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Coastal proximity and individual living standards: Econometric evidence from georeferenced household surveys in sub-Saharan Africa

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Abstract

We investigate georeferenced household-level data consisting of up to 128,609 individuals living in 11,261 localities across 17 coastal sub-Saharan African countries over 20 years. We analyze the relevance of coastal proximity, measured by the geographic distance to harbors, as a predictor of individual economic living standards. Our setting allows us to account for country-time fixed effects as well as individual-specific controls. Results reveal that individuals living further away from the coast are significantly poorer, measured along an array of welfare indicators. Our findings are robust to the inclusion of other geographic covariates of development such as climate (e.g., temperature, precipitation) or terrain conditions (e.g., ruggedness, land suitability). We also explore mechanisms through which coastal proximity may matter for individual welfare and decompose the estimated effect of coastal proximity via formal mediation analysis. Our results highlight the role of human capital, urbanization, and infrastructural endowments in explaining within-country differences in individual economic welfare.

KEYWORDS
coastal proximity, geography, mediation analysis, sub-Saharan Africa

JEL CLASSIFICATION
O15, O18, O55, R12

1 | INTRODUCTION

Cross-country studies investigating the link between physical geography and economic development consistently provide evidence of a positive and statistically significant association between coastal access and national income (e.g., Bloom, Sachs, Collier, & Udry, 1998; Easterly & Levine, 2003; Gallup, Sachs, & Mellinger, 1999; Radelet & Sachs, 1998; Sala-I-Martin, Doppelhofer, & Miller, 2004; UN-OHRLLS, 2013). More recent literature analyzing subnational variation in economic activity also suggests coastal access and, in particular, coastal proximity as relevant indicators of *within-country* differences in income and related developmental outcomes (e.g., Gennaioli, La Porta, Lopez-de-Silanes, & Shleifer, 2013; Flückiger & Ludwig, 2018; Henderson, Squires, Storeygard, & Weil, 2018; Jetter, Mösle, & Stadelmann, 2019; Rappaport & Sachs, 2003; Motamed, Florax, & Masters, 2014; Mitton, 2016).

To systematically complement the literature that focused on outcomes at the national or regional level, this paper analyzes the relevance of coastal proximity in predicting individual economic welfare. We employ a repeated cross-sectional data set from the Afrobarometer, spanning almost 20 years and consisting of up to 128,609 individuals living in 11,261 georeferenced localities across 17 coastal sub-Saharan African countries. Particularly in Africa, countries and regions with coastal access have had higher levels of economic development compared to more remote areas, which has been attributed to factors such as lower costs of trade, the distribution of natural resources, and the amplifying forces of urbanization and agglomeration (e.g., Atkin & Donaldson, 2015; Bloom et al., 1998; Gallup et al., 1999; Henderson et al., 2018; Limão & Venables, 2001; Radelet & Sachs, 1998; Storeygard, 2016). Spatial inequalities such as these have been shown to persist even when the initial advantages of (coastal) regions may have declined in relevance (Bleakley & Lin, 2012; Jedwab, Kerby, & Moradi, 2017).

Our results confirm coastal proximity as a robust indicator of individual economic welfare across African countries: living further away from the coast is associated with a significant and meaningful reduction in the likelihood of having cash employment (income), increases in the occurrence of cash-, food-, water-, and medicinal droughts (deprivation), and lower overall household wealth (possessions). Our results are robust to the inclusion of relevant individual-level covariates, country-time specific influences via fixed effects, as well as an extensive set of other geographic variables related to development such as latitude, elevation, climatic factors (e.g., temperature, precipitation), and features of the terrain (e.g., ruggedness, land suitability).

We also explore potential mechanisms on how coastal proximity may matter for individual living standards and investigate several candidate factors shown to contribute to spatial disparities (for an overview, see Breinlich, Ottaviano, & Temple, 2014). In particular, we analyze the relevance of human capital (e.g., Gennaioli et al., 2013; Flückiger & Ludwig, 2018; Skoufias & Katayama, 2011), urbanization–agglomeration (e.g., Chauvin, Glaeser, Ma, & Tobio, 2017; Gollin, Kirhberger, & Lagakos, 2017; Henderson et al., 2018; Motamed et al., 2014;

Young, 2013), institutions (e.g., Acemoglu, Johnson, & Robinson, 2001; Michalopoulos & Papaioannou, 2014; Mitton, 2016; Nunn & Wantchekon, 2011; Radeny & Bulte, 2012), infrastructure (e.g., Bluhm, Dreher, Fuchs, Parks, & Strange, 2018; Calderón & Servén, 2010; Dinkelman, 2011; Donaldson, 2018; Jedwab & Moradi, 2016; Jetter et al., 2019), as well as market access and trade (e.g., Brülhart, 2011; Bosker & Garretsen, 2012; Hirte, Lessmann, & Seidel, 2020; Jedwab & Storeygard, 2020). We consider these factors in turn and assess their power in mediating the relationship between coastal proximity and individual welfare through a formal mediation analysis. The results highlight human capital, urbanization, as well as infrastructural endowments as the predominant channels through which the observed within-country differences in individual economic welfare may be explained.

Our findings at the individual level emphasize the relevance of coastal proximity as an indicator of economic development and lend further support to the previously discussed interrelation between first- and second-nature causes of development (see Breinlich et al., 2014; Lessmann & Seidel, 2017; Rodrik, Subramanian, & Trebbi, 2004).

The remainder of this paper is structured as follows: Section 2 presents the data and the estimation strategy. Our results are given in Section 3, where we also present the insights from our mediation analysis. Concluding remarks are offered in Section 4.

