{ct-1}, for the following reasons. The figures on annual catches refer to the total catches over a year. Considering the differences in harvesting seasons, some fish species are caught later in the year than others. There are likely delays between the exchange of fish for money on the market and the arrival of this money in the coastal region (a large fraction of fish are traded in central hubs or the capital cities which are not necessarily on the coast); and then the transformation of the money into physical assets that increase nighttime light via investment (e.g., fish related plants), private consumption (e.g., electronic devices), or public infrastructure (e.g., harbor infrastructure).

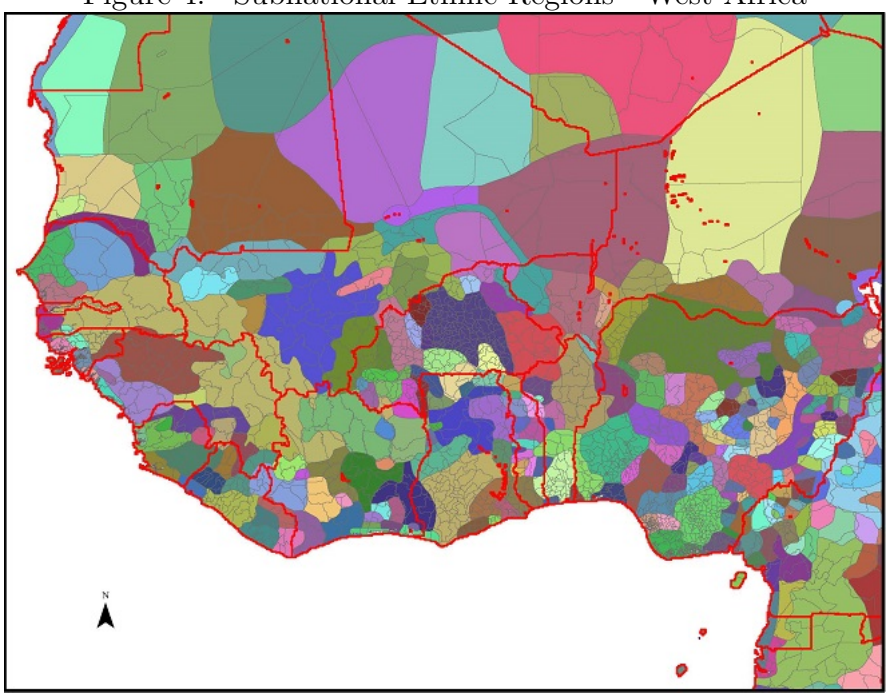
2.3 Pre-colonial, Ethnic Institutions

We attain our data on pre-colonial deeply rooted ethnical institutions from Murdock's "Ethnographic Atlas" (Murdock 1967), which captures the spatial distribution together with cultural, economic, geographic and political characteristics of 1270 societies around the world. We then use again the subnational boundaries and overlap it with the ethnic homelands to assign each subnational region i in country c to an ethnic homeland.[6] To capture the type of institutions in each ethnic homeland region we take a measure of pre-colonial political centralization provided in Murdock's Atlas. It is an ordered variable ranging from 0 (stateless society) over 1 and 2 (petty and paramount chiefdoms) to 3 and 4 (large states). We re-scaled the variable to a dummy variable "High Hierarchy" with 0 capturing stateless or petty and paramount chiefdoms and 1 standing for larger states beyond village level.[7] This variable is labelled $POLINS_{ic}$.

[6] There are 8 cases where subnational regions are located in two ethnic homelands. These regions have been excluded from the dataset because an exact allocation was not possible.

[7] See Michalopoulos & Papaioannou (2013) for a thorough discussion of using this database in a similar context.

