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Historical Prevalence of Infectious Diseases and Entrepreneurship: evidence from 125 Countries[1]

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Historical Prevalence of Infectious Diseases and Entrepreneurship: evidence from 125 Countries

Messono O. Omang & Simplice A. Asongu

Abstract

Purpose –This investigates the effects of the historical prevalence of infectious diseases on contemporary entrepreneurship. Previous studies reveal numerous proximate causes of entrepreneurship, but little is known about the fundamental determinants of this widespread economic concern.

Design/methodology/approach –The central hypothesis is that historical pathogens exert persistent impacts on present-day entrepreneurship. We provide support for the underlying hypothesis using Ordinary Least Squares (OLS) and Two Stage Least Squares (2SLS) with cross-sectional data from 125 countries consisting of the averages between 2006 and 2018.

Findings –Past diseases reduce entrepreneurship both directly and indirectly. The strongest indirect effects occur through GDP per capita, property rights, innovation, entrepreneurial attitudes, entrepreneurial abilities, entrepreneurial aspirations, and skills. This result is robust to many sensitivity tests. Policy makers may take these findings into account and incorporate disease pathogens into the design of entrepreneurship.

Originality/value –The novelty of this paper lies in the adoption of a historical approach that sheds light on the deep historical roots of cross-country differences in entrepreneurship.

Keywords: entrepreneurship; diseases; property rights, innovation

JEL Classification: I0, J24, I21, I31

1. Introduction

Entrepreneurship is very important for economic development around the world. The aspiration, ability, and capacity to develop entrepreneurship are crucial for economic growth. Unfortunately, some countries performed better than others in this case (Fleck et al., 2021; Saberi & Hamdan, 2019; Schiavone et al., 2020; Susanto et al., 2023). While entrepreneurship is important for all countries, its explanatory factors vary quite widely (Mohamad et al., 2021). The literature on the determinants of entrepreneurship has focused on foreign direct investment inflows (Albulescu & Tămăşilă, 2014), unemployment (Dvouletý, 2018) , trade (Asongu & Nwachukwu, 2018), institutional quality (Chowdhury & Audretsch, 2018), social norm (Maâlej, 2013), and education (Tunali & Sener, 2019; Tchamyou, 2017). It has also been shown that the epidemiology of the past affects the current level of development through the quality of institution (Alsan et al., 2015; Acemoglu et al., 2003a; Sokoloff & Engerman, 2000; Asongu & Odhiambo, 2019; Diamond, 1997). Thus, it appears that the historical prevalence of infectious diseases may affect entrepreneurship through institutions. We hypothesize that property rights protection in a country reduces the effect of the historical prevalence of infectious diseases on the level of entrepreneurship. To our knowledge, no study has attempted to conduct an interdependence analysis between historical disease prevalence, property rights protection, and entrepreneurship levels.

We propose that a country's historically high prevalence of infectious diseases compels people to move to other localities. This prevents them from performing agricultural activities, organizing themselves better, and from having a sedentary and powerful political power able to guarantee humans being and innovation (Thornhill & Fincher, 2014). This justifies their low level of entrepreneurship today. On the other hand, in countries with low historical prevalence of infectious diseases, the populations had the opportunity to develop agricultural activities, and to set up a formal organization capable of guaranteeing property rights, innovation, and effective cooperation with the outside world. This justifies their good entrepreneurial performance today (Sachs, 2003; Olsson & Hibbs, 2005). For example, Canada, Iceland, Luxembourg, Switzerland, and the United Kingdom present low scores in the historical prevalence of infectious disease as they score -1.31, 1.19, -1.11, -1.08, and -1.01, respectively; the scores of these countries in entrepreneurship - 79.15; 78.17; 74.2093; 80.09; and 79.97, respectively - reveal that they also perform well in entrepreneurship. (Lafuente *et al*. 2019; Murray & Schaller 2010). In contrast, countries with poor entrepreneurship scores (as a percentage of GDP) such as Chad (40),

Cameroon (55), Madagascar (40), Malaysia (70), Philippines (64) have high levels of past infectious disease prevalence (1.04; 1.17; 0.63; 0.5 and 0.5 respectively).

In the light of the above, the objective of this paper is to analyze the effect of historical disease prevalence on entrepreneurship. We propose a framework suggesting that historical pathogens exert persistent impacts on present-day entrepreneurship. We also provide support for the underlying hypothesis using Ordinary Least Squares (OLS) and Two Stage Least Squares (2SLS) with cross-sectional data from 125 countries between 2006 and 2018. Past diseases reduce entrepreneurship both directly and indirectly. The strongest indirect effects occur through GDP per capita; Property rights; Innovation; Entrepreneurial Attitudes; Entrepreneurial Abilities; Entrepreneurial Aspirations and skills. This result is robust to many sensitivity tests. Policy makers may take these findings into account and incorporate disease pathogens into the design of entrepreneurship.

First, we contribute to the literature on the causes of entrepreneurship by suggesting that cross-country differences in entrepreneurial outcomes such as skills, aspirations, and entrepreneurial capacity have their root in the historical prevalence of disease, which in the present study, is an exogenous environmental factor (Faulkner et al., 2004; Park et al., 2007). Specifically, we combine the value theory of parasitic stress with the literature on deep-rooted factors of development. This leads us to identify countries with low entrepreneurial capacity that have a history of high prevalence of infectious diseases; countries with good entrepreneurial performance that have low historical disease prevalence. Second, we explore the extent to which the relationship between past pathogenic stress and contemporary entrepreneurship is determined. Finally, we also identify other transmission channels that can be seen to mediate the relationship between the historical prevalence of infectious diseases and contemporary entrepreneurship. The remainder of the paper presents the literature review in section 2. Section 3 provides a descriptive analysis of the data and specifies the methodology. Sections 4 and 5 present the results and sensitivity tests, section 6 discusses the results, and section 7 concludes.

2. Historical prevalence of infectious diseases and entrepreneurship: theoretical framework and transmission channels

To justify the mechanisms by which diseases of the past affect entrepreneurship, we draw on the parasitic stress theory of infectious diseases developed by Thornhill et al. (2009) and echoed by Thornhill and Fincher (2014), Nikolaev and Salahodjaev (2017), and Bennett and Nikolaev

(2021). We also follow the studies on the determinants of entrepreneurship (Ahmad &Bajwa, 2023; Costa & Pita, 2020; Duncan-Horner et al., 2022; Henriquez-Daza et al., 2023; Susanto et al., 2023; van der Westhuizen & Adelakun, 2023; Zamberi Ahmad & Xavier, 2012). According to these authors, differences in infectious disease risk, across countries of the world, in the past, are a general cause affecting the overall variation in three central aspects of democratization. First, past diseases affect the willingness of leaders to extend economic and social resources and opportunities beyond their own family or ethnic group and to encourage political participation by the population. They also influence the validity of the rank of authority, as perceived by the general population, and thus the authoritarian-anti-authoritarian dimension. Finally, diseases of the past determine attitudes toward non-traditional ideas and lifestyles that determine whether innovation occurs and whether it spreads within and across geopolitical boundaries (Thornhill & Fincher, 2014).

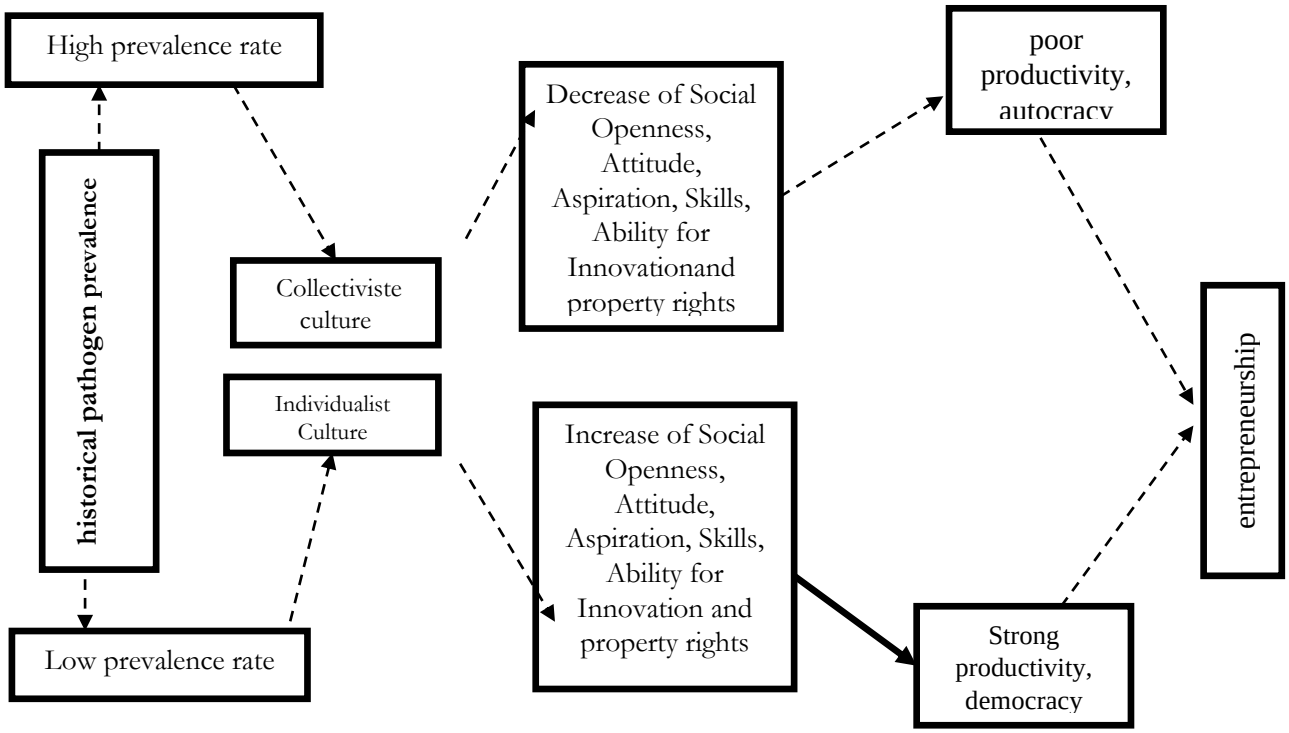
In light of the above, the relevance of the historical underpinnings of infectious diseases and entrepreneurship is fundamentally based on the parasitic stress theory of economic development (Schaller& Murray, 2008; Thornhill *et al*., 2009; Murray & Schaller, 2010; Murray *et al*., 2011, 2013; Fincher *et al*., 2013; Thornhill & Fincher, 2014; Randy, Thornhill & Fincher, 2011, 2014; Bennett & Nikolaev, 2021). Thornhill and Fincher, (2014) describes an evolutionary process linking the historical prevalence of disease in a region to the development of individualistic/collectivistic cultural attitudes, beliefs, and values. Indeed, humans have adapted to defend themselves against infectious diseases, which is a major source of morbidity and mortality either, through an adaptation of the classical (physiological) immune system or through an adaptation of the behavioral (psychological) immune system (Bennett & Nikolaev, 2021). These psychological immune system adaptations, through adaptive feelings, attitudes, and values, influence the relationships between the members inside and outside of the society. This will explain the natural selection of cultural values in human evolutionary history in relation to political regime formation (Nobles & Diamond, 1999; Schaller & Park, 2011; Soemari *et al*., 2020).

