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Democracy, Natural Resources, and Infectious Diseases: the Case of Malaria, 1990–2016

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Abstract
Recently, work on the natural resource curse thesis has extended to testing the effects of natural resources on public health. Focusing on the case of malaria, this paper examines the effects of the interaction between resource dependence and political institutions on malaria management. To be more specific, this work argues that in a resource-abundant state, democracy plays an active role in providing health goods to the general public and allocating government funds to public health. Democracies also combat corruption behaviors and diversify economies in a more effective way than their autocratic counterparts. By testing a series of interaction effects between natural resources and democracy, this paper finds a positive and robust effect of democracy on the reduction of malaria death rates in resource-rich states, based on data on malaria deaths during the period of 1990–2016. Resource-rich dictatorships demonstrated the worst performance in malaria control compared with resource-rich democracies and resource-poor democracies and dictatorships. This empirical evidence has policy implications for resource management, public health, and infectious disease control and prevention.

Keywords Democracy · Resource curse · Malaria · Diversification · Public goods · Rent-seeking

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Introduction

Malaria is a major public health concern. According to the World Health Organization (WHO), malaria had 216 million detected cases in 2016. It also took 445,000 lives in 2015.[1] Moreover, cases of malaria infection showed the greatest variations at the regional level. While in 2015 not a single malaria case was reported in Europe, Africa was home to 87.83% of all cases (WHO 2017b). Table 1 and Fig. 1 further demonstrate these differences across regions and countries, respectively.[2] Finally, in recent times, there have been intensified outbreaks of mosquito-borne viruses like Zika, West Nile, and dengue fever in various countries. If we can learn how to contain malaria, it may have certain policy implications for other mosquito-borne viruses.

Scholars who pay attention to communicable disease control and prevention have recently focused on how natural resources may help contain or spread disease. The argument they developed is based on the "(natural) resource curse" theory. This theory argues that natural resource abundance or dependence has detrimental effects on national development, like democratic transition (Mahdavi 2015; Ross et al. 2011), economic development (Battaile et al. 2014; Sachs and Warner 2001), and social stability (Collier and Hoeffler 2005; Lee 2018), among other issues (like female status; Ross 2008; Simmons 2015). However, while some have argued that natural resource abundance or dependence worsens infectious disease control and prevention and overall public health, others have doubted this pessimistic view (Anshasy and Katsaiti 2015; Sterck 2016).

In this paper, I examine the effects of the interaction between resource dependence and political institutions on malaria management from 1990 to 2016. To be more specific, I argue that the effect of natural resources on infectious diseases is conditional on whether the state is democratic or not.[3] In a resource-abundant state, democracy plays an active role in providing health goods to the general public. Furthermore, democracy is also more efficient in combating natural resource-caused rent-seeking behaviors. Finally, democracy enables resource-rich states to curtail malaria by diversifying their economies and investing in the quality of their human capital. These characteristics, which are rarely seen in resource-rich dictatorships, help contain malaria and reduce deaths. Resource-rich dictatorships demonstrated the worst performance in malaria control compared with resource-rich democracies and resource-poor democracies and dictatorships.

After testing the number of deaths from malaria with a series of resource and political variables and their interaction terms between 1990 and 2016, this paper finds strong empirical support for the conditional resource curse argument. This finding has theoretical and policy implications for the resource curse, infectious disease control, and global public health. In the next section, this paper first reviews the literature on the impact of natural resources on infectious diseases and public health issues, before

[1] HIV/AIDS had 36.7 million reported cases and caused 1 million deaths in 2016, while TB's figures were 10.4 and 1.7 million, respectively (WHO 2017b).

[2] The six regions in Table 1 come from WHO definitions.

[3] There is no denying that resource abundance may result in the suspension of democratic transitions, leading to the topic of this paper being endogenous. However, this paper avoids dealing with this endogeneity issue by treating political performance as existent, as Arezki and Gylfason (2013) and Bhattacharyya and Hodler (2010) did in their paper.

Table 1 Sub/regional differences in infectious disease incidence (in 1000s)

Disease/sub/region	TB	HIV/AIDS	Malaria
Africa	2720	25,500	188,000
Americas	268	3400	660
Southeast Asia	4740	3500	20,000
Europe	323	2500	0
Eastern Mediterranean	749	330	3890
Western Pacific	1590	1400	1500
Average no. of cases	1731.67	6105	35,678
Standard deviation	1740.07	9578.65	75,000.78

Average no. of cases and standard deviations are author's calculations. *Source*: WHO (2017b)

advancing the main arguments in the "How Can Democracy Prevent and Control Malaria in Resource-Rich States? A Theory" section. It then turns to model specification and variable selection and operationalization in the "Data, Measurement, and Model Specification" section, and presents and discusses the empirical results in the "Empirical Results and Discussion" section. The "Conclusion" section concludes the paper with policy recommendations and future research directions.

Literature Review: Natural Resources, Infectious Diseases, and Public Health

The argument that natural resources may worsen infectious disease management and public health relies on three main points: the degree to which a government pays attention to human capital, the detrimental health conditions in mining and drilling areas, and reduced government capability in implementing health policies.

Firstly, countries rich in natural resources tend to mobilize revenues for private gains rather than for infrastructure conducive to public health (Robinson et al. 2006; de Soysa and Gizelis 2013). Robinson et al.'s (2006) two-stage probabilistic voter model demonstrates that to secure their positions, political leaders tend to expand the inefficient

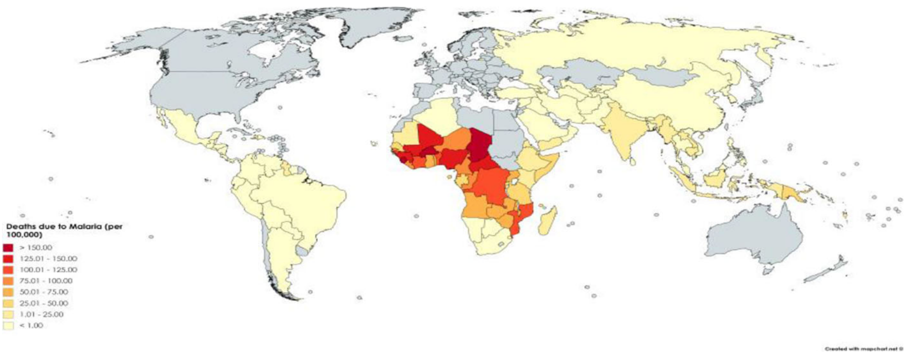

Fig. 1 Deaths due to Malaria (per 100,000), 2010. *Note*: Countries in light gray are not reported by WHO. *Source*: WHO (2017b)

public sector to gain popular support, as seen in many Latin American and African states. Various studies have indicated that resource-rich states may not provide appropriate health spending to tackle public health issues like infectious diseases and child mortality (Cockx and Francken 2014; de Soysa and Gizelis 2013; Wigley 2017).

Moreover, political leaders of countries with abundant natural resources may be reluctant to invest in human capital, since they are able to receive state revenues from resource production. Governments that receive "unearned income" from natural resources tax people less or do not tax them at all. With less of a tax burden, people in these states tend to request less, if any, government accountability (Busse and Gröning 2013; Ross 2001; Levi 1989).[4] This low accountability prevents them from asking the government to combat communicable diseases, and scholars have found evidence that resource-rich states tend to spend less on public health (Anshasy and Katsaiti 2015; Cockx and Francken 2014). Furthermore, Cockx and Francken (2014), de Soysa and Gizelis (2013), and Wigley (2017) argue that politicians' utmost goal is to secure their political survival rather than to create a more development-friendly environment, which may damage them politically, and in turn fail to promote public health.