2 | DATA AND EMPIRICAL STRATEGY

2.1 | Data

We employ the complete set of the georeferenced Afrobarometer survey rounds, spanning a timeframe of 20 years (from 1999 to 2018) across seven survey waves (Afrobarometer, 2019).[1] Afrobarometer surveys are representative at the national level, and respondents are adults of the sampled households. They carry individual- and household-level information on basic characteristics such as living conditions and household assets and, additionally, provide information on individuals' sentiments and opinions towards the economy, democracy, governance, and society. Afrobarometer fits geocoordinates (latitude and longitude) to respondents at the level of their respective enumeration area (EA) (BenYishay et al., 2017). The sampling procedure aims for eight individuals/households per EA. Our main (extended) sample of countries consists of 128,609 (212,037) individuals living in 11,261 (17,319) georeferenced localities across 17 (28) coastal sub-Saharan African countries (see Figure 1). We chose to restrict the main sample to coastal countries so as to separate the distance effect from a more general "landlockedness" effect, which potentially confounds distance with other influences such as administrative dependencies on transit countries (see Faye, McArthur, Sachs, & Snow, 2004; UN-OHRLLS, 2013). We investigate the extended sample including individuals living in landlocked countries in our robustness tests.

2.1.1 | Dependent variables and channels of influence

We employ three main dependent variables as indicators of individual economic welfare: (1) the dichotomous variable *Cash Employment (0/1)*, which indicates whether survey respondents currently have part- or full-time cash employment, serving as a measure of individuals' income; (2) the index *How often gone without enough: [Water/Food/Cash Income/Medical Care] (0–4)*,

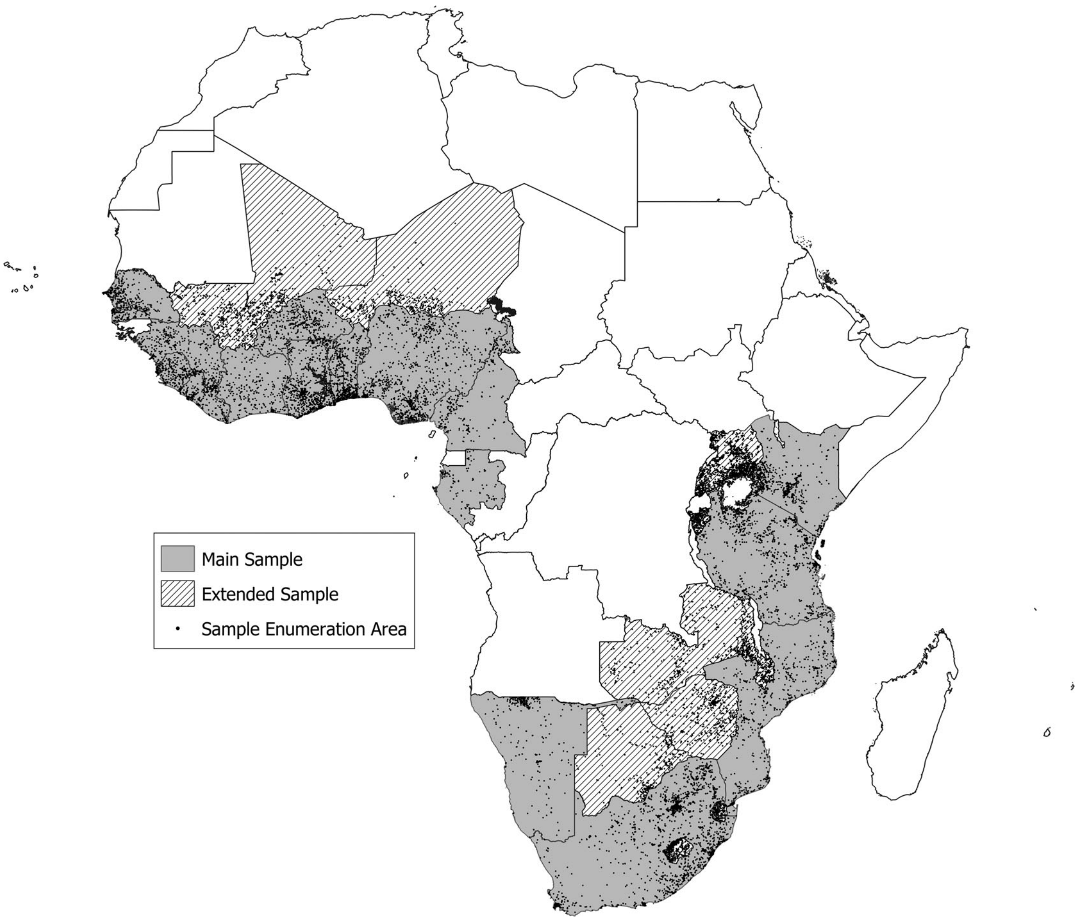

FIGURE 1 Sample coverage

which serves as a measure for individual- and household deprivation and is constructed by averaging individuals' responses in these four categories;[2] (3) the index *Possessions: [Radio/TV/Motor Vehicle] (0–1)*, which serves as a measure of the wealth of survey respondents.[3]

To explore the potential channels through which coastal proximity may matter for individual living standards, we make use of Afrobarometer's opinion polling and first investigate individuals' sentiments regarding the most important issue of their respective country, *Most Important Issue: [Education/Institutions/Infrastructure] (0/1)*.[4] Thereafter, we directly investigate the lived realities around these concerns via *Education Level (0–9)*; two further composite indices, *Institutions Score (1–4)*[5] and *Infrastructure Present in Enumeration Area: [Electricity Grid/Piped Water/Sewerage/School/Paved Road/Health Clinic] (0–1)*;[6] and the dummy variable *Urban (0/1)*. We also analyze individuals' opinions toward supranational organizations aimed at increasing political and economic integration, *Helps Your Country: [AU or ECOWAS/SADC/EAC/IGAD ...] (0–3)*, to directly relate coastal proximity with (regional) trade considerations.[7] To further explore a potential trade channel, we use the information on individuals' occupations and test for a differential effect of distance using *Commercial Farmer (0/1)*, a dichotomous indicator for individuals working as farmers who grow their produce mainly for sale.[8]

2.1.2 | Main independent variables

To construct our main explanatory variable of interest, *log(Distance to Harbor)*, we measure the shortest geodesic (ellipsoidal) within-country distance from each respondent's EA to the respective country's major harbor(s).[9] Similar to Rappaport and Sachs (2003), we define all large- and medium-sized ports listed in the World Port Index as "major harbors" (NGA, 2019).