The empirical implication of this logic is that the degree of democracy should increase as the prevalence of disease decreases in all countries of the world (Fincher *et al*., 2013). A distinction can be made between collectivist societies arising from the historical high incidence of infectious diseases and individualist societies[2] arising from the historical low incidence of infectious

[2]The individualism-collectivism divide from parasitic stress theory suggests that behavioral adaptations to the disease environment influence values along this cultural dimension (Thornhill & Fincher, 2014). Individualistic

diseases. Each of these societies in a respective way determines a sequential approach to entrepreneurship. The main steps of our argument are illustrated in Figure 1 below. The examination of potential mechanisms linking non-contemporary diseases and contemporary entrepreneurship outcomes is based on several mechanisms that we will detail in two steps, on the one hand, the consequences of a high historical incidence of infectious diseases and on the other hand, those related to a low prevalence.

Figure 1. Historical prevalence of pathogens and entrepreneurship



Source : authors' counstruction (2023)

First, the high historical incidence of infectious diseases influences entrepreneurship by imposing collectivist (autocratic) societies that reduce innovative initiatives.

According to parasitic stress theory, a higher historical prevalence of infectious diseases on the one hand, reduces the likelihood of developing productivity, innovation, social openness, and government effectiveness, and leads to the establishment of autocratic regimes (Bennett & Nikolaev, 2021; Hill *et al*., 2016; Nikolaev, Boris & Salahodjaev, 2017; Thornhill *et al*., 2009; Thornhill & Fincher, 2014; Varnum, & Grossmann, 2017). On the other hand, these elicited

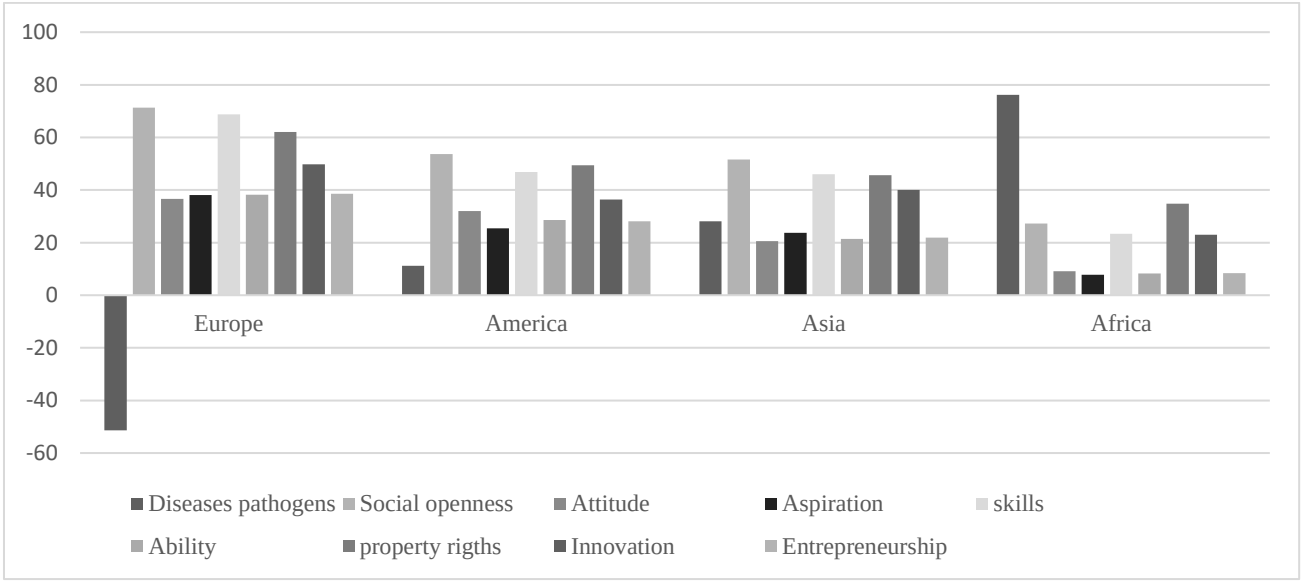
societies are those in which the ties between individuals are loose: each person is expected to take care of himself and his immediate family. Collectivist societies, on the other hand, are those "in which people are integrated from birth into strong, cohesive groups that continue to protect them throughout their lives in exchange for unquestioning loyalty (Bennett &Nikolaev, 2021; Hofstede, 2011).

factors are real determinants of entrepreneurship (Avnimelech *et al*., 2011; Draghici & Albulescu, 2014; Dvouletý, 2018; Maâlej, 2013; Miroshnychenko *et al*., 2021; Rusu, 2017; Tunali & Sener, 2019).

The behavioral immune system is partly based on adaptive feelings, attitudes, and values. This system can result in distrustful or trustful behaviors between people inside the group and people outside, depending on the risk of exposure to a contagious disease. For example, Schaller and Murray (2008) show that extraversion, introversion, openness or closure to new experiences and ideas are correlated with variation in the prevalence of parasites in many countries around the world. People living in countries with high parasite stress have cautious personalities, which allow them to avoid exposing themselves to contagion from their peers. These people will develop high scores of introversion and low interest in new ideas and experiences.

In contrast, individuals living in countries with low parasite stress develop extraversion and openness to novelty (Thornhill &Fincher, 2014). For instance, Navarrete *et al*. (2007) demonstrate that feelings of xenophobia, distrust, aversion, devaluation, avoidance of the out-group, as well as ethnocentrism, are psychological adaptations to reduce contact with infectious diseases, and to manage morbidity and mortality effects. These attitudes reduce the possibilities of innovation and entrepreneurship. Figure 2 below provides an empirical illustration of this theory. Comparing data from Murray and Schaller (2010) with the World Bank data, we see that the African continent is the most affected by infectious diseases.

Figure 2: Past Infectious Diseases and Drivers of Entrepreneurship



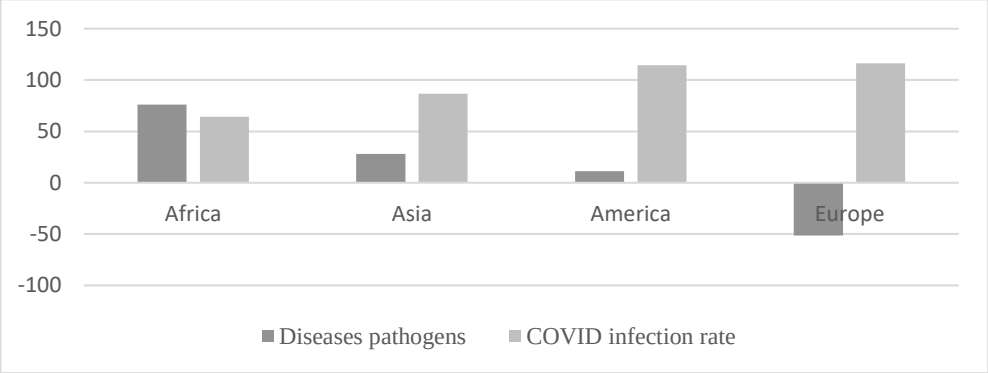
Source: Authors' construction (2023)

score for the historical prevalence of infectious diseases (about 70%) ahead of Asia (about 40%) America (about 20%) and Europe (about -50%). On the other hand, in terms of social openness, innovation, property rights, skills, attitudes, and innovative aspirations, Africa ranks last behind the other three continents. This illustrates, on the one hand, a negative relationship between the historical prevalence of infectious diseases and social openness, entrepreneurship, innovation, GDP per capita, skills, ability, and attitude, thus leading to entrepreneurship.

It can be said here that the high prevalence of diseases in the past reduces social openness, skills, innovation, property rights and productivity, which in turn affect entrepreneurship.