Mining, drilling, and deforesting activities also facilitate the outbreak of malaria in two ways. A resource boom attracts workers, who migrate to earn a living (Castellanos et al. 2016; Knoblauch et al. 2014). The quick expansion of dwelling areas without sufficiently improved sanitary conditions may become the channel through which malaria breaks out. Additionally, undocumented workers and illegal mining activities also increase the difficulty of malaria control (Castellanos et al. 2016), as the monitoring system may not be effective and these workers' activities are more difficult to trace than those of documented ones. Drilling and mining also create specific conditions conducive to malaria transmission by degrading the environment through air and water pollution, deforestation, solid waste, and so on. These activities help with mosquitoes' survival and adaptation (Hunt et al. 2011; Kweka et al. 2016). Together these reasons explain why in sub-Saharan Africa and Latin America, a substantial proportion of malaria cases are reported in resource-rich administrative regions. Nigeria, with all its oil wealth, accounted for 55% of detected cases, followed by Côte d'Ivoire and Mali, both of which have lucrative extractive industries (WHO 2017c; Appendix 2). In Latin America, malaria cases found in Brazil, Venezuela, and French Guiana were highly concentrated in the Amazonian gold-mining area (Douine et al. 2018; de Oliveira et al. 2013).

Natural resources tend to strengthen rent-seeking or corruption behaviors, which is harmful to eliminate malaria (WHO 2015; 11–21). One major reason that resource-rich states fail to improve social development is the lack of "transparency around the governance of rents from oil" (Vadlamannati and Soysa 2016; 458). Arezki and Gylfason (2013) and Okada and Samreth (2017) found that total natural resource rents were positively correlated with corruption in selected sub-Saharan and other countries. Furthermore, the establishment of patronage politics leads to the provision of resource rents to supporters but not to all subordinates (Collier and Hoeffler 2005; Robinson et al. 2006). Therefore, in their studies of natural resources and public health issues, scholars have found that resource income is usually associated with high infant/child

[4] The "taxation effect," a term coined by Ross (2001; 332–333), proposes that a lower tax burden gives political leaders more policy space by reducing the demand for accountability from the government.

mortality rates (Makhlouf et al. 2017), low health expenditure (Cockx and Francken 2014; Hong 2017), and short life expectancy (as one dimension of the Human Development Index; Pendergast et al. 2011). Evidence also proves that in China, in provinces that rely highly on natural resources certain functions are substituted by corporations, leading to less health spending on the public (Zhan et al. 2015).

How Can Democracy Prevent and Control Malaria in Resource-Rich States? A Theory

At first glance, if resource wealth has detrimental effects on disease control and prevention, as discussed in the previous section, then there should be no substantial differences between resource-rich democracies and autocracies.[5] However, based on several institutional characteristics, this paper argues that the effect of natural resources on malaria is not homogeneous across all countries. Rather, democracies outperform autocracies in malaria control and prevention for three reasons.

Firstly, compared to their autocratic counterparts, democracies are more likely to provide health goods to the general public. The selectorate theory by Bueno de Mesquita et al. (1999, 2004, 2005) explains how this is possible. This theory proposes that in each state, there are two groups of people: the selectorate, who have some say in determining political leaders, and the winning coalition, a subset of the selectorate who has a decisive role in sustaining current leaders. Typically, a democracy's selectorate is composed of those who have the right to choose political leaders, namely qualified voters. However, the size of the winning coalition varies. In certain democracies, leaders require the support of 50% plus one vote; in others, such as the Westminster-style parliamentary system, slightly over a quarter of the selectorate is a sufficiently large proportion to secure political power (Bueno de Mesquita and Smith 2010; Quiroz Flores 2019). This variation is highly applicable to authoritarian regimes, but overall, selectorates and winning coalitions tend to be larger in democracies than in authoritarian states. In certain countries where elections are possible, such as Cameroon or Singapore, the selectorate size is larger than those in countries without elections, where political leaders are chosen on the basis of hereditary succession or an arbitrary election of a few individuals. Whichever regime type a country has, the decision to have current leaders stay in office is primarily based on their performance. If leaders fail to satisfy the needs of the selectorate and winning coalition, their chance of being replaced is high.

To survive politically, leaders can either offer public goods (such as infrastructure, higher-quality education) or private goods (such as export and import licenses, oligopolies or monopolies of certain industrial sectors, franchises, etc.) to the public. In democracies, political leaders find it cheaper and more efficient to offer public goods,

[5] For example, in Wigley's (2017) discussion of oil wealth and child mortality, the author's observation regarding how oil wealth affects political leaders' tenure shows there should be no difference between different regime types:

> It is argued that access to oil revenues enhances the ability of incumbent elected leaders to secure reelection. Thus, access to non-tax revenues enhance the ability of *autocratic and democratic leaders* to stay in power. ... governments in resource-poor countries have a greater incentive to invest in public goods such as health and education. (Wigley 2017; 143, *emphasis added*)

since this type of good can easily reach many selectorate members and sustain (or even increase) the size of the winning coalition. In autocracies, because winning coalition members are decisive "kingmakers," leaders will seek to satisfy them by continuously providing private goods in exchange for loyalty.

Public health is a public good (Anomaly 2011; Stein and Sridhar 2017). To combat malaria, a government can enact many health measures like expanding the number of health stations and hospitals, training qualified medical staff, and providing insecticide-sprayed mosquito nets. In remote mining, drilling, and logging areas, the government can also have all documented and undocumented workers registered to establish a monitoring system and improve sanitary conditions. Compared to their autocratic counterparts, democratic leaders are more likely to carry out these measures, because they will *try harder*[6] to accomplish certain goals to maintain their political survival. In contrast, dictators will prioritize the provision of private goods over malaria control, since coalition members have more impact on their survival than the general public.

Studies have demonstrated that natural resources may strengthen a country's likelihood of regime survival, for both democracies and dictatorships (Bueno de Mesquita and Smith 2009; Morrison 2007; Ross 2015; Smith 2004). Morrison (2007) and Smith (2004) demonstrated that natural resources help stabilize authoritarian regimes and reduce the likelihood of regime transition. Bueno de Mesquita and Smith (2009) offered a more generalizable explanation. They proposed that political leaders in democracies had a tendency to seek support from the public by providing resource revenue in the form of public goods to sustain regime survival. However, these non-tax revenues were primarily distributed privately within the close circle of key power holders. Therefore, natural resources can improve democratic performance or consolidate authoritarian rule.

There is no denying that in some resource-rich dictatorships, government leaders can also improve public health to keep their position; that is, they may spend their resource dollars *smartly* to sustain support. In Venezuela and Saudi Arabia, for example, the public can receive medical treatment at no cost (Saudi Gazette 2017; teleSUR 2017). However, evidence reveals that overall, six oil-rich Gulf monarchies still spend less on per head healthcare than Organisation for Economic Cooperation and Development states. In addition, resource-abundant Eastern Mediterranean member states have far fewer medical staff for every 10,000 people than Europe and the Americas (Klautzer et al. 2014; 111–112, and Fig. 4).[7]

Secondly, scholars have argued that corruption or rent-seeking behaviors are more likely to be offset by democratic institutions in resource-rich states (Bhattacharyya and Hodler 2010; Bulte and Damania 2008), and evidence also proves that democracy or democratization has beneficial effects on overall health improvement (Álvaro Franco et al. 2004; Mackenbach et al. 2013; Pieters et al. 2016). In contrast, in some malaria-affected autocracies, several fraud and corruption cases were raised as millions of

[6] The "*try harder*" statement means democratic leaders will exert every effort to deliver public goods. As Bueno de Mesquita et al. (1999; 799) observed, "leaders in states with large winning coalitions cannot easily compensate for policy failure by doling out private goods, they need to succeed in foreign and domestic policy."

[7] Figure 1 in the Supplementary Materials summarizes the global relationships between democracy and health expenditure per head (1a), and health expenditure as a % of government spending (1b), respectively, between 1990 and 2016. Both figures clearly show that the more democratic a country is, the more it spends on health.

dollars provided by the Global Fund were unspent and embezzled and drugs were expired or not even provided when health stations were running out of stock.