We also employ alternative conceptions of coastal proximity for robustness checks: shortest within-country distance to the coastline, *log(Distance to Coastline)*; distance to major harbors using beelines (as the crow flies), *log(Beeline Distance to Harbor)*; and distance to the coastline using beelines, *log(Beeline Distance to Coast)*.[10] Shapefile data for country administrative areas, the boundaries of which we use to calculate within-country distances—and also from which we construct the coastline—come from the Center for Spatial Sciences at the University of California (GADM, 2020).

2.1.3 | Further covariates

To isolate coastal proximity from other, potentially correlated, geographic influences of development, we closely follow Henderson et al. (2018) and add an extensive set of geographic covariates. We include *Elevation* (Farr et al., 2007), *(Abs.) Latitude*, *Ruggedness* (Nunn & Puga, 2012), and *Malaria Ecology* (Sachs et al., 2004), as well as agricultural characteristics such as *Land Suitability* (Ramankutty, Foley, Norman, & McSweeney, 2002), *Growing Days* (FAO & IIASA, 2019), *Monthly Temperature*, and *Monthly Rainfall* (Fick & Hijmans, 2017). We also include seven dummy variables indicating the dominant natural vegetation of the area, according to Olson et al. (2001).[11] We account for individuals' access to rivers or lakes by adding two dummy variables indicating whether individuals live within 25 km of a navigable river or major lake, that is, *Navigable River (0/1)* and *Major Lake (0/1)*, and thereby analyze an extended set of trade-related covariates together with our main explanatory variable, *log(Distance to Harbor)* (see Henderson et al., 2018).[12] We also add the individual-level covariates *Age, Age squared*, and a dichotomous indicator of gender, *Female (0/1)*. The importance of urbanization–agglomeration aspects, argued to be particularly relevant in African contexts (see Chauvin et al., 2017; Flückiger & Ludwig, 2018; Henderson et al., 2018; Jedwab et al., 2017; Gollin et al., 2017; Motamed et al., 2014; Young, 2013), is encapsulated by three distinct indicators of urbanization: *Primate City (0/1)*, a dummy indicating whether individuals live within 25 km of a capital or primate city; *Population Density* (CIESIN, 2017), a continuous measure of population density (per square kilometer); and *Urban (0/1)*, a dichotomous indicator included in the Afrobarometer survey.

Descriptive statistics for all variables are presented in Table S1, parts (a) and (b), in Appendix S1.

2.2 | Empirical strategy

We employ the following regression control approach to analyze the link between coastal proximity and individual economic welfare:

$$Y_{i,c,t} = \alpha + \beta \log(\textit{Distance to Harbor}_i) + \gamma \boldsymbol{X}_i + \delta_{c,t} + \varepsilon_{i,c,t} \tag{1}$$

$Y_{i,c,t}$ represents the respective welfare indicator of individual i, living in country c, surveyed at survey sampling period t. β captures the influence of the logged (within-country) distance to major harbors such that the link between distance and the respective welfare indicator can be interpreted as a semielasticity. Standard errors are clustered at the level of the survey EA, that is, at the survey cluster level. Binary dependent variables are estimated with a simple linear probability model (LPM) specification.[13] $\boldsymbol{X}$ represents a vector of control variables that allows us to account for influences potentially conflating the relationship between coastal distance and individual economic welfare. In contrast to the cross-country (cross-regional) literature, our setting allows us to account for country-time fixed effects $\delta_{c,t}$ such that we can explore a within-country estimate of the distance to harbor on (individual) outcomes, *net of* time-specific influences as well as country-specific influences at specific points in time, such as the Kenyan Post-Election Crisis of 2007–2008. $\varepsilon_{i,c,t}$ is an idiosyncratic error term.

We explore potential mechanisms and factors affecting the link between coastal proximity and individual living standards via both a "bad control" approach and a formal mediation analysis, after establishing the relevance of coastal proximity for individual living standards. Numerous robustness checks for the persistence of the observed links are offered (mostly relegated to Appendix S1).

3 | RESULTS

Table 1 presents the main estimation results employing our three distinct individual welfare indicators as dependent variables. We report a parsimonious specification including country-time fixed effects in the odd-numbered columns. Even-numbered columns include the full set of controls and represent our stringent setting.[14]

The results systematically indicate that distance to harbors is inversely related to individual economic welfare throughout all specifications.[15] To facilitate the interpretation of the quantitative relevance of the main explanatory variable of interest, *log(Distance to Harbor)*, we report the predicted change of the respective dependent variable when moving from the minimum distance in the sample (i.e., effectively living by a major port) to living as far as 564 km away from the harbor (third quartile of the sample) and compare the predicted change of each individual's welfare indicator to the respective sample mean reported in brackets. The results show that distance to harbors is statistically significantly and negatively related to cash employment (columns 1 and 2) and positively and statistically significantly related to deprivation (columns 3 and 4). Quantitatively, increasing individuals' distance to major ports to the third quartile in the sample translates into a 5.5 percentage point decrease in the probability of having part- or full-time cash employment (column 2) and can explain 17% of the occurrence of monetary-, medicinal-, food-, and water-related shortages compared to the mean in the sample (column 4). Coastal remoteness is significantly related to having fewer (wealth) possessions: increasing individuals' distance to the third quartile corresponds to a 12 percentage point decrease in the probability of owning a radio, a TV, or a motor vehicle, accordingly, a 23% reduction compared to the mean in the sample (column 6). Importantly, the results for our indices of deprivation (columns 3 and 4) and possessions (columns 5 and 6) also hold when analyzing the variables that compose our indices separately (see Table S3 in Appendix S1).