Figure 4: Subnational Ethnic Regions - West Africa

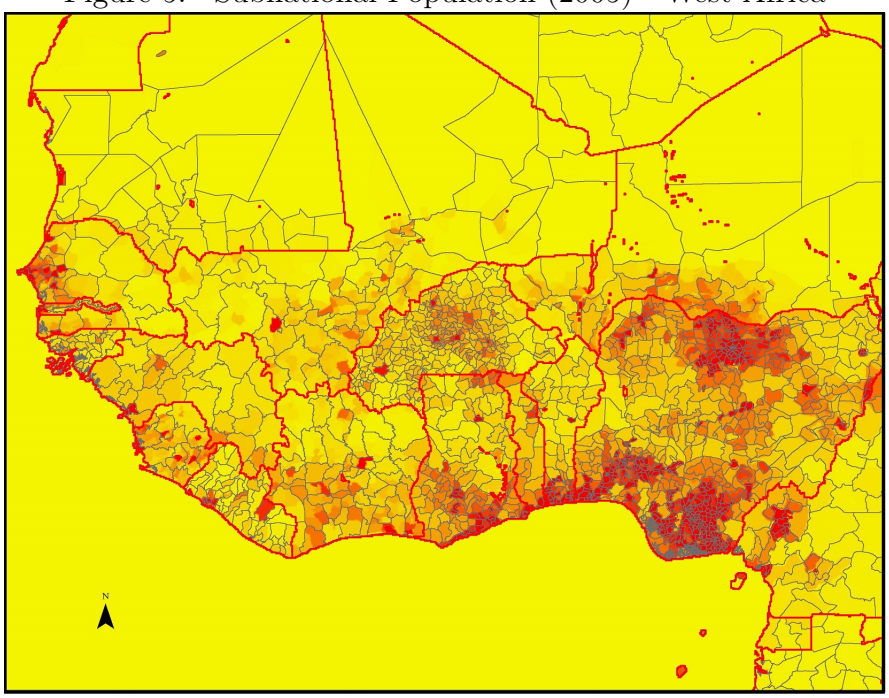


Additionally, we use several control variables of Murdock's Ethnographic Atlas for our empirical analysis, namely a measure for a society's dependence on Fishing, Agricultural type, Settlement Pattern, Elections, Slavery and Polygyny.

2.4 Subnational Population

In order to capture the effect of population growth, we accessed high resolution data on the spatial distribution of the world population by CIESIN. This dataset contains geo-referenced information about total population in a particular area and is based on national census data. CIESIN provides GIS raster files for every fifth year from 1990 onwards. We combine these raster files with the shapefiles of the subnational boundaries to calculate the total population in each region i for each of these five years. We the replace the missing years by a linear interpolation and take the log to create the variable, Pop_{ict}. The spatial distribution of population for the West Africa is depicted in Figure 5.

Figure 5: Subnational Population (2005) - West Africa



2.5 Descriptive statistics

Our final data set used in the empirical analysis comprises the information on night-time light intensity as a measure of economic activity for any region in any country, total fish catches in a country's EEZ and deeply rooted ethnic characteristics. It consists of 12,196 observations over a period of 16 years (1992-2007) for 812 coastal regions in 31 African countries. Table 1 reports descriptive statistics of the variables we use in our regressions.

Table 1: Descriptive Statistics (1992-2007)

Variable	Description	Mean	Std. Dev.	Minimum	Maximum
$Light_{ict}$	Nighttime light intensity	0.547	2.547	−4.605	4.143
FP_{ct}	Fish production	11.430	1.274	6.947	13.805
SST_{ct}	Sea surface temperature	3.122	0.135	2.847	3.400
Pop_{ict}	Population	3.830	1.497	−0.338	8.259
$POLINS_i$	Political centralization	0.241	0.428	0.000	1.000
$FISH_i$	Historical dependency on fish	1.278	0.989	0.000	4.000
$PDisaster_{ict}$	Natural disaster occurrence	0.051	0.221	0.000	1.000
$Precip_{ict}$	Precipitation	64.052	57.871	0.000	442.833
$PDSI_{ict}$	Palmers drought index	−1.505	2.147	−9.549	7.506

3 Empirical strategy

To analyze the impact of maritime fisheries on regional economic activity in Africa we formulate the following empirical specification:

$$Light_{ict} = \alpha_i + \lambda_t + \gamma Light_{ict-1} + \beta FP_{ct-1} + \theta Pop_{ict} + \epsilon_{ict} \tag{1}$$

where the dependent variable, $Light_{ict}$, is the log of average nighttime light in region i of country c in year t and stands for the economic activity in a region in a given year. α_i is a regional dummy variable which captures all time-invariant regional characteristics, like size and geography. The year dummy, λ_t, controls for all time-variant shocks and changes that are common to all regions in all countries, e.g., changes in satellites and their sensor settings, overall climatic changes. We include the lagged value of $Light_{ict}$ as an explanatory variable, which captures potential dynamic effects of past economic activity on current economic outcomes. Further, the logged population size for a region i of country c in year t, Pop_{ict}, controls for population growth which can influence the nighttime light intensity. And finally, our key explanatory variable, FP_{ct-1}, stands for the fish production of country c in year *t-1*. The standard errors are clustered at country-year level.