For example, Uganda is a one-party state with a lucrative oil industry, yet malaria has been the leading cause of health issues for the country, with about 16 million infected and 10,000 deaths reported in 2014. This mosquito-borne disease also accounted for as many as 50% of outpatient visits and one-fifth of hospital admissions (Uganda Ministry of Health 2005, 2014). However, as stated by the Global Fund, the Ugandan government's "capacity to promptly take up, efficaciously use, and credibly account for millions of dollars was found to be *largely ineffective*" (The Observer 2016; *emphasis added*). This ineffectiveness includes the overall weakness of the health care system, which lacks stable resources and coordination; an insufficient understanding of malaria and subsequent lack of an efficient monitoring and control system; inappropriate case management; and so on (Yeka et al. 2012; 12–14). Similar issues are also found in resource-rich dictatorships or semi-democracies like Zambia, Nigeria, Mauritania, and Mali (Boseley 2011; Ogundipe et al. 2016), leading to fund suspension or cancelation.

On the other hand, Botswana has reached the elimination stage—the last stage of malaria eradication. Its malaria incidence rate was reduced to 0.33 in 2016 from 42.52 in 2000 for every 1000 people (WHO 2017a). This diamond-rich landlocked state has often been praised for its political cleanliness and democratic performance since its independence. As the least corrupt government in Africa, along with its political commitment to malaria elimination (WHO 2017a), Botswana has substantially improved its malaria control and management.

Elections are another feature of democracy that may contribute to improving public health. In democracies, where elections are free, fair, and regular, politicians who compete for political office may provide public goods to secure their chance of election or reelection with the resources they are able to mobilize. Bueno de Mesquita and Smith (2009) observed that leaders may use unearned resources to secure political survival when confronted with revolutionary threats. It is evident that in certain authoritarian regimes in which a form of election exists, politicians may also use resources to provide public goods to the public in addition to providing private goods to key supporters. Scholars have observed that in China, Iran, and Tanzania, members of the public also receive public goods, and all of these countries have some form of local or national election (Luo 2018; Mahdavi 2015; Rosenzweig 2015).

However, I argued that overall, democracies provide higher a larger quantity of and higher-quality public goods to their people than authoritarian regimes, because of differing degrees of electoral competition in these regimes. In authoritarian regimes, the degree of electoral competition is low or even nonexistent. Crucially, these elections do not affect the chance of survival of the ruling coalition. The Chama Cha Mapinduzi (or Party of the Revolution, formerly known as Tanganyika African National Union) has ruled the resource-rich country of Tanzania since its independence. In China's village elections, "candidates who are not members of the Chinese Communist Party are not allowed to organize into political parties and can only run as individuals" (Luo 2018, 1291–1291). Finally, in Iran, the candidates in this theocratic republic's parliamentary elections are highly likely to be deprived of their candidacy "on the basis that they might be a threat to the stability of the republic" (Mahdavi 2015, 231). Because elections in dictatorships are not as competitive as those in democracies, the candidates may not need to satisfy all the needs of the public.

Additionally, when authoritarian regimes face a threat, leaders tend to contract the provision of public goods (Bueno de Mesquita and Smith 2009). For example, Gottlieb and Kosec (2018, Supporting Information) identified a positive relationship of electoral competition with public goods provision and spending. Furthermore, most countries with higher electoral competition are democracies. Deacon (2009, 242, 254) examined the association between regime types and a variety of public goods, including safe drinking water and sanitation and determined that “low public goods provision often seems to accompany nondemocratic rule,” and “public goods provision is significantly greater in more democratic regimes than in less democratic regimes.”

Thirdly, a somewhat less direct yet efficient way in which democracy can help curtail malaria in resource-rich states is through economic diversification. Empirical evidence has proven that whether resource-rich or resource-poor, democracy is more likely to diversify a country’s economic structure (Ahmadov 2014; Cuberes and Jerzmanowski 2009; Luong and Weinthal 2006). The logic of why diversification can contain malaria is straightforward: If the economic structure’s dependence on the non-traded resource sector leads to higher malaria transmission and death, then diversifying the economy may have the reverse effect.

There are at least two explanations for why democracy favors diversification. First, Dunning (2005) argued that it is because any monopolization of the economic structure renders political opposition less likely. Alternatively, the introduction of new competitors within the economic sphere prevents rulers from monopolizing economic rents (Acemoglu and Robinson 2000; Cuberes and Jerzmanowski 2009). When faced with the possibility of losing office, politicians in democracies may encourage economic diversification in order to use nonresource revenues for political mobilization and support.

Economic diversification may have several consequences that are conducive to malaria management. First, diversification may mitigate the pressure of over-exploitation of natural resources and therefore environmental degradation, which increases the chance of malaria transmission and outbreak as reviewed in the previous section. Second, when countries reduce dependence upon natural resources for government revenues, they have to look for sustainable sources of revenues from its people and their economic activities. Thus, diversifying a resource-dependent economy may encourage the government to invest more in not only the quantity of human capital but also its quality to enlarge the taxable income base. This means it has to not only enlarge the pool of human resources (the *quantity* dimension) but also keep the pool healthy (the *quality* dimension) (Levine and Rothman 2006; Novignon and Atakorah 2016). Figure 2 in the Supplementary Materials clearly shows that lower export diversification (in all sub-figures) is negatively associated with a series of public health expenditure indicators during the period 2000–2010 (International Monetary Fund 2017; World Bank 2017). Scholarly evidence has also proven that natural resource rents are negatively associated with public health, like infant and child mortality and fertility rates, and health spending (Frantál and Nováková 2014; Hong 2017; Klautzer et al. 2014; Makhlouf et al. 2017; Wigley 2017; Zhan et al. 2015). Diversification will drive governments to invest more in health promotion and medical staff training, and take action against malaria.

Additionally, diversification also reduces the chance of large health budget cuts, which are harmful to malaria control and prevention, when commodity price volatility hits resource-rich countries deeply (Akinleye 2017; Pazouki and Pazouki 2014). In Saudi Arabia, an oil price drop in 2014 led to a record-high fiscal deficit in 2015, which was then followed by a 34.4% drop in the health budget in 2016 (Economist Intelligence Unit 2015). Diversification can also revert the impact of an overreliance on resource dollars to subsidize health expenditure on malaria, when a government decides to redirect resource dollars to other sectors (Gupta et al. 2015).

This paper exclusively explored the moderating effects of democratic institutions on the relationship between natural resources and malaria control and prevention. However, I recognize that resources also influence political performance. For instance, studies have repeatedly confirmed that resource wealth reduces the likelihood of democratic transition and enhances regime stability (Morrison 2007; Ross 2015). Several studies have claimed that democracies tend to perform better than authoritarian countries in terms of providing public health; this hypothesis has several theoretical and practical implications. First, because resource wealth stabilizes authoritarian regimes and reduces the likelihood of democratic transitions, resource-rich dictatorships should have the lowest level of malaria control and prevention. Second, if resource wealth helps to sustain and improve democratic practice, then resource-rich democracies should have the strongest performance in malaria control. Third, because resources have little or no effect on political performance in resource-poor dictatorships and democracies, democracies should have stronger performance than dictatorships.

Based on the arguments detailed above, this paper developed the following core hypotheses:

H_1: Democracies tend to perform better than autocracies in malaria management.
H_2: Resource-rich democracies tend to perform better than resource-rich autocracies in malaria management.