On the other hand, the high incidence of infectious diseases in the past can also foster strong resilience in the humanitarian system. When a community is exposed to an infectious disease, herd immunity can develop over time. This reduces the risk of contagion. Similarly, if the community has experienced several diseases in the past, it limits the development of another epidemic in the future. Lu *et al*. (2021) demonstrate that the high historical prevalence of diseases in the past explains the differences in the spread of COVID19 between countries around the world. Figure 3 below, for example, shows that Africa has the highest rate of disease infection in the world. But the Covid 19 infection is the lowest (about 55%) as compared to Asia (over about 60%), America, and Europe (over about 90%). This high resilience of the immune system is also related to the ecological past of the continents. On the one hand, the high historical incidence of infectious diseases can lead to the establishment of collectivist societies that reduce openness, innovation, entrepreneurship, and productivity, and favor autocratic regimes. On the other hand, it can also lead to the strong resilience of the humanitarian system that favors the resistance of human capital to new diseases.

Figure 3: Historical disease and covid19 infection



Source: Authors' construction (2023)

Therefore, the high incidence of infectious diseases affects innovation, openness, and productivity, which in turn influences the entrepreneurial capacity of future generations.

Second, the historically low prevalence of infectious diseases affects entrepreneurship by promoting the establishment of individualistic societies (democracy) open to innovative initiatives.

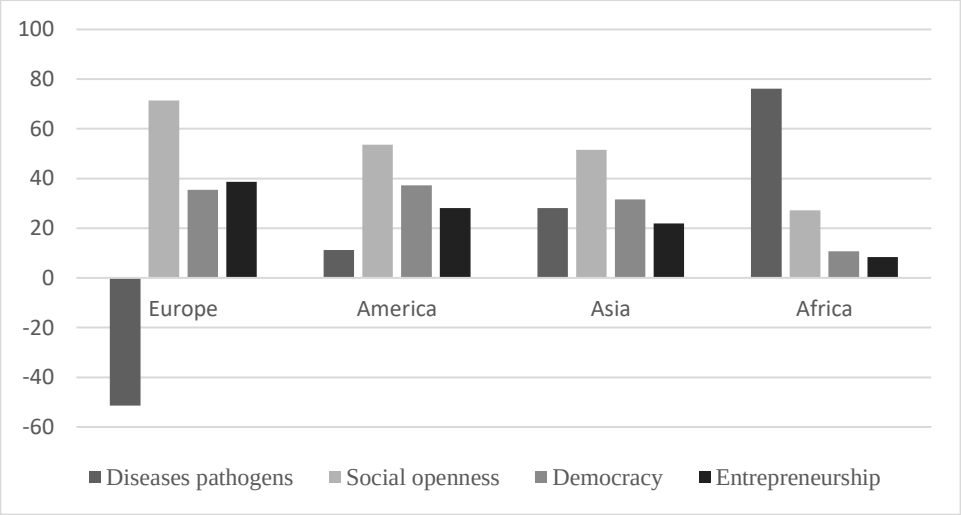
According to North (1991), Third World countries are poor because the institutional constraints that should frame economic policy do not encourage productive activity and entrepreneurship. These countries are often characterized by extractive (versus inclusive) institutions that do not encourage economic activity (Acemoglu *et al*., 2001). In comparative development analysis, the quality of institutions depends on the type of settlement. The localities hostile to the development of the colonists were inherited institutions that had to protect only the advantages of the colonial power to the detriment of the colony. This sometimes left a low level of entrepreneurship. This was the case in Africa. On the other hand, localities with hospitable advantages led the colonists to install inclusive institutions that favored local development and the emergence of local elite. Acemoglu *et al*. (2012) revisited this theory by empirically showing that the protection of property rights is historically based and depends on the divide between inclusive and bad institutions. This further establishes the importance of history on the origins of institutions. Using Argentina and Ghana as case studies, Acemoglu *et al*. (2003) show that, policy distortions are not the real determinants of poor economic performance. Indeed, there are symptoms of historical facts related here to the type of colonization. It is also shown that institutional environments create appealing individual decision making conditions, which are relevant in entrepreneurial cognition and the quality of entrepreneurship (Maâlej, 2013). The institutional setting surrounding the performance of an activity often determines whether that activity is productive, destructive or unproductive. Thus, the quality and quantity of entrepreneurial activity improves when institutional reforms change the environment in which decisions are made and implemented. The study of Baumol (1990) on the legal and policy environment determines the willingness of entrepreneurs to exploit or commercialize different opportunities. The analysis of geographical distributions presented in Figure 1 and Figure 2 clearly shows that countries with poor property rights scores also have poor entrepreneurship scores.

In the parasitic model of democratization, Thornhill *et al*. (2009) show that as parasitic stresses diminish in a region, there is a concomitant evocation, spread, adoption, and legalization of liberal attitudes and values that encompass all traditional groups without marginalization. This favors the generalization of equality of wealth, social welfare, economic and educational

opportunities, health care, and drinking water. In short, sanitation and the right to own private property are becoming more widespread and equitable. There is also a decrease in infant mortality and an increase in adult longevity. In addition, there is a simultaneous increase in openness to innovations from within and outside the group. This suggests that economic development, social equality, elite emancipation, and diffusion are only variables caused by the overall variation in infectious disease problems. Therefore, variation in parasitic stress is a proximate cause of political democratization, as well as some associated economic, health, and diffusion components that in turn affect entrepreneurship through effects on human capital.

According to Wejnert (2005), democratization is a consequence of the liberalization of values that depend on the ecological conditions of low stress caused by infectious diseases. In other words, the political participation of women, the distribution of suffrage under the respect of rights and freedom in general, constitute a component of the liberalization of traditional values that leads to political regimes (Inglehart & Norris, 2003).

Figure 4: The Illness of the Past and the Quality of Democracy



Source: Authors' construction (2023)

For example, Figure 4 above constructs with the comparative values of the quality of the V-DEM 2020 Democracy Index, which shows that Africa ranks last in terms of the quality of democracy and social inclusion. Also/Meanwhile, entrepreneurship in this continent register the worst scores compared to other continents. The historical prevalence of infectious diseases is an important determinant of entrepreneurship. Fincher et al. (2013) demonstrate that individuals who lived in areas with low parasite prevalence were at lower risk of infectious disease contagion; they tended to engage in economic and social interactions that ensured benefits with individuals from the

outgroup. This is simply because the potential cost of contagion was lower than the costs of exchange (Bennett & Nikolaev, 2021). The exchanges made here by the different communities promoted a sharing of experience necessary for the improvement of human capital. Moreover, as the size of the market increases, there is generally a specialization and division of labor. This is favorable for innovation and allows the financing of projects necessary for entrepreneurship. We then witness the development of a virtuous cycle of attitudes, aspirations, and capacities to undertake, driven here by the improvement of productivity, the decrease of production costs and the improvement of the quality of available goods and services. Cooperation between individuals encourages innovative ideas and the development of infrastructure and intuitions conducive to innovation (Audretsch *et al*., 2015; Bennett, 2019; Chowdhury & Audretsch, 2018; North, 1991; Woolley, 2014). There is also the diffusion of new knowledge that should actually sustain human capital.

In summary, the historically low prevalence of infectious diseases fosters the development of innovation, entrepreneurship, governance, policy regimes, that in turn help determine entrepreneurship.

3. Data and methodology

3.1 Data

3.1.1. The entrepreneurship index

To measure entrepreneurship, we chose the index of "The Global Entrepreneurship and Development Institute" proposed by Lafuente *et al*. (2019). It ranges from 0 (no entrepreneurship) to 100 (high entrepreneurship capacity). This index combines entrepreneurial attitudes, capabilities, and aspirations in each country. It measures the proportion of people who have the vision of an innovation and the ability to bring it to the market for each country in our sample. The calculation of this variable was made possible by collecting 14 pillars of information necessary for entrepreneurship. These are: Opportunity Perception, Risk Acceptance, Startup Skills, Networking, Cultural Support, Technology Absorption, Opportunity Startup, Human Capital, Product Innovation, Competition, Process Innovation, Internationalization, High Growth, and Venture Capital. This index has already been used in several empirical works (Cacciotti *et al*., 2016; Bennett, 2018; Bennett, 2019; Bylund & Mccaffrey, 2017). In summary, this index measures both the quality of entrepreneurship in a country and the breadth and depth

of the entrepreneurial ecosystem that supports it (Chowdhury & Audretsch, 2018). The map below shows the geographical distribution of entrepreneurship across the world.

3.1.2. Historical prevalence of infectious diseases

The variable "***historical prevalence of infectious diseases"*** is chosen under the inspiration of the vast cross-cultural literature developed by many authors such as Bennett and Nikolaev (2021), Bennett (2019), Bennett (2018), Nikolaev *et al*. (2017) and Fincher *et al*. (2013). The index used is that of Murray and Schaller (2010). This index assesses the intensity of historical disease prevalence for over 150 countries. The calculation of this index is based on the severity of nine diseases dangerous to human survival and reproductive health. These include: dengue, trypanosomes, schistosomes, leprosy, typhus, malaria, filariae, leishmanias, and tuberculosis. It also provides evidence for the parasitic stress theory of disease developed by Thornhill and Fincher (2014). The creation of the index was possible due to the availability of epidemiological information from the early 20th century, and the archives of historical epidemiological atlases of infectious diseases. The combination of these two data sources allowed the authors to obtain a concrete measure of historical disease prevalence.

3.1.3. The control variables

Following the work on the comparative economic development literature (Ali *et al*., 2020; Ang & Fredriksson, 2021; Vu, 2021a), we control our baseline results with factors which influence entrepreneurship at the individual country level. First, we include religion, level of development[3]and colonial origin. That is, dummy variables related to the origins of a nation's legal system (French, English, German and Scandinavian), and culture (Bennett & Nikolaev, 2021). Subsequently, the potential determinants of entrepreneurship developed by Maâlej (2013), Draghici and Albulescu (2014), Dvouletý (2018), and Tunali and Sener (2019) are also considered. These are the variables such as foreign direct investment, unemployment, freedom in business, level of democracy and human capital. We also take into account the geographical variables (Sternberg, 2007) and the set of control variables which in general are held constant in the literature) as well as the origin of the continents which allows taking into account the level of development. We also control our estimates by other historical and sociocultural characteristics (religion, ancestral biodiversity, pre-colonial institutions ethnic fragmentation).