TABLE 1 Coastal proximity and individual living standards

	Dependent variable					
	Cash Employment (0/1)		***How often gone without enough: [Water/Food/ Cash Income/ Medical Care] (0–4)***		***Possessions: [Radio/TV/ Motor Vehicle] (0–1)***	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Log(Distance to Harbor)	−0.018***	−0.009***	0.073***	0.035***	−0.037***	−0.019***
	(0.001)	(0.002)	(0.004)	(0.006)	(0.001)	(0.002)
Discrete change from the harbor to the third quartile (564 km)	***−0.115***	***−0.055***	***0.460***	***0.223***	***−0.234***	***−0.120***
Sample mean of dependent variable	[0.39]		[1.28]		[0.51]	
Basic controls						
Age		0.031***		0.011***		0.012***
		(0.001)		(0.001)		(0.000)
Age^2		0.000***		0.000***		0.000***
		(0.000)		(0.000)		(0.000)
Female (0/1)		−0.106****		0.020***		−0.083***
		(0.003)		(0.004)		(0.002)
Urbanization controls						
Urban (0/1)		0.055***		−0.284***		0.134***
		(0.004)		(0.010)		(0.003)
Primate city (0/1)		0.029***		−0.084***		0.029***
		(0.007)		(0.016)		(0.006)
Population density		−0.001		0.004***		−0.001*
		(0.000)		(0.001)		(0.000)
Trade-related controls						
Navigable river (0/1)		−0.013		−0.121***		0.029***
		(0.009)		(0.021)		(0.008)
Major lake (0/1)		0.010		0.033		−0.023***
		(0.012)		(0.024)		(0.008)
Full geographic controls	No	Yes	No	Yes	No	Yes
Country-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	123,793	122,238	128,609	126,982	103,889	102,990
R-squared	0.09	0.14	0.17	0.20	0.15	0.22

Notes: Results in each column come from separate regressions and are estimated using the main sample of coastal sub-Saharan African countries included in survey rounds 1 through 7 of the Afrobarometer. Changes in the number of observations across columns stem from differences in the response rates of dependent/independent variables. The samples used in columns (5) and (6) do not include individuals surveyed in rounds 1 and 2 of the Afrobarometer, as questions on ownership of household items were not asked in these rounds. We also report estimated interquartile differences in the respective dependent variables between minimum- and third quartile harbor distances within the sample. Binary dependent variables are estimated through a simple linear probability model specification. The standard errors reported are clustered at the survey enumeration area level.
*$p < .1$, **$p < .05$, ***$p < .01$.

3.1 | Robustness checks and extensions

We conduct a large array of robustness checks on our main results and summarize them in Table S4 in Appendix S1. All interpretations regarding the relevance of coastal proximity for individual living standards remain robust. (1) We re-estimate our main results by altering the distance specification to a simple "beeline" ("as the crow flies") measure. (2) We use a different conceptualization of coastal proximity by regressing our outcome variables on individuals' distance to the coastline instead of port locations, using *log(Distance to Coastline)*. (3) Accordingly, we test beeline distances to the coastline with *log(Beeline Distance to Coastline)*. We add dummies for living within 25 km of a major harbor (4) or the coast (5), *Harbor (0/1)* and *Coast (0/1)*, to separate the distance effect from a pure "coastal access" effect.[16] (6) We keep observations constant across rows and columns. (7) We exclude distances larger than the 80th percentile (629 km) from the sample. (8) We exclude localities marked with a precision code of 2 and larger in the Afrobarometer survey (scales 1–8) from our sample. (9) We include survey sampling weights. (10) We employ clustering at the country-sample level. Moreover, we check the main coefficient's stability to potentially exclude controls via Oster (2019) tests in Table S14 in Appendix S1.

All robustness checks corroborate our general findings of a negative, independent, and statistically significant relationship between coastal proximity and individual living standards. The results reiterate the relevance of coastal proximity, in varying conceptualizations, in predicting individual economic welfare.

Next to the aforementioned robustness tests, we extend our analysis and (1) expand our main sample to include individuals living in landlocked countries (see "Extended Sample" in Figure 1) and also (2) analyze the persistence of our estimated effects over time. For (1), we include individuals living in landlocked countries and thereby explore a potential "placebo" group compared to individuals living in coastal countries, that is, it allows us to compare the effect of sheer coastal distance within countries to a more general landlockedness effect, the one often explored in the literature (UN-OHRLLS 2013). The idea is that differences in coastal proximity *within* landlocked countries should influence individual welfare to a lower degree, given that national borders need to be crossed in any case, creating other potentially large restrictions unrelated to sheer distance (Faye et al., 2004).[17] As expected, Table S15 in Appendix S1 suggests that the relevance of individual distance to harbors tends to be less pronounced for individuals living in landlocked countries. (2) The relative importance of trade-related factors of geography might be expected to change along a country's developmental path (see Henderson et al., 2018). Hence, we estimate differential effects using an interaction effect constituting *log(Distance to Harbor)* and *Young (0/1)*, which indicates respondents below the median age in the sample (33). The results in Table S16 in Appendix S1 show a clear pattern. The negative effect of distance becomes less stark for younger generations, potentially hinting at a reduction in the relevance of trade-related aspects over time (see Henderson et al., 2018).[18]

3.2 | Mechanisms explaining the relevance of coastal proximity

Table 2 explores potential mechanisms through which coastal proximity may influence individual economic welfare. Following the literature, we focus on the link between coastal proximity and human capital, urbanization, institutional quality, infrastructural development, and the perceived relevance of trade to investigate potential (indirect) channels that explain the spatial