Although we are using the one year lagged value of fish production in a country, we still expect a potential endogenous relationship between regional income and fish production, e.g. unobserved structural or technological changes, measurement error in official data on fish production. Therefore, we apply an instrumental variable procedure and use exogenous variation in sea-surface temperature (SST) as an instrument for primary fish production. This leads to following econometric specification of the first stage of our two-stage least squares estimation approach:

$$FP_{ct-1} = \alpha_i^{'} + \lambda_t^{'} + \gamma^{'} Light_{ict-1} + \delta SST_{ct-1} + \theta^{'} Pop_{ict} + u_{ict} \tag{2}$$

where SST_{ct-1} is the sea surface temperature per country's EEZ in year *t-1*.[8]

To be an useful instrument, SST needs to be a strong predictor of a country's fish production (relevance), and to be orthogonal to the error term in the second stage (validity). SST has a significant effect on the productivity of fish stocks, which makes it a relevant instrument. Fish in warmer waters are going to have a

[8] Our data on SST stems from the NOAA's National Oceanographic Data Center and the University of Miami's Rosenstiel School of Marine and Atmospheric Science and is based on the Advanced Very High Resolution Radiometer (AVHRR) Pathfinder (Version 5.0) multichannel sea surface temperature dataset. Data on SST is recorded for each 1 km^2 cell on daily basis, which is further aggregated on a monthly level by the NOAA. We use these monthly aggregates to calculate simple yearly averages of SST per EEZ.

smaller maximum body size and a higher mortality rate. With rising temperatures the spatial distribution of fish will change (they will mover deeper and towards the poles). Further, the size and structure of planktonic communities is likely to change, which affects the amount of energy transferred to higher trophic levels (Rijnsdorp, Peck, Engelhard, Möllmann & Pinnegar 2009, Sumalia, Cheung, Lam, Pauly & Herrick 2011).

When using sea-surface temperature as an instrument for fish production in Africa we also have to ask if it is a valid instrument, i.e., changes in SST have no effect on regional economic development, expect through the effects on fish production. First, sea-surface temperature is a product of several factors influencing it, e.g., strength and direction of current, energy uptake through solar radiation, depth, etc., which are not highly correlated with local weather variables in the region. Second, any time-invariant factors will be captured by region fixed effects, α_i, e.g., regions with different levels of SST may differ in ways that could affect economic development, like geography. Third, to control for any potential time-varying other climatic factors that potentially affect both regional economic development and SST in coastal regions, like precipitation and climatic natural disasters, we use climate variables as additional control variables. For climatic 'phenomena' (el niño, la niña) with differential trends we employ a natural falsification test that uses leads of the instrumental variable.

In the second part of our empirical analysis we aim at exploring the impact of deeply rooted ethnic institution on the relationship between fish production and regional economic activity as discussed in section 1. Therefore, we extend equation 1 by adding an interaction term of fish production and pre-colonial political centralization, which leads to following second stage equation:

$$\begin{aligned} Light_{ict} = \alpha_i + \lambda_t + \gamma Light_{ict-1} + \beta FP_{ct-1} + \zeta POLINS_{ic} \\ + \kappa FP_{ct-1} * POLINS_{ic} + \theta Pop_{ict} + \epsilon_{ict} \end{aligned} \tag{3}$$

where $POLINS_{ic}$ is a dummy variable, which is 1 in regions with a high degree of pre-colonial centralization and 0 otherwise. The interaction term $FP_{ct-1} * POLINS_{ic}$ captures systematic differences in the relationship between fish production and regional economic activity depending on the type of pre-colonial institutions. Due to the fact that pre-colonial political institutions can be correlated with other sub-

national characteristics, we include interaction terms of fish production with various other controls.[9]

4 The results

Our baseline results of the empirical model specified in equation 1 are presented in Table 2. Column 1 and 2 in Table 2 report our results based on a fixed effect estimation of equation 1 including region dummies to control for time-invariant regional effects, like geographic characteristics, and year dummies capturing all time-variant shocks and changes that are common to all regions in all countries, e.g., changes in satellite technology.