Data, Measurement, and Model Specification

Variables

Outcome Variables

To test these hypotheses, I selected the mortality rates for all ages and for ages of less than 5 years as outcome variables (All, ≤ 5). The mortality rate was measured according to the number of deaths from malaria for every 100,000 individuals (Roser and Ritchie 2017). The data were compiled by Roser and Ritchie (2017) after they retrieved all relevant information from the Institute for Health Metrics and Evaluation (IHME 2017). Compared to other datasets like the WHO's (2017b) Global Health Observatory data repository, which only covers 107 states from the 2000–2014 period, IHME's (2017) data are more inclusive, reporting 205 political entities' information between 1990 and 2016.[8]

The reason for including children under five but not other age groups was that kids are extremely vulnerable to malaria. According to the WHO (2017c), in 2015, children

[8] Due to missing values, the statistical results report on 149–156 political entities.

younger than five accounted for 67.937% of all malaria deaths (303,000/446,000 × 100% = 67.937%) worldwide. Therefore, there is precedent for the use of these two outcome variables in malaria studies.

Explanatory variables The first explanatory variable is the resource variable, and this paper used the World Bank's total natural resource rents (% of GDP) (Rents). Total resource rents are composed of rents from oil, natural gas, minerals, coal, and forests. A resource rent is the difference between the average cost of extraction and the global commodity price. Usually, higher-valued rents will reduce the possibility of investing in human or financial capital, since countries consume this unearned income to meet their current demand.

The second explanatory variable is democracy, and this paper selected Marshall et al.'s (2017) Polity IV dataset (Polity). The Polity IV dataset evaluates each country's political performance on a 21-point scale, with − 10 denoting the least democratic country and + 10 the most. I added 11 to each value and then divided it by 21 to make it a numerical value within the range of 1/21 (≈ 0.048) and 1.

An interaction term between Polity and Rents (Polity × Rents) was created to test their interplay effects on malaria death cases. In capturing their effects on malaria death rates, this paper expected negative signs for the coefficients of Polity and the interaction term, and a positive one for Rents.[9]

Control variables A set of factors that affect malaria death rates, as discussed by scholars and the WHO (2016b; 35–36), was also included. Data, unless specified, were retrieved from the World Bank's World Development Indicators (WDI). First, this paper tested individual economic wealth by using gross domestic product (GDP) per head by selecting GDP per capita measured in constant 2010 US dollars and taking the form of natural logarithm.

Two relevant demographic variables are urbanization and population growth rates (Urb. Growth, Pop. Growth). Urbanization growth was measured as the growth ratio of urban population to total population, and population growth rate was the average yearly rate of change in population size.

There were three climate and geographical variables: Nunn and Puga's (2012) latitude (Latitude) and % of tropical climate (Tropical), and the Central Intelligence Agency's (CIA 2018) mean elevation (logged, ln Elev). Latitude is the geographical centroid of a country, and % of the tropical climate is the percentage of the land surface area that has a tropical climate. Finally, mean elevation is the average meters above sea level of a country. I expected the associations between malaria death rates and latitude and average elevation to both be negative, and that between the death rate and a tropical climate to be positive.

Model Specification

The data structure is time-series and cross-sectional (TSCS), with 205 political entities over the 1990–2016 period. Therefore, the TSCS model was appropriate, the country

[9] A further examination of alternative regimes and resource indicators is introduced in the "Robustness Checks" section, including data sources, measurement methods, descriptions, and discussions of statistical results.

random-effects (RE) model is applied for a variety of reasons.[10] First, the RE model could handle time-invariant variables, which were region, climate, and geography. These variables were treated as controls because they are primary factors in mosquito-borne diseases. Second, as Groh and Rothschild (2012) argued, the RE model can incorporate both between- and within-country variations in growth rate trends and can reflect these trends in the coefficient of explanatory variables. If we apply the FE model, then these trends are "absorbed" by the country-specific fixed trends (Groh and Rothschild 2012, 81). Third, Bell, Fairbrother, and Jones (2019) and Bell and Jones (2015, 139) argued that "time-invariant processes can have effects on time-varying variables, which are lost in the FE model." Fourth, the FE model seems better than the RE model at addressing omitted variable bias (OVB). However, Clarke (2005, 2009, 2012) repeatedly claimed that OVB is unavoidable. Adding or removing the control variable may not reduce the OVB and may increase bias as a result of measurement errors (Clarke 2005, 349). Instead, a concentrated discussion on the intended topic and careful research design are needed. Thus, the OVB, although a crucial consideration, is not the primary concern of this study. Fifth, when considering the possibility of applying the ordinary least squares model in this paper, the results of the Breusch-Pagan Lagrange multiplier (Breusch and Pagan 1980) estimator rejected the null hypothesis that there was no substantial difference across the units of analysis. These results suggested that the RE model was more appropriate.

The fundamental model used in this paper is as follows:

$$Y_{i,t} = \alpha_i + \sum_{x=1}^{n} \beta X_{i,t-1} + \eta_i + \varepsilon_{it}$$

Y denotes outcome variables, i; t are states and year, respectively; α stands for the constant term; and X stands for all explanatory and control variables. η_i is the unit-specific error term, and ε_{it} ($= \mu_i + \nu_{it}$) is also an error term where μ_i covers all unobserved effects and ν_{it} the remainder disturbance. I also used clustered robust standard errors to control for heteroscedasticity (Drukker 2003; Hoechle 2007).

Additionally, since public health is highly trended and this trend basically assumes the possibility of serial correlation, I modeled dynamics in this paper with an AR(1) process by performing the Baltagi and Wu (1999) locally best invariant (LBI) test. I also included the year fixed effects by including year dummies to capture the general trend. That is, countries with more positive democracy score trends also demonstrated downward trends in malaria mortality rate. I present all results from both the simple RE and the AR(1) process estimation to avoid model selection bias. All explanatory and control variables were lagged by 1 year to avoid the problem of reverse causality.[11]

[10] Therefore, the Hausman test which is claimed standard when specifying whether the RE model is appropriate or not was not conducted as recent evidence shows this test is mis-specified (Baltagi 2013; Bell et al. 2019; Bell and Jones 2015).

[11] The simplest description of reverse causality is that instead of the explanatory variable(s) causing variations in outcomes, outcomes cause variations in explanatory variables. This study examined the effects of democracy and natural resources on malaria management, but we must consider that malaria management may affect democratic quality. For instance, Butler (2005) and Mattes (2003) determined that HIV/AIDS, another major infectious disease, had a profoundly negative effect on democracy in Southern Africa.

Figure 1 illustrates the variation of malaria cases among different WHO regions, suggesting a substantial regional effect on the mortality rates of this mosquito-borne disease. Thus, I clustered the error at the regional level by creating a nominal variable called Region. Countries that belonged to the WHO African region were coded as 1, in the Americas were coded as 2, in Southeast Asia were coded as 3, in Europe were coded as 4, in the Eastern Mediterranean were coded as 5, and in the West Pacific were coded as 6.

Empirical Results and Discussion

Table 2 presents the first set of statistical results.[12] In each statistical result table, I report the effects of the explanatory variables and their interaction terms on malaria mortality rates in the first and second models and with all of the control variables in the third and fourth models. Models 5–8 provide results from the AR(1) process. As indicated in Table 2, there were significant negative associations between Polity and mortality rates, in all ages and in children younger than 5 years, across all eight models, whereas Rents had positive effects on the outcome variables. The interaction term between Polity and Rents was of the greatest interest; the signs for all eight coefficients were negative, and half of them were statistically significant at the 95% confidence level. These results indicate that the effects of natural resource rents on malaria are moderated by political regimes.

To interpret the results, I used model 1 on the data in Table 2 to provide an example of the minimal and maximal values of Rents within the sample and thereby explain the predicted changes. In model 1, the regression results demonstrated that if a state has no natural resources overall (Rents = 0), then a unit increase in Polity leads to a 0.69 decrease in malaria mortality rates for all age groups ($[-14.56–1.306 \times 0] \times 1/21 = -0.69$). However, if natural resources accounted for 89.17% of GDP, the maximal value within the sample, then an increase in Polity of 1 unit would lead to a 6.23 decrease in mortality rates ($[-14.56–1.306 \times 89.166] \times 1/21 = -6.23$). Inversely, if a state was fully authoritarian (Polity = 1/21), then a unit change in Rents would lead to a 0.71-fold increase in mortality rates for all age groups ($-1.306 \times 1/21 + 0.771 = 0.71$). This effect decreases to a 0.54-fold increase if the state is fully democratic (Polity = 1, $-1.306 \times 1 + 0.77 = -0.54$). In other words, the effect of Polity on mortality rate reduction is strengthened if the state has higher Rents, but Polity can also reduce the effect of natural resources on malaria mortality rates.