TABLE 2 Exploring potential mechanisms of influence of coastal proximity

	Dependent variable								
	***Most important issue*: Education (0/1)** (1)	***Education*: Educational level (0–9)** (2)	**Urban (0/1)** (3)	***Most important issue*: Institutions (0/1)** (4)	**Institutions score (1–4)** (5)	***Most important issue*: Infrastructure (0/1)** (6)	***Infrastructure present in enumeration area*: [Electricity Grid/Piped Water/Sewerage/School/ Paved Road/Health Clinic] (0–1)** (7)	***Helps your country*: REC (0–3)** (8)	***Helps your country*: AU (0–3)** (9)
Log(Distance to Harbor)	0.001	−0.106***	−0.071***	0.002	0.025***	0.005***	−0.009***	0.034***	0.046***
	(0.001)	(0.012)	(0.007)	(0.001)	(0.003)	(0.001)	(0.003)	(0.009)	(0.008)
Discrete change from the harbor to the third quartile (564 km)	***0.007***	***−0.670***	***−0.449***	***0.010***	***0.158***	***0.030***	***−0.056***	***0.214***	***0.293***
Sample mean of dependent variable	[0.06]	[3.40]	[0.46]	[0.09]	[2.81]	[0.06]	[0.56]	[1.80]	[1.68]
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Urbanization controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade-related controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Full geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	120,461	126,555	127,075	120,461	126,683	120,461	116,174	35,409	47,298
R-squared	0.03	0.29	0.30	0.06	0.21	0.04	0.43	0.11	0.07

Notes: Results in each column come from separate regressions and are estimated using the main sample of coastal sub-Saharan African countries included in survey rounds 1 through 7 of the Afrobarometer. Changes in the number of observations across columns stem from differences in the response rates of dependent/independent variables. The sample used in column (7) includes individuals from rounds 2 through 7 of the Afrobarometer, columns (8) and [9] includes data from rounds 2, 4, [5], and 6. We also report estimated interquartile differences in the respective dependent variables between minimum- and third quartile harbor distances within the sample. Binary dependent variables are estimated through a simple linear probability model specification. The standard errors reported are clustered at the survey enumeration area level. AU, African Union; REC, Regional Economic Community. $^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$.

economic disparity given by individual geographic distance to harbors (see Breinlich et al. 2014, for an overview).

Individual educational attainment has been linked to economic welfare at the cross-regional level (e.g., Chauvin et al., 2017; Flückiger & Ludwig, 2018; Gennaioli et al., 2013; Skoufias & Katayama, 2011). Individuals' opinions regarding education, as shown in column (1), do not mirror these findings, as respondents living in more remote locations do not report education as the most important issue (facing the country/government) more often than individuals living closer to the coast. However, we do find that individuals' actual educational attainment decreases substantially along coastal distance (column 2): moving from the minimum distance to the third quartile within the sample reduces the level of education by 0.670, which corresponds to about 20% of the sample mean.

As shown by recent literature (Henderson et al., 2018; Motamed et al., 2014), levels of urbanization are negatively correlated with increased distance to the coast in Africa and can negatively impact individual economic welfare directly, or indirectly, via agglomeration economies (e.g., Bosker & Garretsen, 2012; Flückiger & Ludwig, 2018; Henderson et al., 2018; Gollin et al., 2017; Skoufias & Katayama, 2011; Young, 2013). Consistent with this literature, we also find a negative, statistically significant, and quantitatively large relationship between (coastal) remoteness and living in urban environments (column 3). Given the strong interconnection between coastal proximity and urbanization, we also explore the differential effects of distance for individuals living in urban environments in Table S17 in Appendix S1 separately, by estimating the interaction term *log(Distance to Harbor) * Urban(0/1)*. The results show that, while less pronounced, the distance penalty remains for two of our three outcome variables for respondents living in urban settings.

Regarding institutions, we proceed similar to Mitton (2016; 107) and construct an index, *Institutions Score (1–4)*, which combines responses concerning individuals' experiences with and opinions on local authorities, offices, and government. The results suggest that individuals living further away from the coast do not report institutional issues to be at the top of their concerns (column 4) nor is the institutional score negatively affected when living further way from major harbors (column 5). Recent literature has also suggested a weak link between institutions and differences in subnational development within countries (Michalopoulos & Papaioannou, 2014; Mitton, 2016; Radeny & Bulte, 2012). In fact, individuals living in interior regions even seem to evaluate institutions more positively than those living in coastal areas according to our findings (column 5), a result that mirrors the one in Nunn and Wantchekon (2011), whereby coastal remoteness positively influenced levels of trust via a lower intensity of slave trade.

Infrastructure has been highlighted as a relevant factor for regional development (e.g., Bluhm et al., 2018; Calderón & Servén, 2010; Dinkelman, 2011; Donaldson, 2018; Jedwab & Moradi, 2016; Storeygard, 2016; Jetter et al., 2019). Consistent with this literature, our results at the individual level show that coastal proximity is negatively associated with respondents' sentiments that infrastructure needs are issues of concern (see columns 6 and 7). The actual access to basic infrastructure (as measured by our composite infrastructure index) is also negatively associated with the distance to major ports.

Increased trade costs and reduced market access have been shown to be an inherent issue of remote areas in Africa (e.g., Atkin & Donaldson, 2015; Bosker & Garretsen, 2012; Henderson et al., 2018; Jedwab & Storeygard, 2020). While trade volumes are necessarily an aggregate phenomenon, we find that survey respondents further away from the coast exhibit a higher tendency to report their respective regional economic communities (RECs) or the African Union (AU) as helpful to their country, which is consistent with them wishing to improve trade opportunities. Moreover, Table S18 in Appendix S1 shows that the distance penalty is significantly increased for commercial farmers, that is, farmers who mainly grow their produce for sale. Commercial farming depends on access to markets and trade opportunities, leaving commercial farmers more vulnerable to a distance penalty.

3.3 | Bad controls and mediation analysis

All of our results highlight coastal proximity as a statistically and economically meaningful indicator of individual living standards and as a relevant predictor for diverse mechanisms that systematically relate and contribute to economic development and spatial inequalities. As coastal remoteness need not be destiny (Motamed, Florax, & Masters 2014), we aim to gauge the empirical importance of our controls and the potential mechanisms on our main explanatory variable (1) by investigating the relevance of a bad controls problem and (2) by performing a formal mediation analysis.