[3] i.e. the probability that two randomly selected people in a country's population belong to the same ethnic group (Bennett & Nikolaev, 2021)

The classification of countries by income, fragility, and size is also taken into account. The combination of these variables is done in a sample that consists of a maximum of 125 countries.

3.2 Methodology

With a cross-sectional specification, the nature of the variable "historical prevalence of infectious diseases", obliges the study to use several estimation methods to test our hypothesis. We first start with ordinary least squares (OLS). This technique in the sense of Wooldridge (2010) allows us to analyze the direct effect of disease infection on entrepreneurship. The method has been used by Bennett and Nikolaev (2021) to analyze the economics effects of disease pathogens. Secondly we run several sensitivity tests following Ang and Fredriksson (2021). Thirdly, a mediation analysis is made by ttesting its effectiveness and measuring its magnitude according to Baron and Kenny (1986) and Zhao et al. (2010).In the last method, we run the estimates with the robust option using the two-stage OLS regression by using "ivreg2" command in Stata. The “P” value of the Anderson-Rubin test for endogeneity is significant at the 1% level. This method performs the weak-instrument robust inference using the Anderson and Rubin (1949) approach as Ang et al. (2018). The first step of model specification is defined in cross section through the following equation:

$$\boldsymbol{entrepreneurship_i = \alpha + \beta . Diseases\ pathogens_i + \sigma . X_i + \varepsilon_i}$$

In this equation $\boldsymbol{entrepreneurship_i}$ is the average of the overall entrepreneurship index of country i between 2007 and 2016; $\boldsymbol{Diseases\ pathogens_i}$ is the historical prevalence index of infectious diseases;X_i is a control variable matrix and ε_i the error term. This method allowed the study to test the validity of the employed instrumental variable. In order to test the potential mediating impact of institutions on the relationship between disease prevalence and entrepreneurship, we used the double least squares estimator. This allows us to circumvent endogeneity problems. Our results were then subject to several sensitivity and robustness tests. We first test the sensitivity of our OLS results to each country's continental origin, and social, cultural, historical and economic characteristics.

4. Results

In this section, we comment on the basic results and perform a mediation analysis to identify some transmission channels. Appendix 1 and 2 present the descriptive statistics and the correlation matrix. The complete list of countries can be found in Appendix 3.

4.1. Base line results

The estimation results are presented in Table 1. We consider several alternative specifications to ensure that the results are not driven by any particular model specification. In particular, we include ancestral characteristics of the modern population recognized by Giuliano and Nunn (2018) as determinants of development. We also add characteristics related to continental origin in all regressions. This reduces the possibility of obtaining spurious estimates. Our hypothesis is that, historical prevalence of infectious diseases reduce entrepreneurship. The OLS estimates in Table 1 confirm this hypothesis. The bivariate analysis in column (1) shows that the coefficient on the historical prevalence of infectious diseases is statistically significant at the 1% level and that pathogens alone can explain about 49% of the total variation in entrepreneurship. The disease coefficients are estimated even after controlling for ancestral characteristics of the modern population and continent fixed effects in columns (2) and (3), respectively. In column (4), we add all control variables; the effect of disease pathogens remains robust. The results suggest that an increase in the standard deviation of pathogen intensity significantly reduce entrepreneurship.

Table 1. Baseline results

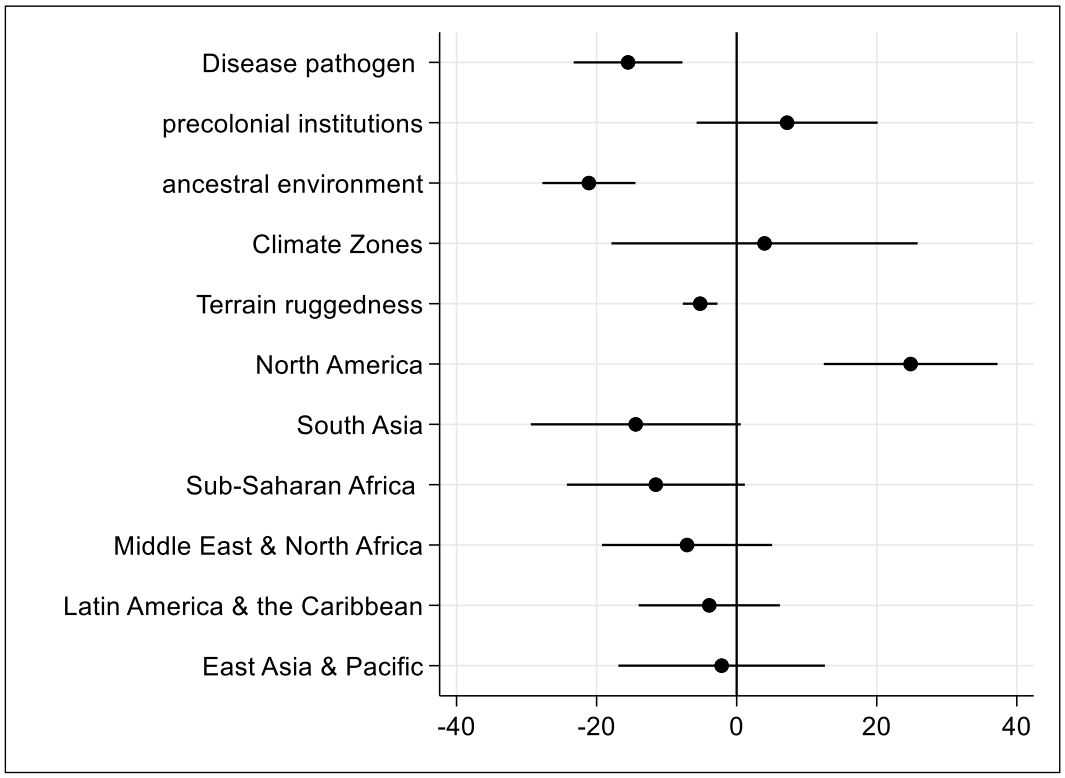
	(1)	(2)	(3)	(4)
	Basic specification	Add Ancestral characteristics	Add Regional dummy	Full specification
	Dependent variable :	**entrepreneurship**		
Disease pathogen	**-22.266*** **	**-22.541*** **	**-19.035*** **	**-15.507*** **
	(1.851)	**(1.734)**	**(3.961)**	**(3.919)**
precolonial institutions		9.354*		7.199
		(5.504)		(6.520)
ancestral environment		-26.723***		-21.102***
		(1.810)		(3.354)
Climate Zones		6.548		3.979
		(9.661)		(11.028)
Terrain ruggedness		-4.163***		-5.214***
		(1.280)		(1.251)
North America			20.417***	24.836***
			(6.829)	(6.255)
South Asia			-6.719	-14.416*
			(8.146)	(7.559)
Sub-Saharan Africa			-6.131	-11.547*
			(6.519)	(6.414)
Middle East & North Africa			-4.442	-7.090
			(6.142)	(6.130)
Latin America & the Caribbean			0.058	-3.914
			(4.766)	(5.090)
East Asia & Pacific			4.748	-2.146
			(7.035)	(7.440)
Constant	27.374***	-3.723	28.252***	-7.395
	(1.410)	(9.744)	(3.561)	(10.205)
Observations	125	121	125	121
R^2	0.49	0.58	0.53	0.62
Fisher	144.77	102.68	32.26	67.14

Source: author's construction. Notes: This table shows the correlation between disease pathogen including nine items (dengue, trypanosomes, schistosomes, leprosy, typhus, malaria, filariae, leishmanias, and tuberculosis) in the past and entrepreneurship. Consistent with our prediction, the results suggest that a higher level of historical prevalence of infectious disease is associated with lower score in entrepreneurship. The results are robust to the inclusion of precolonial institutions; Terrain ruggedness; climates zones and ancestral environment controls and continental fixed effects. Robust standard errors are used and t-statistics are reported in the parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Thus, variations in the historical prevalence of infectious diseases can explain a reasonable fraction of entrepreneurship across countries. For example, countries with low prevalence of infectious diseases such as Canada (-1.31), Iceland (-1.19), Luxembourg (-1.11), Switzerland (-1.08), and the United Kingdom (-1.01) perform well in entrepreneurship (79.15; 78.17; 74.2093; 80.09; and 79.97, respectively). In contrast, countries with poor entrepreneurship scores (as a percentage of GDP) such as Chad (40), Cameroon (55), Madagascar (40), Malaysia (70), Philippines (64) have high levels of past infectious disease prevalence (1.04; 1.17; 0.63; 0.5 and 0.5, respectively). This suggests that the observed differences in entrepreneurship across

countries can be explained by cumulative variations in historical prevalence of infectious diseases. In fact, the plots of coefficients with 95% confidence intervals of the baseline results in Figure 5 below show that the effect of pathogenic disease is negative and that countries in South Asia in contrast to countries in North America, South America, Sub-Saharan Africa, Middle East and North Africa, Latin America and the Caribbean, and East Asia and the Pacific are less advanced in entrepreneurship. All coefficients are from equivalents to the benchmark column (4), Table 1. The effect of disease pathogens is more pronounced in South Asia than in any other region.