Table 2: Regression results

	FE	FE	IV	IV	GMM-SYS
Dependent variable	$Light_{ict}$	$Lightpc_{ict}$	$Light_{ict}$	$Light_{ict}$	$Light_{ict}$
	(1)	(2)	(3)	(4)	(5)
$Light_{ict-1}$	0.4872***		0.5252***	0.5232***	0.8332***
	(0.031)		(0.031)	(0.030)	(0.008)
$Lightpc_{ict-1}$		0.4732***			
		(0.032)			
FP_{ct-1}	0.0542***	0.2062***	0.2322***	0.3752***	0.2432***
	(0.020)	(0.071)	(0.086)	(0.092)	(0.101)
$Ln(Pop)_{ict}$	0.049	−0.2602**		−0.6862***	−0.1372***
	(0.062)	(0.117)		(0.259)	(0.015)
Region FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
1st stage F-Stat			12.77	21.33	
AR(1)					(0.582)
Hansen J-Stat					(0.386)

Notes: # of obs.: 12,169. # of regions: 812. Standard errors are clustered at the country-year level. ***, ** and * indicate significance at the 1, 5 and 10%-level. 1st stage results not reported - available from the authos upon request.

[9] Ethnic characteristics: agricultural type$_i$, settlement pattern$_i$, elections$_i$, slavery$_i$, polygyny$_i$, dependence on fish$_i$. Geographic characteristics: land use$_i$, suitability for agriculture$_i$, distance to the capital$_i$, distance to the border$_i$, elevation$_i$, soil composition$_i$. National characteristics: quality of governance, ICRGQOG$_{ct}$.

In column 1 of Table 2 we show the results for nighttime light intensity in region i of country c in year t, whereas in column 2 we use another dependent variable, which is nighttime light intensity per capita, to capture potential population size effects. In both specifications our main coefficient of interest, fish production in country c in year t, is positive and highly significant.

To deal with the potential endogeneity of our key explanatory variable, fish production, we implement, as discussed in section 3, an instrumental variable procedure based on a 2 stage least squares estimation specification. As an instrumental variable for fish production in country c we use exogenous variation in sea surface temperature. Column 3 and 4 (controlling for population size effects) in Table 2 report our results for our instrumental variable specifications. The 1st stage F-stats are 12.77 and 21.33, respectively, which suggest that SST_{ct} is a relevant instrument. Our key variable, fish production, stays significant and positive. The size of our coefficient indicates a large impact of fish production on regional economic activity. We find that a 10 % change in fish production in the past year increases the current economic activity of a country by approximately 3 %.

Finally, in column 5 of Table 2 we report the results of an alternative estimation approach by implementing a system generalized method-of-moments estimator (e.g., Blundell & Bond 1998). This estimator can be used for short panels with independent variables that are potentially correlated with past and possibly current outcomes of the error. Our key explanatory variable of interest, fish production, stays robust in size and significance.

To test the validity of our instrument we perform robustness checks, which are reported in Table 3. To control for any potential time-varying climatic factors that affect regional economic development in coastal regions, like precipitation and other climatic natural disasters, we extend specification 1 by additional control variables. In column 1 we show the results of estimating specification 1 including a dummy variable, $Disaster_{ict-1}$, which is 1 whenever a region experienced a natural disaster in year *t-1*. Further, we extend specification 1 by Palmers' drought severity index, $PDSI_{ict-1}$, which is a measurement of dryness based on recent precipitation and temperature.[10] A negative value of the PDSI index indicates an arid soil condition in a specific area. Due to the fact that the PDSI is especially well suited in determining long term droughts, we also extend equation 1 by a precipitation index, $Precip_{ict-1}$, to control for shorter term situations, which is reported in column 3 of Table 3. In all three cases our main variable of interest, fish production, remains robust in size, sign and significance. With 24.01, 47.99 and 24.71, respectively, the 1st stage

[10] http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml

Table 3: Robustness checks - Exclusion restrictions

Dependent variable	IV $Light_{ict}$ (1)	IV $Light_{ict}$ (2)	IV $Light_{ict}$ (3)	FE $Light_{ict}$ (4)
$Light_{ict-1}$	0.521***	0.509***	0.522***	0.418***
	(0.029)	(0.028)	(0.029)	(0.034)
FP_{ct-1}	0.184***	0.285***	0.199***	
	(0.077)	(0.093)	(0.069)	
$Disaster_{ict-1}$	0.0791*			
	(0.044)			
$PDSI_{ict-1}$		0.015***		
		(0.004)		
$Precip_{ict-1}$			0.003***	
			(0.001)	
SST_{ct+1}				−0.723
				(0.415)
Region FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
1st stage F-Stat	24.09	47.99	24.71	

Notes: # of obs.: 12,169. # of regions: 812. Standard errors are clustered at the country-year level. ***, ** and * indicate significance at the 1, 5 and 10%-level. 1st stage F-Stat based on Kleibergen-Paap Wald F-stats. Other controls included.