3.3.1 | Bad controls

We add all of our baseline covariates and the explored mechanisms to our baseline specification in a stepwise fashion and report the corresponding changes of our main coefficient, *log(Distance to Harbor)*, as well as changes in the residual variance. Results are presented in Table 3. Row 1 shows the coefficient of *log(Distance to Harbor)* in a regression including country-time fixed effects only. Row 2 proceeds to add our basic controls, that is, *Age*, *Age squared*, and *Female (0/1)*, as done in Table 1. Row 3 adds our three urbanization controls to the specification, and so on.[19] The results show that, while the coefficient size of *log(Distance to Harbor)* diminishes, as is expected, coastal proximity remains a statistically relevant predictor of individual living standards throughout all rows and columns. The covariates contributing most to the specifications, as seen by changes in the coefficient (odd column numbers) and changes in the R-squared (even column numbers), are *Urbanization Controls, Educational Level*, and *Infrastructure*, which are the ones we will explore as potential mediators next.

3.3.2 | Mediation analysis

To further evaluate the link between coastal proximity and individual economic welfare, and in particular, its potential channels of influence, we conduct a formal mediation analysis. We empirically decompose the total effect of coastal proximity and individual welfare into *indirect effects*, that is, effects that run through the proposed mediating factors, and *direct effects*, that is, effects of coastal proximity that are unrelated to the proposed channels.

We employ the following system of equations to conduct this analysis:

$$Y_{i,c,t} = \alpha_1 + \beta_1 \log(\mathit{Distance\ to\ Harbor}_i) + \theta M_i + \gamma_1 \boldsymbol{X}_i + \delta_{c,t} + \varepsilon_{i,c,t} \tag{2}$$

$$M_{i,c,t} = \alpha_2 + \beta_2 \log(\mathit{Distance\ to\ Harbor}_i) + \gamma_2 \boldsymbol{X}_i + \delta_{c,t} + \mu_{i,c,t} \tag{3}$$

β_1 measures the *direct effect* of coastal proximity on our different welfare indicators Y, and β_2 measures the effect of distance to harbor on the respective mediator M (e.g., education,

TABLE 3 Bad controls: relevance of included covariates

	Dependent variable					
	Cash Employment (0/1)		***How often gone without enough: [Water/Food/Cash Income/ Medical Care] (0–4)***		***Possessions: [Radio/TV/ Motor Vehicle] (0–1)***	
	Log(Distance to Harbor)	**Δ *R*-squared**	**Log(Distance to Harbor)**	**Δ *R*-squared**	**Log(Distance to Harbor)**	**Δ *R*-squared**
	(1)	(2)	(3)	(4)	(5)	(6)
(a) no controls	−0.020***	–	0.076***	–	−0.037***	–
	(0.001)		(0.004)		(0.001)	
(b) = (a) + basic controls	−0.020***	[0.054]	0.075***	[0.003]	−0.037***	[0.026]
	(0.001)		(0.004)		(0.001)	
(c) = (b) + urbanization controls	−0.009***	[0.004]	0.024***	[0.021]	−0.014***	[0.036]
	(0.002)		(0.004)		(0.001)	
(d) = (c) + trade-related controls	−0.009***	[0.000]	0.024***	[0.000]	−0.014***	[0.000]
	(0.002)		(0.004)		(0.001)	
(e) = (d) + geographic controls	−0.009***	[0.001]	0.037***	[0.010]	−0.019***	[0.003]
	(0.002)		(0.006)		(0.002)	
(f) = (e) + educational level	−0.006**	[0.017]	0.029***	[0.025]	−0.015***	[0.056]
	(0.002)		(0.006)		(0.002)	
(g) = (f) + institutions score	−0.006**	[0.000]	0.036***	[0.016]	−0.015***	[0.000]
	(0.002)		(0.006)		(0.002)	
(h) = (g) + infrastructure	−0.005**	[0.000]	0.032***	[0.011]	−0.014***	[0.010]
	(0.002)		(0.006)		(0.002)	
Country-time fixed effects	Yes		Yes		Yes	
Observations	114,857		115,307		102,287	
R-squared	0.18		0.25		0.28	

Notes: Odd columns present the coefficient (changes) of our main explanatory variable *log(Distance to Harbor)* when subsequently adding seven distinct (sets of) control variables to a parsimonious baseline regression, constituted of our main regressor and country-time fixed effects. Even columns report the corresponding changes in the total *R*-squared values compared to the previous specification. The results in each row come from separate regressions, and observations are held constant across rows. Inclusion of mediating factors in (*h*), variables on infrastructure, limits the sample to rounds 2 to 7 of coastal sub-Saharan African countries included in the Afrobarometer. The remaining changes in the number of observations across columns stem from differences in the response rates of dependent variables (see notes in Table 1). Binary dependent variables are estimated through a simple linear probability model specification. Test statistics at the bottom of the table are produced from the full regression, that is, specification (*h*). The standard errors reported are clustered at the survey enumeration area level. *$p < .1$, **$p < .05$, ***$p < .01$.

urbanity, infrastructure). θ represents the direct effect of the mediator M on the outcome variable such that the *indirect effect* is retrieved by multiplying $\beta_2 \times \theta$ (Alwin & Hauser, 1975; MacKinnon, Fairchild, & Fritz, 2007). The total effect is then given by a summation of the *direct* (β_1) and *indirect effects* ($\beta_2 \times \theta$).[20] Figure S2 in Appendix S1 provides a visual representation of the mediation analysis. As before, $\boldsymbol{X}$ is a vector including all of our usual controls. We keep country-time fixed effects $\delta_{c,t}$ to evaluate a stringent setting.