Figure 5. Coefficient plots with 95% confidence intervals



Source: author's construction (2023)

4.2 Robustness Checks

In this subsection, we perform two additional controls. The first include culture, history and geographic controls. The second integrate the potential determinant of entrepreneurship. In Table 2, we control for several other exogenous forces. First, Spolaore andWacziarg (2018) show that ethnicity/ethnic fragmentation is a key variable in fostering innovation between people. Column (2) gives the results of this control by taking into account ethnic fragmentation. The effect of colonization and precolonial institutions is controlled in column (3), based on the hypothesis of Acemoglu et al. (2001a) and Michalopoulos and Papaioannou (2013). In column (4), geographic

characteristics are in line with work of Alsan (2015), who showed that past disease is strongly correlated with landlockedness and tropical areas. Comin et al. (2010) examined the effect of historical technology adoption on innovation and economic development. We include this specificity in column (4). Column (5) incorporates all of these controls with the importance of religion, as suggested by Bénabou et al. (2015), thus, showing that religiosity is strongly correlated with personal attitude. It is clear that the coefficient on the historical prevalence of infectious diseases remains significant in all cases.

Table 2. Cultural, Historical, and Social Controls

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable:		**entrepreneurship**			
Disease pathogen	**-22.266*****	**-14.575*****	**-13.647*****	**-9.792****	**-8.287*****	**-8.346*****
	(1.851)	**(4.014)**	**(4.176)**	**(3.953)**	**(3.095)**	**(3.118)**
Ethnic fragmentation		-21.006***	-19.883***	-11.577	-11.568	-11.604
		(6.380)	(6.544)	(8.021)	(7.526)	(7.546)
Ex-colony dummy			-0.985	-7.864*	-6.627*	-6.620*
			(5.396)	(4.527)	(3.620)	(3.636)
Pre-colonial political			5.542	8.711	14.440**	14.415**
			(5.060)	(6.394)	(5.722)	(5.802)
Tropical dummy				-12.225**	-14.621***	-14.410***
				(5.041)	(4.108)	(4.179)
Landlocked				-2.241	0.295	0.259
				(3.716)	(3.668)	(3.716)
Technology in 1500 AD					-5.722	-5.874
					(8.154)	(8.659)
Religious diversity						0.097
						(0.700)
Constant	27.374***	-1.990	-8.949	-17.420	-2.186	-1.930
	(1.410)	(10.327)	(12.357)	(14.311)	(15.747)	(16.622)
Observations	125	121	120	104	86	86
R^2	0.49	0.66	0.66	0.74	0.84	0.84
Fisher	144.77	97.48	83.26	87.77	101.74	94.70

Source: authors' construction (2023). **Notes:** Robust standard errors are used and t-statistics are reported in the parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

The above results demonstrate that the baseline findings are largely robust to using culture, geography, religion, and other historical controls, which at least partially accounts for omitted variables. This sub-section also accounts for other effects according to the potential determinant of entrepreneurship. More specifically, foreign direct investment (FDI) is associated with entrepreneurship. Albulescu and Tămăşilă (2014) showed that the inwards FDI positively influence the opportunity-driven entrepreneurs while the outwards FDI have a positive influence on the necessity-driven entrepreneurs and a negative impact on the other category of entrepreneurs. These controls are made in column (1) in table 3 below. Dvouletý, (2018) for example show that somebody who does not have a job can try by himself to obtain the

opportunity to create wealth. Column (2) takes into account this control. In columns (3), (4) and (5) we control our baseline results with the role of business freedom and political regime (Dutta & Meierrieks, 2021; Andersson, 2005; Avnimelech et al., 2011). Miroshnychenko et al. (2021) consider more democracy as a key determinant of entrepreneurship. They find positive effect of political regime on entrepreneurship ability. We also take into account the macro effects of religion, which can affect the country's level of entrepreneurship beyond the direct effects on the behavior of the religion's members, as recommended by the work of Zelekha et al. (2014). In column (5) we put all these variables. The results below suggest that our main findings are not driven by these influences. In all cases, the coefficients of disease pathogens remain highly significant. Our controls also show that, Protestant country interact sufficiently in entrepreneurship than Catholic and Muslim countries.

Table 3. potentials determinants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependentvariable : **entrepreneurship**						
Disease pathogen	**-16.038*** **	**-15.311*** **	**-14.946*** **	**-15.708*** **	**-15.679*** **	**-10.490** **	**-10.791** **
	(3.900)	**(3.920)**	**(4.094)**	**(3.884)**	**(3.976)**	**(4.009)**	**(4.589)**
Foreign Direct Investment	-0.389*						-0.292
	(0.227)						(0.203)
unemployment		0.078					0.060
		(0.240)					(0.268)
business freedom			0.130				0.070
			(0.104)				(0.121)
Institutionalized autocracy				0.006			0.018
				(0.129)			(0.186)
Democracy					0.009		-0.046
					(0.106)		(0.167)
Catholic trust						0.123**	0.117*
						(0.059)	(0.068)
Muslim trust						-0.049	-0.045
						(0.080)	(0.082)
Protestant trust						0.214***	0.177**
						(0.064)	(0.071)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-5.463	-7.288	-10.215	-7.725	-7.724	0.421	-0.653
	(9.971)	(10.824)	(11.473)	(10.724)	(10.635)	(10.733)	(14.118)
Observations	121	119	116	115	115	113	103
R^2	0.63	0.63	0.60	0.63	0.63	0.73	0.71
Fisher	62.63	60.29	72.15	66.61	67.06	107.52	76.91

Source: authors' construction (2023). **Notes:** Robust standard errors are used and t-statistics are reported in the parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

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5. Transmission channels and mediation analysis

5.1 Potential channels linking past diseases to entrepreneurship

According to the parasitic stress theory, higher historical prevalence of infectious diseases negatively affects the likelihood of developing productivity. In fact, people facing past epidemic illness become more conservatives, and their GDP per capita and Property rights decrease

(Thornhill & Fincher, 2014). More so, entrepreneurial attitudes and innovation decrease in the absence of open mindset (Bennett & Nikolaev, 2021). To test this hypothesis, we first regress pathogens on seven potential transmission channels. The results in Table 4 below support this argument. Pathogens significantly reduce GDP per capita, Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, and Entrepreneurial Aspirations and skills.

Table 4. effect of disease on potential channels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	GDP per capita	Property rights	Innovation	Entrepreneurial Attitudes	Entrepreneurial Abilities	Entrepreneurial Aspirations	skills
Disease pathogen	**-15.219*****	**-15.669*****	**-15.633*****	**-1.225*****	**-0.154*****	**-20.281*****	**-9.087*****
	(4.182)	**(3.748)**	**(4.175)**	**(0.219)**	**(0.035)**	**(4.955)**	**(2.126)**
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-12.497	-15.004	5.315	6.621***	0.275***	2.630	28.085***
	(10.615)	(10.255)	(10.580)	(0.528)	(0.087)	(10.758)	(5.402)
Observations	121	121	121	121	117	119	121
R^2	0.59	0.65	0.59	0.76	0.78	0.56	0.66
Fisher	62.05	76.73	60.65	166.58	267.44	123.98	165.88

Source: author's construction (2023); Notes: This table shows effect of disease on potential channels. GDP per capita; Property rights; Innovation; Entrepreneurial Attitudes; Entrepreneurial Abilities; Entrepreneurial Aspirations and skills. Robust standard errors are used and t-statistics are reported in the parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 5. Controlling by interaction of potential channels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Disease pathogen	-5.823	-8.270	-4.137	-7.937	-2.863	-20.071*	-1.909
	(4.468)	(19.081)	(3.494)	(8.354)	(3.160)	(12.025)	(1.270)
GDP per capita(log)	**7.071*** **						
	(1.696)						
Disease pathogen XGDP per capita		-0.615					
		(2.314)					
property rights			**0.517*** **				
			(0.047)				
Disease pathogen Xproperty rights				-0.035			
				(0.129)			
Global innovation					**1.154*** **		
					(0.114)		
Disease pathogen X Global innovation						0.254	
						(0.276)	
entrepreneurial attitudes							**0.885*** **
							(0.036)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-43.055**	-2.509	3.714	-1.273	-30.001***	-3.008	2.016
	(20.083)	(14.252)	(10.377)	(13.808)	(9.386)	(13.667)	(3.567)
Observations	104	104	102	102	103	103	104
R^2	0.75	0.69	0.85	0.71	0.87	0.71	0.97
Fisher	74.34	47.59	143.05	67.99	168.23	69.35	625.48

	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Disease pathogen	-9.467	-0.178	-11.635	-1.035	-16.367*	-5.220	-10.142
	(7.606)	(0.917)	(7.874)	(1.268)	(8.381)	(3.601)	(9.227)
Disease pathogen X entrepreneurial attitudes	-0.124						
	(0.182)						
entrepreneurial abilities		**0.985*** **					
		(0.023)					
Disease pathogen X entrepreneurial abilities			-0.059				
			(0.203)				
entrepreneurial aspirations				**0.896*** **			
				(0.032)			
Disease pathogen X entrepreneurial aspirations					0.098		
					(0.221)		
Skills						**68.407*** **	
						(9.273)	
Disease pathogen X							-5.463
							(14.507)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.080	8.128**	-1.608	-9.987**	-3.368	-19.632	-3.648
	(14.675)	(3.323)	(14.723)	(4.072)	(14.253)	(12.611)	(14.346)
Observations	104	104	104	104	104	100	100
R^2	0.69	0.98	0.69	0.97	0.69	0.81	0.68
Fisher	47.35	5751.96	47.46	2103.13	48.39	135.17	46.84

Source: authors' construction (2023). **Notes:** Robust standard errors are used and t-statistics are reported in the parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