I witnessed a similar pattern in model 2 for the age group of under 5 years. The coefficient for Polity was negative and statistically significant at the 95% confidence level, whereas the coefficient for Rents was positive. The interaction term between the two variables warrants further attention. The findings from model 2 were consistent with those from model 1, and we can therefore conclude that the estimated marginal effect of Polity was stronger when the value of Rents was higher and that the marginal effect of Rents was lower when the state was more democratic.

Models 3 and 4 in Table 2 included all variables and examined their effects on both age groups. The findings were also highly consistent with those from model 1. The signs of all explanatory variable coefficients supported the argument developed in this

[12] Summary statistics are presented in the Supplementary Materials Table 1 and the Pearson's correlation matrix of all time-varying covariates is in the Supplementary Materials Table 2.

Table 2 Polity, Rents, and malaria death rates, 1990–2016

	(1) All	(2) ≦ 5	(3) All	(4) ≦ 5	(5) All	(6) ≦ 5	(7) All	(8) ≦ 5
Polity	− 14.56* (− 2.07)	− 78.27* (− 2.15)	− 13.77 (− 1.95)	− 74.31* (− 1.97)	− 0.929 (− 1.00)	− 4.235 (− 0.95)	− 1.037 (− 1.05)	− 4.631 (− 0.96)
Polity × Rents	− 1.306** (− 2.89)	− 6.858* (− 2.36)	− 1.176* (− 2.26)	− 6.578* (− 2.24)	− 0.0668 (− 1.43)	− 0.408 (− 1.82)	− 0.0630 (− 1.30)	− 0.414 (− 1.75)
Rents	0.771* (2.02)	4.252 (1.91)	0.735* (2.17)	4.208* (2.08)	0.0352 (1.46)	0.220 (1.89)	0.0347 (1.37)	0.225 (1.82)
ln GDP PC			− 1.820 (− 0.73)	2.969 (0.36)			− 3.144** (− 3.25)	− 11.21* (− 2.37)
Pop. growth			− 3.419* (− 2.42)	− 11.77** (− 2.98)			− 0.228 (− 1.05)	1.154 (1.08)
Urb. growth			1.977** (2.75)	7.561* (2.50)			0.274 (1.69)	1.049 (1.33)
ln Elev			0.731 (0.70)	9.152 (1.42)			0.0223 (0.01)	0.431 (0.02)
Latitude			− 0.236** (− 2.93)	− 0.996** (− 2.77)			− 0.225 (− 1.37)	− 0.945 (− 1.19)
Tropical			0.453 (1.32)	2.364 (1.35)			0.358*** (3.77)	1.742*** (3.80)
Constant	34.28 (1.46)	159.0 (1.47)	33.57 (1.13)	18.16 (0.19)	29.68*** (7.50)	135.4*** (7.26)	46.61 (1.71)	178.8 (1.36)
No. of Obs.	4114	4114	3789	3789	4114	4114	3789	3789
No. of states	164	164	149	149	164	164	149	149
R^2 within	0.17	0.19	0.18	0.20	0.12	0.12	0.11	0.12
Year dummies	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
AR(1)					*Y*	*Y*	*Y*	*Y*

T statistics in parentheses; $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

paper that the effect of natural resources on malaria mortality rate is dependent on whether the state is democratic.

The statistical results from the AR(1) process are presented in Table 2 (models 5–8). The effects of Polity, Rents, and their interaction terms were not statistically significant, but their coefficients agreed with the hypothesis that the interactions of democracy values and Rents are negatively associated with malaria mortality rate. Moreover, Rents was positively associated with malaria mortality rate.

Furthermore, Brambor, Clark, and Golder (2006) and Williams (2015) suggested that visualizing the marginal effects of an interaction term was preferable to simply stating them in statistical tables. Therefore, we used marginal effect plots (Fig. 2) to demonstrate how the change in Polity affected Rents' effect on the outcome variables by using the mean value of Rents (7.597) across all eight models. Figure 2 has eight sub-figures, each representing a model in Table 2. The *X*-axis has a Polity score within the range of 0.050 to 1, with incremental increases of 0.05. All eight figures exhibit a strong negative effect of Polity on reducing the number of deaths for every 100,000 people.

Overall, these marginal effects plots demonstrate that stronger democratic performance reduces the effects of resource rents on malaria mortality rate. Therefore, higher democratic values moderate the negative effects of resource rents on malaria mortality rate. These results support the main hypothesis that resource-rich democracies tend to have better malaria management, measured as lower malaria mortality rates for two age groups (All, ≤ 5), than their resource-rich autocratic counterparts. Inversely, the effects of Rents on malaria mortality rates when using the mean value for Polity (0.667), as illustrated in Fig. 3, indicate that with the same Polity score, higher dependence on Rents is associated with a higher malaria mortality rate.

With respect to the control variables, higher personal income (logged) was associated with lower mortality rates for both age groups, with two out of four results being statistically significant at the 5% level or higher. This finding was expected because a higher income enables families to mobilize more resources for medical treatment. Two demographic variables demonstrated mixed results. Higher population growth rates generally led to lower mortality rates, whereas urban growth led to higher mortality rates. These findings were unexpected because urbanization is considered an efficient approach to improving public health due to its provision of better access to health facilities and treatment from medical staff. A possible explanation for these findings is that the rapid expansion of urban areas is not always accompanied by a corresponding increase in health measures. This explanation is plausible and warrants further investigation.

The three climate and geographical variables and the regional dummy variable all produced mixed results. Although some were concurrent with our expectations, others did not support our initial observations. First, our findings regarding the effects of latitude and tropical climate were in agreement with the expected results. The latter was statistically significant at the 0.05 level in models 7 and 8. The logged average meters above sea level (ln Elev) appeared to play a decisive role in determining malaria mortality rates: the effects of this factor were negative, and half of the results were significant. Figure 1 illustrates that some states at high altitudes still suffer from malaria.