Table 4 reports the coefficients of the total direct and indirect effects of coastal proximity on individual economic welfare. Estimations are performed via structural equation modeling (SEM). To save space, we present the mechanisms on which the distance to harbor had the largest impact in Tables 2 and 3, *Education Level*, *Urbanization Controls*, and *Infrastructure*, and estimate their mediating effect on our three main outcome variables (results for our proxies of *Institutions* and *Trade* are relegated to Table S19 in Appendix S1).

TABLE 4 Mediation analysis: direct and indirect links of distance to harbor

	Dependent variable								
	Cash Employment (0/1)			***How often gone without enough: [Water/Food/Cash Income/ Medical Care] (0–4)***			***Possessions: [Radio/TV/Motor Vehicle] (0–1)***		
	***Mediator*: Education (0–9) (1)**	***Mediator*: Urban (0/1) (2)**	***Mediator*: Infrastructure (0–1) (3)**	***Mediator*: Education (0–9) (4)**	***Mediator*: Urban (0/1) (5)**	***Mediator*: Infrastructure (0–1) (6)**	***Mediator*: Education (0–9) (7)**	***Mediator*: Urban (0/1) (8)**	***Mediator*: Infrastructure (0–1) (9)**
Baseline (total) effect: Log(Distance to Harbor)	−0.009***	−0.012***	−0.009***	0.035***	0.055***	0.037***	−0.019***	−0.028***	−0.019***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.006)	(0.002)	(0.002)	(0.002)
Direct effect: Log (Distance to Harbor)	−0.005**	−0.009***	−0.008***	0.027***	0.035***	0.032***	−0.015***	−0.019***	−0.017***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.006)	(0.002)	(0.002)	(0.002)
Indirect effect: distance to harbor via mediator	−0.003***	−0.004***	−0.001***	0.009***	0.020***	0.005***	−0.004***	−0.009***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Direct effect of mediator: [education/urban/ infrastructure]	0.033***	0.055***	0.089***	−0.082***	−0.284***	−0.582***	0.044***	0.134***	0.210***
	(0.001)	(0.004)	(0.008)	(0.002)	(0.010)	(0.019)	(0.001)	(0.003)	(0.006)
Proportion mediated	[0.39]	[0.30]	[0.09]	[0.25]	[0.36]	[0.14]	[0.21]	[0.33]	[0.10]
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Urbanization controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade-related controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Full geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	121,823	122,238	115,480	126,401	126,982	116,084	102,514	102,990	102,990

Notes: This table presents results from a formal mediation analysis testing the influence of three potential mediators of *log(Distance to Harbor)* on our three main outcome variables, respectively. Row 1 presents the baseline effect, its counterpart is shown in Table 1. Row 2 shows the direct effect of our main explanatory variable, that is, the effect of distance not attributable to the mediating factor, while row 3 depicts the part of the effect that runs precisely via its influence on the mediator. Row 4 shows the direct effect of the mediator on the respective outcome variable. Row 5 provides the proportion mediated, which is given by dividing the indirect effect by the total effect. Results in each column come from a separate SEM regression. Changes in the number of observations across columns stem from differences in the response rates of dependent/independent variables. The sample used is comprised of coastal sub-Saharan African countries included in survey rounds 1 through 7 of the Afrobarometer. The sample used in columns 3, 6, [7], [8], and [9] do not include individuals surveyed in rounds 1 [and 2] of the Afrobarometer, as questions on infrastructure (household items) were not asked in this round. Binary dependent variables are estimated through a simple linear probability model specification. The standard errors reported are clustered at the survey enumeration area level. *$p < .1$, **$p < .05$, ***$p < .01$.

The results in Table 4 suggest that a substantial part of the total effect of distance to harbors is mediated by educational attainment. Including respondents' level of schooling in the main specification (Equation 2) reduces the coefficient size of the direct effect of coastal proximity by 28% (see *proportion mediated* at the bottom of Table 4[21]) on average, that is, across outcome variables. In other words, coastal proximity matters for educational outcomes, and, through education, it matters for individuals' living standards subsequently. The direct effect of education on living standards is quantitively large and statistically significant throughout all estimations, indicating a relevant effect of education on economic welfare on its own. These results are in line with cross-country and subnational evidence, identifying educational differences as an important factor for explaining disparities in economic development (see Chauvin et al., 2017; Gennaioli et al., 2013; Flückiger & Ludwig, 2018; Skoufias & Katayama, 2011).

Similar insights arise for the role of urbanity in explaining relevant parts of distance's effect on living standards, mediating 33% of the effect on average. The mediator *Urban (0/1)* is therefore picking up a substantial part of the total effect of the coastal distance, in similar magnitude as do educational differences.

It is important to note that while both education and urbanization absorb variation in individual living standards on their own (Table 3), and via their mediation of coastal proximity (Table 4), empirically, we cannot fully separate them. Indeed, existing literature has provided evidence suggesting that they are interrelated and mutually reinforced (e.g., Chauvin et al., 2017; Flückiger & Ludwig, 2018; Skoufias & Katayama, 2011).

Infrastructure, proxied by our composite measure *Infrastructure Present in Enumeration Area: [Electricity Grid/Piped Water/Sewerage/School/Paved Road/Health Clinic] (0–1)*, while relevant, does not show an influence in similar magnitudes as do education or urbanization, mediating only an average of 11% of the effect. Table S19 in Appendix S1 explores the role of institutions as a mediator in explaining the distance penalty. Contrary to human capital and urbanity, the pronounced gap in individual living standards across distances does not seem to be associated with perceived differences in (local) institutional quality when controlling for country-time fixed effects. Also, our evidence for a positive, direct effect of institutional quality on individual economic welfare is mixed (see row 4), consistent with other findings from subnational (regional) contexts (see Gennaioli et al., 2013; Mitton, 2016; Michalopoulos & Papaioannou, 2014).