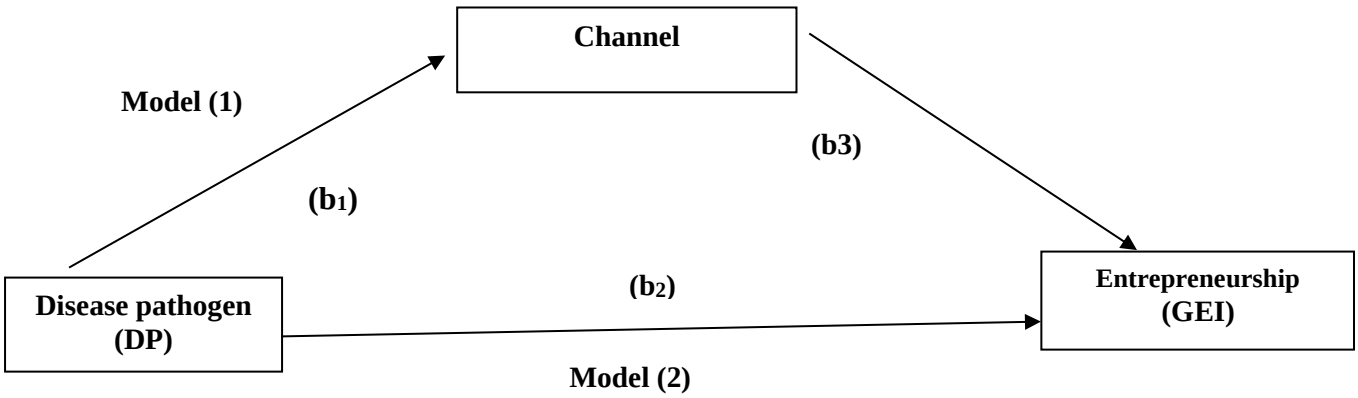
Second, we control the effect of any channels in the significance of historical prevalence of infectious disease. The results are presented in Table 5 above. In column (1), the effect of GDP per capita is more significant than the influence of the historical prevalence of infectious diseases. The same observation can be made in columns (3), (5), (7), 9, (11), and (13) where we add the effect of Pathogens that significantly reduce Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and skills. It is also relevant to

note that the absolute value of the pathogen coefficient and its significance drop dramatically when these seven variables (Pathogens significantly reduce GDP per capita; Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and skills) are included. All of these combined suggest that a considerable portion of the influence of past diseases on entrepreneurship occurs through these variables. Building on the work of Zelekha (2016) and Bennett and Nikolaev (2021), these variables should be considered as the main transmission channels for the effect of historical infectious disease prevalence on entrepreneurship. In this case, according to the authors, the historical variable (past pathogens) is a good instrument to control the effect of these channels on entrepreneurship.

5.2 Mediation analysis

The idea of conducting a mediation analysis is motivated by several works. Tunali and Sener (2019) for example, show that income level determines entrepreneurial ability. Alsan (2015) on the other hand, empirically states that a country's income level is determined by its epidemiological history in the context of sleeping sickness in Africa. Model 4 in our Table 1 demonstrates this moreover. To highlight this mediation, we test its effectiveness and measure its magnitude (Ang and Fredriksson, 2021). This test is developed using the approaches of Baron and Kenny (1986), and Zhao et al. (2010). According to Baron and Kenny (1986), there is no mediation if the historical prevalence of diseases has no effect on the mediator (institutions) and/or if the institutions (mediator) have no effect on entrepreneurship. There is some mediation if the above effects are both significant, in this case (i) mediation is complete if the test for the indirect effect is significant, but not the direct effect; (ii) it is partial if only one of the direct and indirect effects is significant; or (iii) none is significant. In the approach of Zhao et al. (2010) , mediation is not considered to exist if the coefficient of the indirect effect obtained by the Monte Carlo z-test is not significant. Figure 6 shows the transmission channels of historical prevalence of infectious diseases.

Figure 6.: Transmission mechanisms of historical prevalence of infectious diseases



Model 1 : $\boldsymbol{Channel}_i = \boldsymbol{\alpha_1} + \boldsymbol{b_1}.\boldsymbol{DP}_i + \boldsymbol{c'_1 controls}_i + \boldsymbol{u}_i$

Source: Authors' construction (2023)

In table 6 we test all hypotheses. The results indicate that the null hypothesis of no mediation is rejected at the 1% significance level for these potential channels. The estimates also suggest that about 69% of the effect of pathogens on entrepreneurship is channeled through GDP per capita and Property rights, 80% through Innovation, 93% through Entrepreneurial Attitudes,100% through Entrepreneurial Abilities, 94% through Entrepreneurial Aspirations, and 83% through skills.

Table 6: Mediation analysis using the structural equation method

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable mediation	GDP per capita	Property rights	Innovation	Entrepreneurial Attitudes	Entrepreneurial Abilities	Entrepreneurial Aspirations	skills
				Mediation trough Disease pathogen			
Step 1 (X -> M)	-0.806***	-0.659***	-0.722***	-0.695***	-0.723***	-0.718***	-0.802***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Step 2 (M -> Y)	0.554***	0.566 ***	0.761 ***	0.923***	0.997***	0.935***	0.822***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Step 3 (X -> Y)	-0.196*	-0.171 *	-0.138	-0.048***	0.001	-0.044	-0.136
	(0.077)	(0.063)	(0.077)	(0.000)	(0.975)	(0.163)	(0.127)
Sobel test (of	-0.447 ***	-0.373***	-0.540 ***	-0.549***	-0.721***	-0.672***	-0.660***
indirect effect)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RIT	2.275	-0.659	0.799	0.931	1.001	0.939	0.829
RID	0.695	0.566	3.968	13.459	995.536	15.419	4.850
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conclusion ZLC	Full mediation	Full mediation	Full mediation	Full mediation	Full mediation	Full mediation	Full mediation
Conclusion BK	Complete mediation	Complete mediation	Complete mediation	Complete mediation	Complete mediation	Complete mediation	Complete mediation
	69%	69%	80%	93%	100 %	94 %	83 %

Notes: **Source:** author construction (2023); **Notes:** This table reports the partial results of structural equation modelling and distinguishes direct and indirect effects. P-value are in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01. RIT = (Indirect effect / Total effect). RID = (Indirect effect / Direct effect) ZLC: Zhao, Lynch and Chen (2010); BK: Baron and Kenny (1986).

Source: Authors' construction

The previous results show that the main channels through which the historical prevalence of infectious diseases can influence entrepreneurship are significant. Using a two-stage instrumental variable method, we test whether the reduced form effect of pathogens operates through these seven variables (GDP per capita, Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and Skills). The results are presented in Table 7. We treat our channels as endogenous. We use four instruments. The first is the historical prevalence of infectious diseases. We then add the share of the informal sector, trade freedoms, and productive capacity. These three variables are determined by past ecological conditions; they also affect entrepreneurship (Diamond, 1997). The results in table 7 below show that, GDP per capita, Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and skills are the transmission channels between past diseases and

entrepreneurship.

Table 7: Dealing with endogeneity

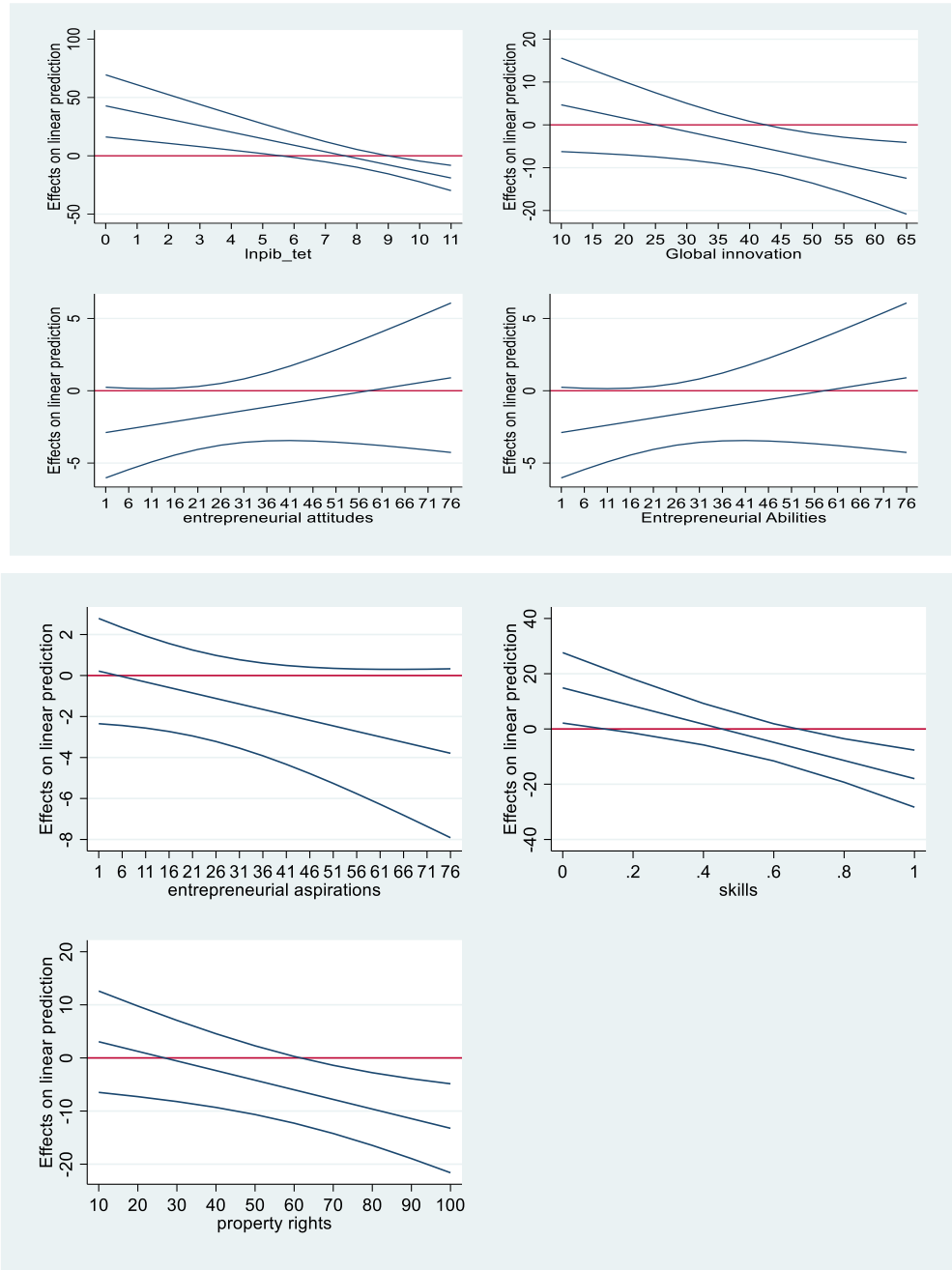
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: 2nd-stage regressions							
Dependent variable: entrepreneurship							
GDP per capita(log)	**14.624*** **						
	(2.171)						
property rights		**0.700*** **					
		(0.060)					
Global innovation			**1.405*** **				
			(0.125)				
entrepreneurial attitudes				**1.111*** **			
				(0.068)			
entrepreneurial abilities					**1.022*** **		
					(0.030)		
entrepreneurial aspirations						**0.927*** **	
						(0.034)	
skills							**45.92*** **
							(11.946)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Potential determinant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-83.436***	4.642	-37.691***	1.563	10.814***	-9.445**	-32.371**
	(18.967)	(9.620)	(9.130)	(3.094)	(2.658)	(3.709)	(13.717)
Observations	102	101	102	102	102	102	98
R^2	0.68	0.83	0.86	0.96	0.99	0.97	0.63
Hansen	0.29	0.50	0.44	0.12	0.25	0.65	0.56
Anderson-Rubin	0.00	0.00	0.00	0.00	0.03	0.03	0.00
LM test	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: This table reports 2SLS estimates of the effects of disease pathogen on present-day entrepreneurship. **Instruments**: historical prevalence of infectious disease, informal sector, trade freedoms and productive capacity. Anderson-Rubin represent Anderson-Rubin endogeneity test (p-value),Hansen represent Hansen over-identification test (p-value), LM test is for under identification (p-value)Robust standard errors are in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Authors' construction (2023)