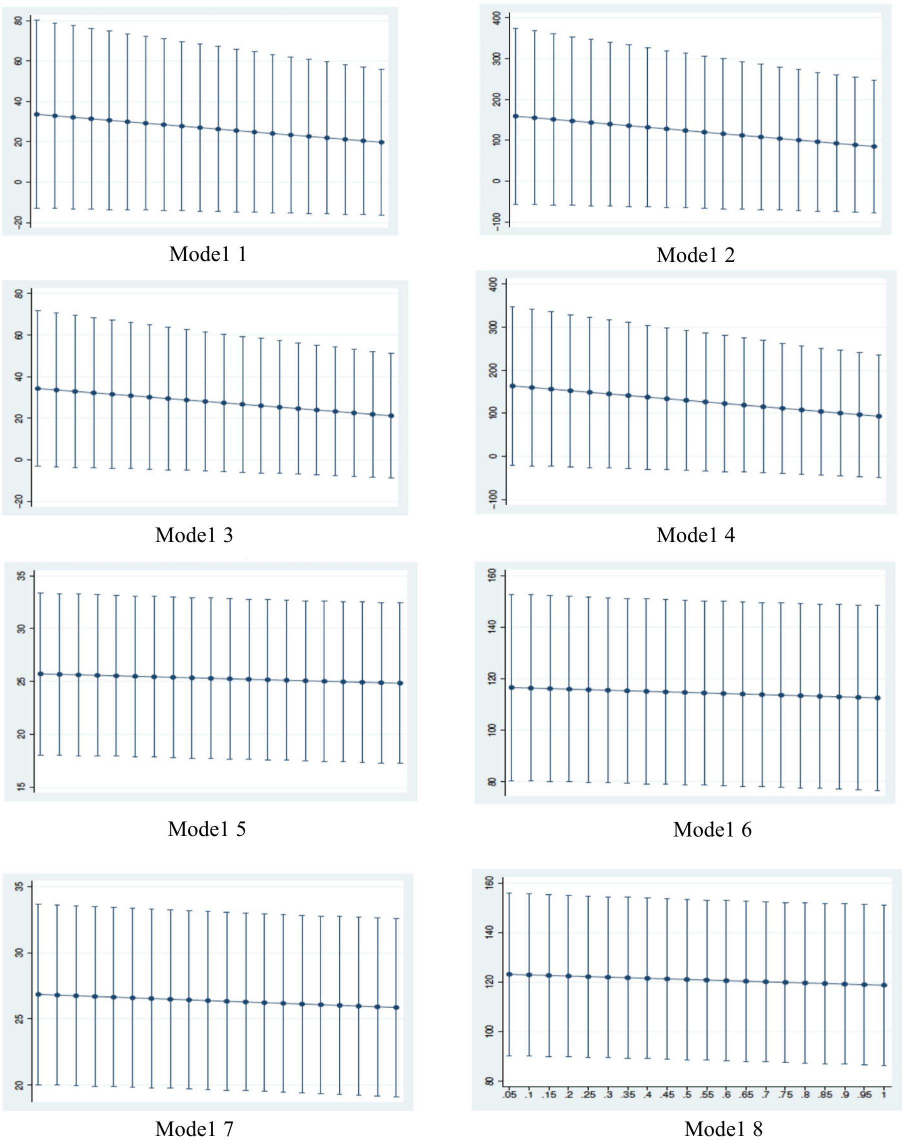

Fig. 2 Marginal effect plots of Polity and Rents on malaria death rates. Note: The *X*-axis represents the value of Polity between 0.05 and 1.00, when Rents is held at its mean value. The *Y*-axis represents the number of malaria deaths per 100,000 people. Vertical lines represent the 95% confidence interval

Robustness Checks

This paper conducted some robustness checks. To this end, I first replaced the resources variable with the adjusted savings of natural resource depletion (Depletion) provided by the World Bank (2017) as a percentage of gross national income (GNI), and then replaced it with resource revenue per capita generated from the total resource revenue specified by ICTD/UNU-WIDER (2019) and Prichard, Salardi, and Segal (2018). The

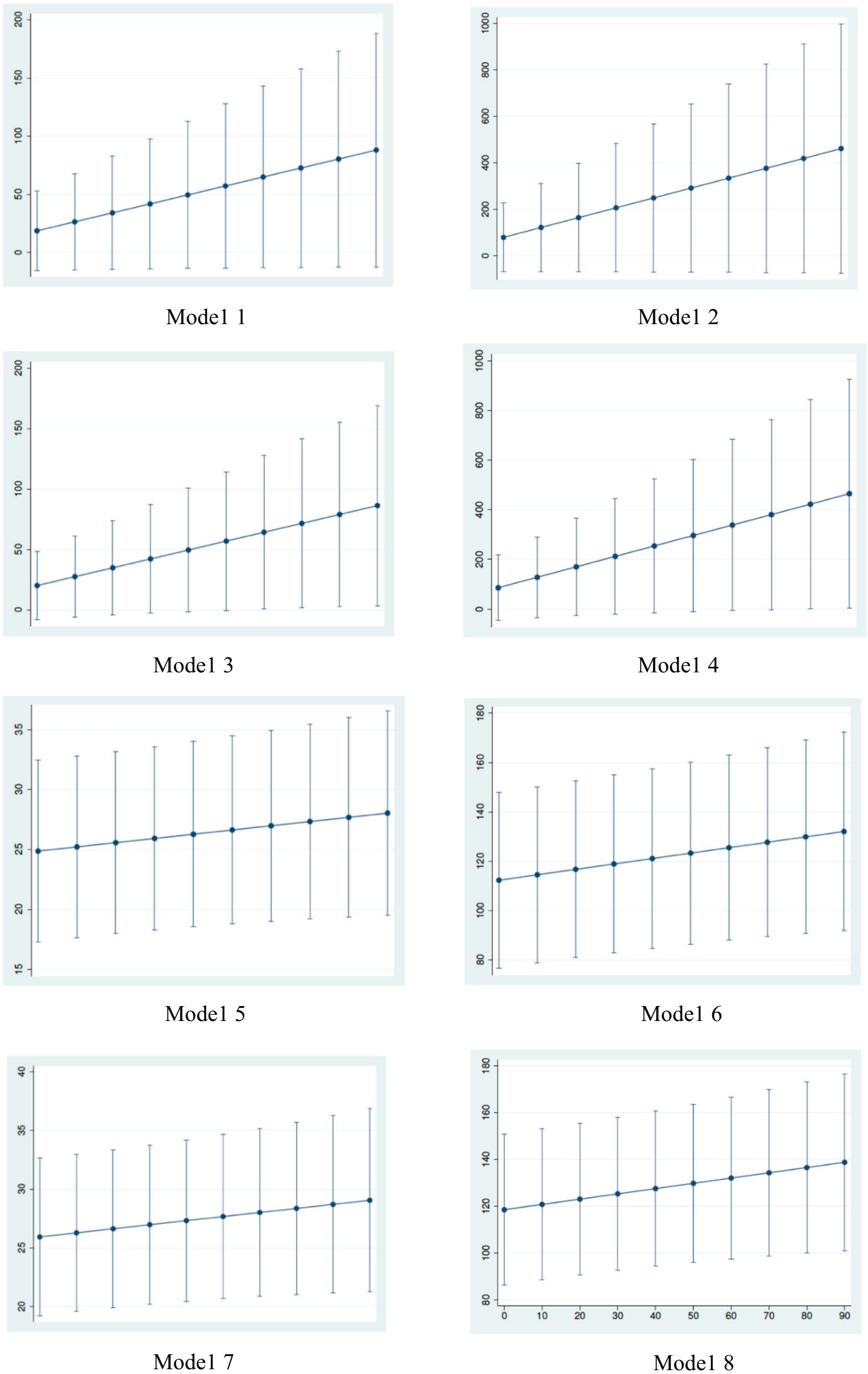

Fig. 3 Marginal effect plots of Polity and Rents on malaria death rates. Note: The *X*-axis represents the value of Rents between 0.00 and 90.00 when Polity is held at its mean value. The *Y*-axis represents the number of malaria deaths per 100,000 people. Vertical lines represent the 95% confidence interval

first variable was the exhaustion speed of a country's natural resource endowments that were used for national income. To ensure long-term growth, country's levels of physical, financial, and intangible capital investments must be higher than their consumption levels, including the depletion of natural resources (Brahmbhatt, Canuto, and Vostroknutova 2010, 112). Therefore, this variable can be viewed as the degree to which a nation's income depends on natural resources. According to Ross (2012, 15–16), the second variable helps to solve any conceptual or spuriousness problems that may arise when applying other indicators of resource wealth. In his book, Ross (2012) measured oil income per capita. I adopted a similar approach by dividing a country's total resource revenue by its total population to generate resource revenue per capita (Revenue PC). Furthermore, I constructed two interaction terms between Polity and (Depletion: Polity × Depletion[13] and between Polity and Revenue PC: Polity × Revenue PC. The results are presented in Table 3. An additional model for modeling dynamics with an AR(1) process was also constructed and is presented in Table 3 (models 5–8).