F-stats are high and indicate that SST is a relevant instrument. Finally, to control for climatic 'phenomena' with differential trends we employ a natural falsification test that uses leads of the instrumental variable. The results of this falsification test are shown in column 4 of Table 3. Based on a fixed effect estimation and using SST in year *t+1* as a control variable, potential climatic trends does not have a significant influence on current regional economic activity.

4.1 Deeply rooted political institutions, resource stock shocks and regional economic activity

In the second part of our empirical analysis we investigate the impact of subnational deeply rooted political institutions on the relationship between fish production and regional economic activity. The findings of this analysis are reported in Table 4, Table 5 and Table 6. We start our empirical analysis by introducing an interac-

tion term between subnational ethnic institution and a region's fish production as specified in equation 3 and as reported in column 1 of Table 4. This enables us to explore potential systematic differences in the impact of fish production on regional economic activity depending on the type of subnational ethnic institution. Fish production remains positive and highly significant in this specification, but we can not find any significant differences regarding the type of subnational political institutions. These findings do not change also if we additionally control for a society's historical dependency on fish (Column 2 of Table 4) and quality of a country's national institutions (Column 3 of Table 4). These findings suggest that subnational ethnic institutions do not play a role how fish production translates into regional economic activity.

Table 4: Subnational ethnic institutions

Dependent variable	IV $Light_{ict}$ (1)	IV $Light_{ict}$ (2)	IV $Light_{ict}$ (3)
$Light_{ict-1}$	0.517***	0.466***	0.517***
	(0.028)	(0.027)	(0.028)
FP_{ct-1}	0.344***	0.351***	0.344***
	(0.108)	(0.102)	(0.108)
$POLINS_{ic}$	0.766	0.693	0.766
$\times FP_{ct-1}$	(0.510)	(0.432)	(0.510)
$FISH_{ic}$		0.555	
$\times FP_{ct-1}$		(0.439)	
$ICRGQOG_{ct}$			−0.012
$\times FP_{ct-1}$			(0.008)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
1st stage F-Stat	36.53	24.11	26.31

Notes: # of obs.: 12,169. # of regions: 812. Standard errors are clustered at the country-year level. ***, ** and * indicate significance at the 1, 5 and 10%-level. 1st stage F-Stat based on Kleibergen-Paap Wald F-stats. Other controls included but not reported: Agricultural type$_i$, Settlement Pattern$_i$, Elections$_i$, Slavery$_i$, Polygyny$_i$, Land use$_i$, Suitability for Agriculture$_i$, Distance to the capital$_i$, Distance to the border$_i$, Elevation$_i$, Soil composition$_i$.

Given the insignificant role of subnational ethnic institutions on the overall effect of fish production on regional economic activity, the question arises if there is

Table 5: Subnational ethnic institutions and negative shock to fish production

Dependent variable	IV $Light_{ict}$ (1)	IV $Light_{ict}$ (2)	IV $Light_{ict}$ (3)
$Light_{ict-1}$	0.554***	0.485***	0.554***
	(0.037)	(0.049)	(0.037)
$Shock_{ct-1}$	−0.685***	−0.768***	−0.685***
	(0.221)	(0.329)	(0.221)
$POLINS_{ic}$	0.523***	0.604***	0.523***
$\times Shock_{ct-1}$	(0.217)	(0.239)	(0.217)
$FISH_{ic}$		0.448***	
$\times Shock_{ct-1}$		(0.128)	
$ICRGQOG_{ct}$			0.004
$\times Shock_{ct-1}$			(0.191)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
1st stage F-Stat	14.56	22.18	18.70

Notes: # of obs.: 12,169. # of regions: 812. Standard errors are clustered at the country-year level. ***, ** and * indicate significance at the 1, 5 and 10%-level. 1st stage F-Stat based on Kleibergen-Paap Wald F-stats. Other controls included but not reported: Agricultural type$_i$, Settlement Pattern$_i$, Elections$_i$, Slavery$_i$, Polygyny$_i$, Land use$_i$, Suitability for Agriculture$_i$, Distance to the capital$_i$, Distance to the border$_i$, Elevation$_i$, Soil composition$_i$.