We run the estimates with the robust option using the "ivreg2" command in Stata. The "P" value of the Anderson-Rubin test for endogeneity is significant at the 1% level. We perform the weak-instrument robust inference using the Anderson and Rubin (1949) approach. According to Ang et al. (2018), this method, which is robust to the presence of weak instruments, tests the significance of an endogenous regression in the structural equation. The test rejects the null hypothesis that the endogenous regression coefficient is zero at the 5% significance level, providing evidence that our endogenous regression is relevant even in the presence of a weak instrument. The results indicate that the exogenous components - GDP per capita, Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and skills - exert a strong positive effect on entrepreneurship. This effect is statistically significant at 1% level.

Figure 7. Conditional marginal effects of disease pathogens on sustainable development



Source: authors' construction (2023); ***Notes***: The upper and lower dashed blue lines represent the 95% confidence intervals.This figure confirms that the promotion GDP per capita; Property rights; Innovation; Entrepreneurial Attitudes; Entrepreneurial Abilities; Entrepreneurial Aspirations and skills moderate the effects of historical prevalence of infectious disease on entrepreneurship.

The "P" value of the under-identification test is significant at the 1% level, suggesting that the historical prevalence of infectious diseases is a good instrument. Using the results in Table 7, we also perform the marginal effects of pathogens on entrepreneurship conditioned on these transmission channels in Figure 7. This figure confirms that GDP per capita, Property rights,

Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and skills, significantly interact between historical infectious disease prevalence and entrepreneurship

6. Discussion

As shown in the previous section, the results obtained make a major contribution to the literature on the determinants of entrepreneurship. This literature specifies that the level of development, foreign direct investment inflow, unemployment; trade, quality of institutions, social norms, and education are essential determinants of the level of entrepreneurship (Dutta & Meierrieks, 2021; Miroshnychenko et al. 2021; Tunali & Sener, 2019; Dvouletý, 2018; Asongu & Nwachukwu, 2018; Chowdhury & Audretsch, 2018; Tchamyou, 2017; Albulescu & Tămăşilă, 2014; Zelekha et al., 2014; Maâlej, 2013).

Unfortunately, this literature does not take in account the importance of historical factors that are fundamental in explaining attitudes, norms, and development (Alsan *et al*., 2015; Acemoglu et al., 2003a; Sokoloff & Engerman, 2000; Asongu& Odhiambo, 2019; Diamond, 1997).

Based on parasitic stress theory, our results show that epidemiological history is a real determinant of entrepreneurship. A high historical incidence of infectious disease favors the development of collectivist societies, which negatively affects entrepreneurship and innovative initiatives (Bennett & Nikolaev, 2021). It also disadvantages government efficiency, social openness, and leads to the establishment of autocratic regimes (Hill et al., 2016; Nikolaev, Boris & Salahodjaev, 2017; Thornhill et al., 2009; Thornhill & Fincher, 2014; Varnum, & Grossmann, 2017). The high historical prevalence of infectious diseases also affects the behavioral immune system. The latter is partly a consequence of feelings, attitudes and adaptive values. An immune system that has experienced high exposure to epidemics can lead to behaviors of distrust or trust between in-group and out-group individuals depending on the risk of exposure to a contagious disease. Empirical evidence across countries for this hypothesis shows that parasite prevalence explains extraversion, introversion and openness to new experiences and ideas (Schaller and Murray 2008). This means that in countries where parasitic stress is high, the population accommodates itself with a cautious personality that limits exposure to contagion. The strong introversion developed by this population reduces interest in new ideas and experiences. This leads to a low entrepreneurial capacity.

Contrarily/Contrastingly, in a locality that has experienced a low level of parasitic stress prevalence, populations tend to develop a strong capacity for extraversion, openness to new ideas, and innovation (Thornhill & Fincher, 2014). This is especially as feelings of xenophobia, distrust, aversion, devaluation and avoidance of the out-group, not to mention the ethnocentrism caused by parasitic stress, are psychological adaptations that reduce contact with infectious diseases. In this case, opportunities for innovation and entrepreneurship are reduced (Navarrete et al., 2007).

7.Concluding implications and remarks

The study of the driving forces behind persistent high levels of entrepreneurship appears to be the most important inquiry in mainstream economics. Previous studies reveal the persistent effects of historical prevalence of infectious diseases, across culture. The novelty of this article lies in the adoption of a historical approach that highlights the deep historical roots of differences in economic development across countries.

This article is part of a successful line of research that examines the effects of the age of environmental quality on institutions, innovation and entrepreneurship across countries. For example, Alsan (2015) who demonstrated that the wealth of nations has been determined by historical causes. This article therefore provides further support for the importance of property rights between historical prevalence of infectious diseases and entrepreneurship (Bennett et al., 2017; Bennett & Nikolaev, 2021).

The central hypothesis is that, historical pathogens affect contemporary entrepreneurship. Specifically, the historical pathogen persists entrepreneurship. Using data for 125 countries, we find strong and robust evidence on the proposed hypothesis and other results. We provide support for the underlying hypothesis using Ordinary Least Squares (OLS) and Two Stage Least Squares (2SLS) on cross-sectional data from 125 countries consisting of the averages between 2006 and 2018. Past diseases reduce entrepreneurship both directly and indirectly. The strongest indirect effects occur through GDP per capita, Property rights, Innovation, Entrepreneurial Attitudes, Entrepreneurial Abilities, Entrepreneurial Aspirations, and skills. This result is robust to many sensitivity tests. Policy makers may take these findings into account and incorporate disease pathogens into the design entrepreneurship policy. Consequently, policymakers must secure Property rights, promote Innovation, and encourage entrepreneurial attitudes. These will ensure

growth productivity and moderate the permissive effect of diseases pathogens on entrepreneurship.

The results of this study also offer prospects for future research. Indeed, it will be interesting to use a more country-specific empirical strategy. This will make it possible to identify entrepreneurship public policies that are more specific to each country. Although the study is pertinent, they are some limits in case of the unavailability of longitudinal data on historical prevalence of infectious disease that can permit the time series regression in panel data. A contemporary example of such limitation in Africa is apparent from the recent COVID-19 pandemic. For example, governments may not provide transparent and timely information about COVID-19 cases, leading to a lack of trust in the reported data. This can make it difficult to accurately assess the situation and implement appropriate interventions. Data collection and reporting systems may vary across African countries, leading to inconsistencies and inaccuracies in the reported numbers. Differences in testing protocols, reporting mechanisms, and data management can affect the reliability of the data. There are also asymptomatic cases, where individuals are infected but do not show symptoms, and hence, can go undetected and unreported. This can lead to an underestimation of the true number of COVID-19 cases in Africa.