I investigated political regimes and their interactions with alternative natural resource indicators, and the statistical results demonstrated similar patterns to the results provided in Table 2. A higher Polity score led to lower malaria mortality rates for people of all ages and children under 5 years, whereas a higher value of Depletion or Revenue PC led to higher mortality rates in both groups. The primary outcome of this study was the interaction effects. I determined that certain interactions had a significantly negative effect on mortality rates and others did not have a significant effect. This suggests that Polity can still moderate the effects of these alternative resource indicators on malaria mortality rates. Marginal effects plots for Polity, Depletion, and their interaction terms and for Polity, Revenue PC, and interaction terms are provided in the Supplementary Materials Figs. 3 and 4.[14]

Second, this paper used Freedom House's (2017) Freedom in the World (FH) data set as a substitute for Polity. FH rates countries' yearly political performance on a scale of 1–7 in terms of the average value of two indicators: political rights and civil liberties. A state is considered freer (more democratic) if it receives a lower numeric average value. To interpret the results consistently, by denoting lower numerical values as worse, less, or fewer, I reverted each state's score by subtracting the original value from 8. This reversion made a score of 7 the freest and 1 the least free.

Furthermore, as argued in the "How Can Democracy Prevent and Control Malaria in Resource-Rich States? A Theory" section, democracy is not different from authoritarian regimes only at the aggregated level. Dahl (1971), Coppedge, Alvarez, and Maldonado (2008), Coppedge et al. (2011, 2018), and Pemstein et al. (2018) reported that certain disaggregated features, especially election or contestation, shape various public policy performances in democracies and dictatorships. According to the argument presented in the "How Can Democracy Prevent and Control Malaria in Resource-Rich States? A Theory" section, I selected one aggregated and two election-related indicators, namely electoral component (component), liberal democracy (liberal), and electoral democracy (electoral), from the Variety of Democracy (V-Dem) project,

[13] Depletion and Polity × Depletion's descriptive statistics are presented in Supplementary Materials Table 1 (Summary Statistics).

[14] The method used for generating the marginal effects plots was exactly the same as that for Figs. 2 and 3 in this section: first holding depletion and then polity at its mean value.

Table 3 Polity, Depletion/Revenue PC, and malaria death rates, 1990–2016

	(1) All	(2) ≦ 5	(3) All	(4) ≦ 5	(5) All	(6) ≦ 5	(7) All	(8) ≦ 5	(9) All	(10) ≦ 5	(11) All	(12) ≦ 5
Polity	− 10.92 (− 1.61)	− 65.67 (− 1.72)	− 10.30 (− 1.60)	− 61.10 (− 1.60)	− 0.500 (− 0.53)	− 2.290 (− 0.50)	− 0.691 (− 0.70)	− 2.904 (− 0.60)	− 17.99 (− 1.01)	− 101.7 (− 1.04)	− 15.75 (− 0.98)	− 86.89 (− 0.94)
Polity × Depletion	− 2.003*** (− 5.91)	− 10.01*** (− 4.68)	− 1.793** (− 3.12)	− 9.736*** (− 3.56)	− 0.172* (− 2.44)	− 0.977** (− 2.88)	− 0.130 (− 1.81)	− 0.875* (− 2.48)				
Depletion	0.657*** (5.73)	4.065*** (4.52)	0.595*** (3.46)	3.879*** (4.09)	0.0496 (1.45)	0.377* (2.29)	0.0421 (1.20)	0.363* (2.10)				
Polity × Revenue PC									0.0439 (0.03)	− 2.217 (− 0.24)	− 0.605 (− 0.45)	− 5.187 (− 0.60)
Revenue PC									0.0499 (0.12)	1.762 (0.67)	0.949* (2.15)	4.376 (1.56)
ln GDP PC			− 4.389 (− 1.35)	− 9.242 (− 0.81)			− 3.454** (− 3.18)	− 12.70* (− 2.39)			− 13.84*** (− 4.02)	− 36.20*** (− 3.61)
Pop. growth			− 2.673* (− 2.19)	− 9.259** (− 2.66)			− 0.172 (− 0.72)	1.324 (1.12)			1.905*** (4.05)	15.08*** (3.63)
Urb. growth			1.551* (2.09)	6.430 (1.86)			0.220 (1.14)	0.614 (0.65)			− 2.112*** (− 3.32)	− 13.73** (− 3.12)
ln Elev			− 0.298 (− 0.31)	3.396 (0.78)			− 0.146 (− 0.04)	− 0.131 (− 0.01)			− 2.456 (− 0.50)	4.090 (0.22)
Latitude			− 0.218*** (− 4.02)	− 0.913*** (− 3.80)			− 0.207 (− 1.25)	− 0.852 (− 1.06)			− 0.135 (− 1.07)	− 0.509 (− 1.00)
Tropical			0.434 (1.24)	2.256 (1.28)			0.370*** (3.86)	1.808*** (3.90)			0.507 (1.71)	2.853 (1.79)
Constant	34.28 (1.35)	161.5 (1.35)	60.69 (1.64)	154.8 (1.13)	29.09*** (7.20)	131.9*** (6.93)	48.65 (1.74)	187.1 (1.38)	48.21 (1.44)	236.2 (1.45)	149.8** (2.89)	380.5* (2.18)
No. of Obs.	3869	3869	3580	3580	3869	3869	3580	3580	1007	1007	966	966
No. of states	163	163	149	149	163	163	149	149	62	62	57	57

Table 3 (continued)

	(1) All	(2) ≦ 5	(3) All	(4) ≦ 5	(5) All	(6) ≦ 5	(7) All	(8) ≦ 5	(9) All	(10) ≦ 5	(11) All	(12) ≦ 5
R^2 within	0.16	0.17	0.16	0.17	0.10	0.11	0.10	0.10	0.18	0.19	0.22	0.21
Year dummies	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
AR(1)					*Y*	*Y*	*Y*	*Y*				

T statistics in parentheses; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

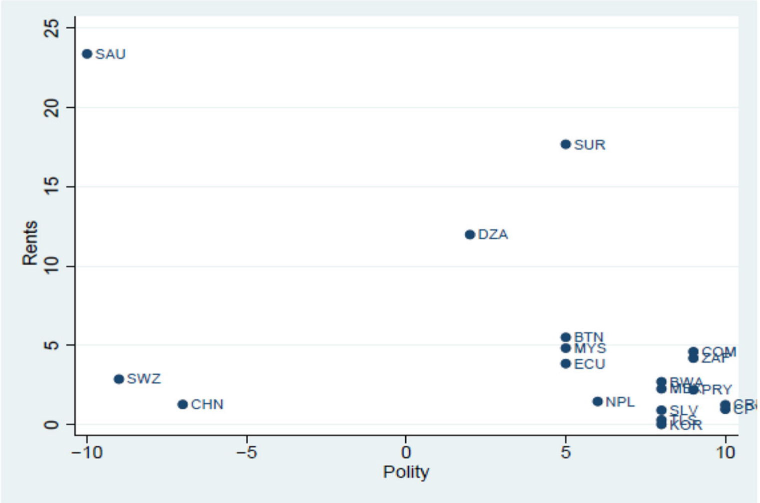

Fig. 4 The scatterplot of Rents values and Polity scores of states which have potential to eliminate malaria by 2020. Note: There are 19 states in the figure for Iran has no rents data and Belize does not have Polity score

version 8 (Coppedge et al. 2018; Pemstein et al. 2018). These variables were retrieved from the Quality of Government data set, version 2019 (Teorell et al. 2019). I also selected two competition indicators, namely competitiveness of executive recruitment (XRCOMP) and participation (PARCOMP), from Polity IV (Marshall, Gurr and Jaggers 2017).