another channel how subnational institutions matter as suggested by Michalopoulos & Papaioannou (2013) and other. Based on case study evidence of the capacity of locally based ethnic institutions in dealing with climatic shocks (e.g., Agrawal et al. 2011) we re-estimate equation 3 using a negative shock to fish production instead of average fish production.[11] Introducing such an interaction term enables us to determine the role of subnational ethnic institutions in dealing with a negative production shock. Table 5 reports the results of this empirical exercise. As expected we find a negative impact of a shock to fish production in year *t-1* on current regional economic activity (see Column 1). Focusing on the interaction term gives us an interesting effect. Our findings suggest that the type of subnational ethnic

[11] A negative production shock to a country's fisheries is defined as a negative change in fish catch of 20 % or more compared to the previous year.

institution matter. In societies which where historically more centralized the negative effect of a production shock on regional economic activity is getting reduced by about 80 %.

Table 6: Fish production, institutions and climatic shocks

Dependent variable	FE FP_{ct} (1)	FE FP_{ct} (2)
lnpop	1.030***	1.027***
	(0.050)	(0.051)
ΔSST 1.5	−0.170***	−0.239***
	(0.0189)	(0.0445)
$POLINS_{ic}$		0.116***
ΔSST 1.5		(0.045)
Region FE	Yes	Yes
Year FE	Yes	Yes

Notes: # of obs.: 12,169. # of regions: 812. Standard errors are clustered at the country-year level. ***, ** and * indicate significance at the 1, 5 and 10%-level. Other controls included but not reported: Agricultural type$_i$, Settlement Pattern$_i$, Elections$_i$, Slavery$_i$, Polygyny$_i$, Land use$_i$, Suitability for Agriculture$_i$, Distance to the capital$_i$, Distance to the border$_i$, Elevation$_i$, Soil composition$_i$.

A reason for this large dampening effect can be that, based on an advanced regulative setting, a stricter definition of property rights and other forms of public goods provision, centralized ethnic societies have developed a higher degree of capability in dealing with shocks. Schleifer & Vishny (1993) and Gennaioli & Rainer (2006) argue that, given the relatively weak national institutions in Africa, centralized societies were able to increase cooperation between multiple governments and thereby strengthening the rule of law, reduce the extend of corruption and secure private property rights. Centralization not only helped to build up an institutional framework that facilitates private sector transitions. Diamond (1997), Gennaioli & Rainer (2007) and Acemoglu & Robinson (2012) argue that in centralized, state-structured societies local chiefs face a higher political competition resulting in a higher degree of accountability to local communities and coordination of government activities. This leads to an increased public good provision across centralized communities in

Africa.[12] This effect of subnational ethnic institutions remains stable also if we additionally control for a society's historical dependency on fish (Column 2). In column 3 we report an extension of specification 3 where we include a measure of the quality of national institutions. The coefficient of this measure is positive but insignificant. This result suggests that on a disaggregated subnational level deeply rooted local institutions do matter whereas national institution do not matter in dealing with a disruptive production shock.

We further explore the role of subnational ethnical institutions by estimating the impact of a climatic shock - a rise in SST by 1.5 degrees Celsius - on fish production taking differences in subnational ethnic institutions explicitly into account. Table 6 reports the results of this empirical exercise. As expected a temperature shock has a negative and highly significant effect on a country's fish production. Again, the positive and highly significant interaction effect reveals an interesting picture. It suggests that societies with a historically more centralized, state-like system are able to handle a climatic shock better than more stateless societies. It seems that a more effective organization of the state and a stronger rule enables to react on shock more efficiently so that its negative impact on fish production gets largely reduced.

5 Conclusions

In this study, we answer two research questions. First, we determine the impact of maritime fisheries on regional economic activity in coastal Africa. We compiled a novel panel dataset of 812 regions in 31 African countries for the period from 1992-2007 that includes, among others, satellite data on nighttime light intensity, fish production, and pre-colonial ethnic institutions. Our empirical strategy is based on an instrumental variable procedure, where we exploit exogenous variation in sea-surface temperature as an instrument for maritime fish production. We show that a 10 % increase in maritime fish production increases regional economic activity by 3 %. This is a large effect and pictures the social and economic importance of this primary industry on regional level in Africa. In combination with a prevalent lack of adaptive capacities these regions are especially vulnerable to shocks to their primary goods production, which are expected to increase in future due to a changing climate.