The relevance of coastal proximity to economic development has often been ascribed to trade-related factors, especially among "late developers" (see Henderson et al., 2018). Table S19 in Appendix S1 explores this link, estimating the direct and indirect effects of regional and supra-regional institutions fostering trade, as measured by respondents' evaluation of the AU and its "corresponding" RECs, respectively. The results show that more positively perceived trade organizations correlate positively with individual living standards (row 4), which emphasizes a potential need for trade facilitation independent of individuals' distance to harbors, that is, (global) markets.

4 | CONCLUSION

We systematically investigate the role of coastal proximity in explaining within-country differences in individual living standards across sub-Saharan African economies, using an extensive data set covering up to 128,609 observations distributed across 11,261 localities over 20 years. Analyzing individuals' distance to harbors and their corresponding living standards allows us to test whether the insights from cross-country and cross-regional contexts also apply at the individual level, complementing the existing literature. Moreover, we can utilize the comprehensiveness of our data set to explore a large set of indicators and potential channels of influence to gauge the relevance of coastal proximity and to investigate the mechanism through which it may matter for individual living standards.

Our results show that coastal proximity, as measured by the geographical distance to harbors, predicts a relevant part of individual living standards and remains a strong predictor of individual economic welfare controlling for individual-level covariates, country-time specific influences via fixed effects, and an extensive set of other established geographical influences of development.

Exploring potential channels, we find that human capital, urbanization, as well as access to infrastructure mediate relevant parts of the link between coastal proximity and economic development. This highlights that even though coastal proximity is a relevant indicator of individual living standards across Africa, coastal proximity need not be "destiny." Fostering education and infrastructural outlays might help in mitigating problems associated with coastal remoteness. Nevertheless, the systematic robustness of coastal proximity as a predictor for individual living standards even in stringent settings suggests that there are relevant development costs of remoteness alone that need to be addressed (see also UN-OHRLLS, 2013).

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available via figshare https://doi.org/10.6084/m9.figshare.19638705.v1 with DOI 10.6084/m9.figshare.19638705.v1.

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ENDNOTES

[1] Surveys were sampled in 1999–2001, 2002–2004, 2005–2006, 2008–2009, 2011–2013, 2014–2015, and 2016–2018, respectively.

[2] The four different questions read: "Over the past year, how often, if ever, have you or anyone in your family gone without: Enough clean water for home use?" / "[...]: Enough food to eat?" / "[...]: A cash income?" / "[...]: Medicines or medical treatment?" Answers are: "Never," "Just once or twice," "Several times," "Many times," "Always," ranging from 0 through 4, respectively. These questions are consistently available in all Afrobarometer survey rounds. Using each question separately does not affect our main insights as shown in the Appendix S1.

[3] The questions read: "Which of these things do you personally own? Radio" / "[...]? Television" / "[...]? Motor Vehicle–Car–Motorcycle." Wealth possessions were surveyed from Round 3 and onward. Using each question separately does not affect our main insights, as shown in Appendix S1.

[4] The question reads: "In your opinion, what are the most important problems facing this country that government should address?."

[5] To measure the quality of institutions, we construct an "Institutions Score" similar to that created by Mitton (2016), which is based on an array of questions regarding local authorities, processes, and the government. The score consists of 21 questions measuring individuals' trust in (local) courts, police, and the government; their experiences with the procedures of local authorities, especially regarding bribery (corruption); the enforcement of crime; and the ease of handling administrative matters. Higher values indicate fewer negative experiences/better judgments of (local) institutions.

[6] Nunn and Wantchekon (2011) use an identical measure for the provision of public goods, excluding roads.

[7] Regional economic communities have the proclaimed aim to foster the movement of goods and people and to improve living standards. The question reads: "In your opinion, how much does each of the following do to help your country, or have not you heard enough to say?.

[8] We thank an anonymous referee for pointing out this additional extension.

[9] We measure distances using the projection of coordinates along the earth's ellipsoid (using World Geodetic System 1984 [WGS 84] and EPSG:7030). We add +1 (kilometer) to our distance measure prior to taking the logarithm.

[10] Beeline distances disregard country boundaries, that is, they cross country borders for shorter distances.

[11] Following Henderson et al. (2018) for the definition of those dummies leaves us with seven indicators relevant to our sample: *Mediterranean (0/1)*, *Desert (0/1)*, *Mangroves (0/1)*, *Tropical Forest (0/1)*, *Tropical Grassland (0/1)*, *Temperate Grassland (0/1)*, and *Montane Grassland (0/1)*.

[12] The inclusion criteria for both rivers, that is, "navigability," and lakes, that is, "major," are defined as in Henderson et al. (2018): we select all natural rivers within size categories 1–5 (scales 1–7) as defined in Natural Earth (2019) and lakes with a surface area of over 5,000 km^2 (Lehner & Döll, 2004).

[13] Results for binary dependent variables estimated via *Probit* yield qualitatively identical and quantitatively similar marginal effects.

[14] See Table S1 for coefficient estimates of all (geographic) control variables.

[15] The variation in the number of observation stems from missing values. Holding the sample size constant by eliminating observations for which not all dependent/independent variables are available does not change our main insights as shown in Appendix S1.

[16] We also investigate differing effects across distance in Figure S1 in Appendix S1. Distance to harbors is systematically related to living standards across all distance increments and tends to intensify along distance.

[17] Empirically, we add an interaction term constituted of log(*Distance to Harbor*) and a binary variable indicating whether the country is *Landlocked*. The sum of the coefficients log(*Distance to Harbor)* and the interaction term represents the total effect of the distance to the coast for individuals living in landlocked countries.

[18] We thank an anonymous referee for pointing out this additional extension.

[19] We do not add sentiments of RECs or the AU to the list of covariates as their availability across survey rounds is sparse, leading to a drop in the number of observations by ∼50%.

[20] Slight deviations in coefficients between the total effects in Tables 1 and 4 arise because of the missing values of the respective mediator variables introduced.

[21] The proportion mediated is given by dividing the indirect effect (row 3) by the total effect (row 1).

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