The component indicator evaluates how politicians and citizens reach responsiveness and accountability through competitive elections, the liberal indicator evaluates the degree to which a government encroaches on individual and minority rights, and the electoral indicator is a combination of all fundamental aspects of a democracy (Teorell et al. 2019, 642, 646, 648, respectively). Polity IV's XRCOMP evaluates the degree of competition for political leaders, and PARCOMP assesses the possibility of policy change and leadership turnover (Marshall, Gurr and Jaggers 2017, 21–22, 26–27). V-Dem's indicators are numerical, whereas Polity IV's XRCOMP and PARCOMP indicators are ordinal variables. I then constructed new additional models by using these new regime variables and three resource indicators with control factors. The statistical results demonstrated similar patterns to those seen in Tables 2 and 3 and are presented in the Supplementary Materials (Tables 4–8). The only exceptions are the interaction effects of liberal, XRCOMP, and PARCOMP with Revenue PC. However, the sample size of Revenue PC was relatively small, so further investigation is warranted. Other than these exceptions, all of these alternative regime and resource indicators and their interaction terms produced the expected results, and certain indicators were statistically significant at the 99% confidence level.

Third, sometimes time-invariant factors such as geography, climate, and region are crucial in determining the severity of malaria transmission and death. This is especially the case when malaria becomes a problem in some highland areas because of global warming. I wondered if malaria is rather the product of the aforementioned issues, which would make all of my results spurious. Therefore, I removed all time-invariant control variables, including geographical and climate variables, and regional dummies.

I then applied the fixed effects (FE) models with clustered robust standard errors to see how all variables affected death rates from malaria for all ages and ages under five. The statistical results (models on Tables 9 and 10 in the Supplementary Materials) provided robust support for the main findings. Although some coefficients for interaction terms were not statistically significant, they were all within expected ranges.

Fourth, I also wondered if the reduction in malaria deaths is simply because of improved living standards. To test this, I separated all countries by their income and divided them into two groups: high income and non-high income. To decide which states were high-income economies, I used the World Bank's (2017) World Bank Atlas Method. Since 1987, the World Bank has evaluated per head GNI in USD (Atlas methodology) to sort countries into high income, upper middle-income, low middle-income, and low-income groups.[15] I classified each country's income status by evaluating its GNI per capita. The results are presented in the Supplementary Materials (Table 11). The statistical results revealed that even after excluding high-income countries, the effects of Polity on malaria mortality rate were negative for both age groups. In fact, higher Rents and Depletion values both led to higher malaria mortality rates. These effects were also moderated by Polity, with negative interaction terms between Polity and the two resource indicators across all models. Therefore, even after replacing the main variables with alternative indicators, removing the time-invariant control variables, or dropping high-income economies, the effects of political regimes, natural resource indicators, and their interaction terms on malaria death rates still held.

Fifth, the application of the Polity IV score introduces the possibility that our main statistical results are largely driven by middle-range countries. These countries may practice certain democratic principles but are not considered true democracies. To better present our argument, I created a dummy variable, PolityD, and interaction terms between this variable and Rents. In accordance with Polity IV's criterion, countries in this paper were coded as 1 (democratic) if they received a Polity score of 6 or higher and 0 otherwise. Table 10 in the Supplementary Materials provides us with estimation results. A similar dummy variable and its interaction term with Rents was also created for autocracies if they received a score of −6 or lower (PolityA).

As indicated in the Supplementary Materials, after replacing the original scale of Polity with a categorical variable of 0 or 1, the effects of all three variables on malaria mortality rates remained the same. Although PolityD lost its statistical significance, all coefficients of the interaction terms were statistically significant at the 99% confidence level. The results from PolityA demonstrated that resource wealth increased malaria mortality rates in autocracies for both age groups. These results clearly indicated that our hypothesis was not affected by semi-democracies or semi-autocracies. In other words, resource wealth in "true" democracies and autocracies had a different effect on malaria control and management outcomes.

Finally, there were certain countries that experienced no malaria outburst during the period of investigation (such as the USA and Canada). Therefore, I performed the last robustness verification to determine whether the hypothesis held true for countries with a possibility of malaria. The results are presented in Table 13 in the Supplementary

[15] The threshold value of high income was not fixed. In 1990, it was 7620 USD or higher and in 2017, it became 12,235 USD or higher. I checked each year's threshold value to classify these two income groups.

Materials. The statistical results exhibit a consistent trend, which suggests that the interaction terms between Polity and two proxies for natural resources are negative and statistically significant across all eight models.

To conclude, the empirical results presented in this paper showed that the effects of natural resources on malaria are conditional on political regimes. This finding offers an answer to the question of why resource curse scholars have failed to reach a consensus on whether natural resources have detrimental effects on public health or not.

Conclusion

Scholars who argue that there may exist a resource curse in public health face some challenges from past empirical findings (Anshasy and Katsaiti 2015; Sterck 2016). This paper argued that this inconclusiveness is the result of failing to take regime type into consideration. I argued that overall, resource-rich democracies perform better in malaria management than resource-rich dictatorships. Reasons include democracies being more likely to offer public health goods, tackle corruption behaviors, and diversify their economies, making them less reliant on natural resources and more likely to invest in human capital. By focusing on malaria and applying large-n analyses, I found substantial support for the above arguments. These findings remained solid even after I conducted several robustness checks by using alternative indicators and different econometric models, and restricting my samples to low- and middle-income countries. Some policy suggestions and possible future research directions will now be offered.

First, combating malaria is not an easy task. According to the ambitious Sustainable Development Goals by the UN (2017), it is expected that malaria and other major infectious diseases will be eradicated by the year 2030. Although between 2000 and 2015 the number of malaria cases decreased by about half (839,000 → 438,000, or a 47.80% decrease), substantial progress still needs to be made in order to attain this goal within 15 years. This paper does not intend to say that by democratizing malaria-affected countries can escape from this mosquito-borne disease. Yet, democracy indeed showed an excellent ability to reduce death rates from malaria, as detailed in the "How Can Democracy Prevent and Control Malaria in Resource-Rich States? A Theory" section. Because natural resources help stabilize both democratic and authoritarian regime survival, it is possible that democracies are more likely to be removed from the malaria list as a result of adequate malaria management while mostly authoritarian countries remain. A new approach to addressing malaria could be warranted. Therefore, though I agree with de Soysa and Gizelis's (2013; 95) argument about the resource curse and infectious diseases, I do not find their claim that regime type cannot play a role in containing malaria to be convincing.

Furthermore, this paper also recognizes that combating malaria requires coordination between local, national, regional, and international players. Other issues such as climate change and environmental degradation, which can increase the survival rate of mosquitoes also merit attention. An overall blueprint for handling malaria is required. However, there is a clear link between politics, natural resources, and malaria. According to the WHO (2016a; 12, Table 2), 21 countries have the potential to eliminate malaria by 2020. Among these countries, Fig. 4 clearly shows that most of them (1) have a high Polity2 score and (2) have Rents as a percentage of GDP at 5% or less (bottom right corner). They are followed by three resource-poor states with lower Polity2 scores (BTN, ECU, and MYS),[16] and then by states with either lower Polity2 scores and Rents of more than 10% (SUR and DZA), or states that are resource poor (Rents $\leq 5\%$) and have very low Polity2 scores (CHN and SWZ). SAU is the only exception in that it has a very high Rents value and the lowest Polity2 score but can still eliminate malaria by 2020.[17]

Finally, there are several interesting questions that merit answering in the future. They include the following: Are the arguments developed in this paper also applicable to two other major infectious diseases: HIV/AIDS and TB? Can they be applied to other mosquito-borne viruses such as Zika virus and dengue fever, due to the similarities of these diseases? And while a generalizable pattern was found in this paper, can we also utilize comparative case studies to clarify how resource-rich democracies outperform resource-rich autocracies in malaria management? To provide practical policy suggestions, further research is needed in order to ensure that the resource curse can be reduced or even eliminated by democracy.

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Compliance with Ethical Standards This paper does not contain any studies with human participants performed by any of the authors. This paper does not contain any studies with animals performed by any of the authors.

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[16] The full list of countries and their abbreviations in World Bank (2017); WHO (2016a; 12, Table 2).

[17] According to World Bank's (2017) Rents data and Marshall et al.'s (2017) Polity2 scores in 2015.

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