Therefore, in the second part of our paper we investigate the role of subnational deeply-rooted ethnic institutions on determining the relationship between fish production and regional economic activity. This idea is motivated by the literature on

[12] Please find a longer discussion on these issues in Michalopoulos & Papaioannou (2013).

the role of deeply-rooted, ethnic institutional characteristics in shaping contemporary economic development (e.g., Michalopoulos & Papaioannou 2013) and by case study evidence on the capacity of locally based ethnic institutions in dealing with climatic shocks (e.g., Agrawal et al. 2011). Our results reveal an interesting picture. We show that subnational ethnic institutions matter in dealing with shocks to fish production. A decrease in regional economic activity due to a negative shock to fish production is dampened by around 80 % in societies with pre-colonial ethnic political centralization. A reason for this large dampening effect can be that, based on an advanced regulative setting, a stricter definition of property rights and other forms of public goods provision, centralized ethnic societies have developed a higher degree of capability in dealing with shocks.

Finally, taking a measure of quality of national institutions into account our results indicate that on a disaggregated subnational level deeply rooted local institutions do matter whereas national institution do not matter in dealing with a disruptive production shock. These findings extend the literature on the impact of deeply rooted ethnical characteristics on contemporary economic development by showing one causal mechanism how ethnic institutional and cultural traits influence current economic performance.

References

Acemoglu, D. & Johnson, S. (2005), 'Unbundling institutions', *Journal of Political Economy* **113**(5), 949–995.

Acemoglu, D., Johnson, S. & Robinson, J. (2001), 'The colonial origins of comparative development: An emprical investigation', *American Economic Review* **91**(5), 1369–1401.

Acemoglu, D., Johnson, S. & Robinson, J. (2002), 'Reveral of fortune: Geography and development in the making of the modern world income distribution', *Quaterly Journal of Economics* **117**(4), 1231–1294.

Acemoglu, D., Johnson, S. & Robinson, J. (2005), Institutions as a fundamental cause of long-run growth, *in* P. Agion & S. N. Durlauf, eds, 'Handbook of Economic Grwoth', Elsevier, pp. 385–472.

Acemoglu, D. & Robinson, J. (2012), *Why nations fail? The origins of power, prosperity and poverty*, Crown Publishers, New York.

Agrawal, A., Mearns, R., Perrin, N. & Kononen, M. (2011), Area-based development, local institutions & climate adaptation: A comparative analysis from west africa and latin america, Technical Report 63886, The World Bank.

Allison, E. H., Perry, A. L., Badjeck, M. C., Adger, W. N., Brown, K., Conway, D., Halls, A. S., Pilling, G. M., Reynolds, J. D., Andrew, N. L. & Dulvy, N. K. (2009), 'Vulnerability of national economies to the impacts of climate change on fisheries', *Fish and Fisheries* **10**, 173–196.

Ashraf, Q. & Galor, O. (2013), 'The "out-of-africa" hypothesis, human genetic diversity and comperative economic development', *American Economic Review* **103**(1), 1–46.

Baldwin, K. (2013), 'Why vote with the chief? political connections and public goods provision in zambia', *American Journal of Political Science* **57**(4), 794–809.

Blundell, R. & Bond, S. (1998), 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics* **87**(1), 115–143.

Chen, X. & Nordhaus, W. (2011), 'Using luminosity data as a proxy for economic statistics', *Proceedings of the National Academy of Sciences* **108**(21), 8589–8594.

Collier, P. & Goderis, B. (2012), 'Commodity prices and growth: An empirical investigation', *European Economic Review* **56**(6), 1241–1260.

Comin, D., Easterly, W. & Gong, E. (2010), 'Was the wealth of nations determined in 1000 bc?', *American Economic Journal: Macroeconomics* **2**(3), 65–97.

Diamond, J. (1997), *Guns, germs, and steel: The fates of human societies*, W. W. Norton & Co, New York.

Dyck, A. J. & Sumalia, U. R. (2010), 'Economic impact of ocean fish populations in the global fishery', *Journal of Bioeconomics* **12**, 227–243.

Easterly, W. & Levine, R. (2012), 'The european origins of economic development', *National Bureau of Economic Research Working Paper* (18162).

Gennaioli, R. & Rainer, I. (2006), Precolonial centralization and institutional quality in africa, *in* M. Gradstein & K. Konrad, eds, 'Institutions and norms in economic development', MIT Press, Boston, MA.

Gennaioli, R. & Rainer, I. (2007), 'The modern impact of precolonial centralization in africa', *Journal of Economic Growth* **12**, 185–234.

Glaeser, E. L., La Porta, R., Lopez-De-Silanes, F. & Shleifer, A. (2004), 'Do institutions cause growth?', *Journal of Economic Growth* **9**, 271–303.

Goldstein, M. & Udry, C. (2008), 'The profits of power: Land rights and agricultural investment in ghana', *Journal of Political Economy* **116**(6), 981–1022.

Greif, A. & Tabellini, G. (2010), 'Cultural and institutional bifurication: China and europe compared', *American Economic Review* **100**(2), 135–140.

Henderson, J. V., Storeygard, A. & Weil, D. (2012), 'Measuring economic growth from outer space', *American Economic Review* **102**(2), 994–1028.

Hodler, R. & Raschky, P. A. (2014), 'Regional favoritism', *Quaterly Journal of Economics* **129**(2), forthcoming.

Jacobsen, K. I., Lester, S. E. & Halpern, B. S. (2013), 'A global synthesis of the economic multiplier effects of marine sectors', *Marine Policy* p. forthcoming.

Logan, C. (2013), 'The roots of resilience: Exploring popular support for african traditional authorities', *African Affairs* **112**(448), 353–376.

Michalopoulos, S. & Papaioannou, E. (2013), 'Pre-colonial institutions and contemporary african development', *Econometrica* **81**(1), 113–152.

Murdock, G. P. (1967), *Ethnographic Atlas*, Pittsburgh University Press, Pittsburgh.

Nakashima, D. & Roué, M. (2002), Indigenous knowledge, peoples and sustainable practice, *in* T. Munn, ed., 'Encyclopedia of Global Environmental Change', Wiley and Sons, Chichester, pp. 314–324.

Noy, I. (2009), 'The macroeconomic consequences of disasters', *Journal of Development Economics* **88**(2), 221–231.

Putterman, L. & Weil, D. (2010), 'Post-1500 population flows and the long-run determinants of economic growth and inequality', *Quaterly Journal of Economics* **125**(4), 1627–1682.

Raddatz, C. (2007), 'Are external shocks responsible for the instability of output in low-income countries?', *Journal of Development Economics* **84**(1), 155–187.

Rijnsdorp, A. D., Peck, M. A., Engelhard, G. H., Möllmann, C. & Pinnegar, J. K. (2009), 'Resolving the effect of climate change on fish populations', *ICES Journal of Marine Science: Journal du Conseil* **66**(7), 1570–1583.

Rodrik, D., Subramanian, A. & Trebbi, F. (2004), 'Institutions rule: The primacy of institutions over geography and integration in economic development', *Journal of Economic Growth* **9**, 131–165.

Schleifer, A. & Vishny, R. (1993), 'Corruption', *Quaterly Journal of Economics* **108**, 599–617.

Shortland, A., Makatsoris, H. & Christopoulou, K. (2013), 'War and famine, peace and light? the economic dynamics of conflict in somalia', *Journal of Peace Research* **50**(5), 545–561.

Spolaore, E. & Wacziarg, R. (2009), 'The diffusion of development', *Quaterly Journal of Economics* **124**(2), 469–529.

Spolaore, E. & Wacziarg, R. (2013), 'How deep are the roots of development?', *Journal of Economic Literature* **51**(2), 325–369.

Sumalia, U. R., Cheung, W. W. L., Lam, V. W. Y., Pauly, D. & Herrick, S. (2011), 'Climate change impacts on the biophysics and economics of world fisheries', *Nature Climate Change* **1**, 449–456.

Tabellini, G. (2008), 'Institutions and culture', *Journal of the European Economic Association* **8**(2-3), 255–294.

Tabellini, G. (2010), 'Culture and institutions: economic development in the regions of europe', *Journal of the European Economic Association* **8**(4), 677–716.

Teh, L. C. L. & Sumaila, U. R. (2013), 'Contribution of marine fisheries to worldwide employment', *Fish and Fisheries* **14**, 77–88.