Declaration

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Appendix 1: Descriptive statistics

Variables	Sources	Obs	Mean	Std. Dev.	Min	Max
Global Entrepreneurship	GEI	125	24.365	20.638	.09	73.742
Disease pathogen	(Murray & Schaller, 2010)	125	.135	.651	-1.31	1.17
Average Expropriation Risk	(Acemoglu et al., 2001)	95	7.348	1.67	3.636	10
Security of property rights	IPD	82	2.436	.492	1.25	3.5
Security of private contracts	IPD	111	2.689	.932	0	4
Foreign Direct Investment	WDI	123	3.664	5.144	-4.054	41.193
unemployment	WDI	120	7.844	5.66	.825	32.226
business freedom	FREEDOM HOUSE	118	65.157	12.974	27.708	98.129
British colonization dummy	(Acemoglu et al., 2001)	115	.278	.45	0	1
Frenche colonization dummy	(Acemoglu et al., 2001)	115	.139	.348	0	1
Foreign Direct Investment	WDI	123	3.664	5.144	-4.054	41.193
total unemployement	WDI	120	7.844	5.66	.825	32.226
business freedom	Freedom house	118	65.157	12.974	27.708	98.129
Polity combined score	Polity 4	116	-1.65	13.774	-66	10
Landlocked	(Comin et al., 2010)	107	.168	.376	0	1
Tropical dummy	(Comin et al., 2010)	107	.477	.502	0	1
Distance to equator	(Comin et al., 2010)	100	.295	.194	.003	.669
Europe dummy	(Comin et al., 2010)	107	.299	.46	0	1
Africa dummy	(Comin et al., 2010)	107	.308	.464	0	1
Asia dummy	(Comin et al., 2010)	107	.224	.419	0	1
America dummy	(Comin et al., 2010)	107	.159	.367	0	1
British colonization dummy	(Giuliano & Nunn, 2018)	115	.278	.45	0	1
Frenche colonization dummy	(Acemoglu et al., 2001)	115	.139	.348	0	1
Biogeography	(Olsson & Hibbs, 2005)	89	53.07	40.623	12.353	100
Pre-colonial political centraliz	(Acemoglu et al., 2001)	123	.849	.258	0	1
German legal origin	(Acemoglu et al., 2001)	122	.041	.199	0	1
French legal origin	(Acemoglu et al., 2001)	121	.529	.501	0	1
scandinavian legal origin	(Acemoglu et al., 2001)	122	.041	.199	0	1
catholic trust	(Acemoglu et al., 2001)	115	31.602	35.924	0	96.9
muslim trust	(Acemoglu et al., 2001)	115	23.691	35.798	0	99.4
protestant trust	(Acemoglu et al., 2001)	121	12.202	21.634	0	97.8
gdp per capita	WDI	123	7182.853	8765.249	153.095	38834.801
Individualisim/collectivisim	(Hofstede, 2011)	66	43.364	23.858	6	91
High income countries	World bank classification	123	.299	.418	0	1
Upper middle income countries	World bank classification	123	.218	.293	0	1
Least developed countries	World bank classification	125	.112	.317	0	1
Lower middle income countries	World bank classification	123	.253	.306	0	1
Low income countries	World bank classification	123	.23	.369	0	1
Small island developing states	World bank classification	125	.192	.395	0	1
Small states	World bank classification	125	.04	.197	0	1
Fragile and conflicted affected	World bank classification	125	.104	.306	0	1

Source: authors' construction

Appendix 2: correlation matrix

	(1) gei	histo_patho	withxpr	f_brit	f_french	landlocked	tropical	distequat	eu	af	as	am
gei	1											
histo_patho	-0.702***	1										
	(0.000)											
withxpr	0.792***	-0.678***	1									
	(0.000)	(0.000)										
f_brit	-0.0616	0.130	-0.0228	1								
	(0.513)	(0.168)	(0.827)									
f_french	-0.365***	0.376***	-0.298**	-0.250**	1							
	(0.000)	(0.000)	(0.003)	(0.007)								
landlocked	-0.135	-0.0231	-0.0876	0.0272	0.0947	1						
	(0.167)	(0.814)	(0.420)	(0.787)	(0.346)							
tropical	-0.571***	0.647***	-0.531***	0.118	0.275**	0.0711	1					
	(0.000)	(0.000)	(0.000)	(0.241)	(0.005)	(0.467)						
distequat	0.687***	-0.803***	0.651***	-0.206*	-0.248*	-0.0893	-0.876***	1				
	(0.000)	(0.000)	(0.000)	(0.046)	(0.015)	(0.377)	(0.000)					
eu	0.506***	-0.716***	0.664***	-0.324***	-0.269**	0.0882	-0.623***	0.793***	1			
	(0.000)	(0.000)	(0.000)	(0.001)	(0.007)	(0.366)	(0.000)	(0.000)				
af	-0.543***	0.595***	-0.482***	0.199*	0.449***	0.187	0.416***	-0.466***	-0.436***	1		
	(0.000)	(0.000)	(0.000)	(0.046)	(0.000)	(0.054)	(0.000)	(0.000)	(0.000)			
as	-0.0521	0.168	-0.0408	0.223*	-0.0319	-0.182	0.0700	-0.129	-0.351***	-0.359***	1	
	(0.594)	(0.084)	(0.707)	(0.025)	(0.752)	(0.061)	(0.474)	(0.200)	(0.000)	(0.000)		
am	0.0656	-0.0297	-0.127	-0.152	-0.195	-0.127	0.199*	-0.207*	-0.284**	-0.290**	-0.234*	1
	(0.502)	(0.761)	(0.240)	(0.129)	(0.050)	(0.192)	(0.039)	(0.039)	(0.003)	(0.002)	(0.015)	
N	125											

Note: Gei: Global entrepreneurship; histo_patho: Disease pathogen; avexpr: Average Expropriation Risk; f_brit:britanique colonization; f_french: frenche colonization; landlocked:geographic position; tropical:l tropical dumy; distequat:distznce to equatoreu :European dummy; af: African dummy; as: Asian dummy; am: americzn dummy

*,**,*** denote significance levels at 10%, 5% and 1% respectively.

Source: authors' construction

Appendix 3: list of countries

List of Countries				
Albania	China	Iceland	Mauritania	Singapore
Algeria	Colombia	India	Mayanmar	Slovakia
Angola	Costa Rica	Indonesia	Mexico	Slovenia
Argentina	Ivory Coast	Iran	Moldova	South Africa
Armenia	Croatia	Ireland	Morocco	Spain
Australia	Cyprus	Israel	Mozambique	Sri Lanka
Austria	CzechRep.	Italy	Namibia	Suriname
Azerbaijan	Denmark	Jamaica	Netherlands	Swaziland
Bahrain	Ecuador	Japan	Nigeria	Sweden
Bangladesh	Egypt	Jordan	Norway	Switzerland
Belgium	El Salvador	Kenya	Oman	Syria
Benin	Estonia	Korea south	Pakistan	Tanzania
Bolivia	Ethiopia	Kuwait	Panama	Thailand
Bosnia	Finland	Laos	Peru	Trinidad and tobago
Botswana	France	Latvia	Philippines	Tunisia
Brazil	Gabon	Lebanon	Poland	Turkey
Brunei	Gambia	Liberia	Portugal	Uganda
Bulgaria	Georgia	Libya	Puerto Rico	Ukraine
Burkina faso	Germany	Lithuania	Romania	United Arab emirate
Burundi	Ghana	Luxembourg	Russia	United Kindom
Cambodia	Greece	Macedonia	Rwanda	Uruguay
Cameroon	Guatemala	Madagascar	Saudi arabia	USA
Canada	Guinea	Malawi	Senegal	Venezuela
Chad	Hong Kong	Malaysia	Serbia Montengro	Vietnam
Chile	Hungary	Mali	sierraleone	Zambia

Source: authors' construction

Appendix 4: controlling by continent dummy

Dependent variable: entrepreneurship				
	OLS	OLS	OLS	OLS
Disease pathogen	-11.615***	-15.019***	-12.017***	-14.963***
	(4.287)	(3.752)	(3.949)	(3.952)
Africa dummy	-8.235**			
	(3.821)			
Asia dummy		-2.684		
		(3.871)		
America dummy			8.023**	
			(3.799)	
Europe dummy				5.217
				(5.117)
Constant	22.460**	27.900**	16.448	28.857**
	(11.252)	(11.861)	(12.282)	(12.269)
Comments	87	87	87	87
R^2	0.69	0.68	0.69	0.68
Fisher	20.71***	20.85***	23.10***	19.93***

*,**,*** denote significance levels at 10%, 5% and 1% respectively.

Source: authors' construction

Appendix5: Robustness to controlling for historical confounders and othersocial and cultural effects

	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)
	Dependent variable: entrepreneurship								
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Disease pathogen	-13.604***	-13.663***	-15.142***	-14.885***	-13.672***	-13.612***	-15.526***	-14.892***	-14.827***
	(3.949)	(3.982)	(3.870)	(3.883)	(3.791)	(3.450)	(3.762)	(3.809)	(3.812)
Biogeography	0.100								
	(0.070)								
Pre-colonial political centralization		8.464							
		(6.148)							
Ex-colony dummy			-1.508						
			(4.378)						
Ethnic fragmentation				-14.412*					
				(7.467)					
Percent Christian					7.023				
					(4.726)				
Percent Muslim						-12.606***			
						(4.154)			
Percent Unaffiliated							26.558**		
							(10.774)		
Percent Hindu								-4.054	
								(9.478)	
Percent Buddhist									-5.843
									(11.331)
Constant	21.072*	17.970	28.085**	34.528***	23.613**	33.275***	24.137**	26.213**	26.492**
	(12.429)	(12.954)	(12.230)	(11.901)	(11.617)	(10.721)	(11.406)	(12.019)	(11.780)
Countries	70	87	87	87	87	87	87	87	87
R^2	0.75	0.68	0.68	0.70	0.69	0.72	0.70	0.68	0.68

Source: authors' construction. *,**,*** denote significance levels at 10%, 5% and 1% respectively.

Appendix 6 Robustness to controlling for other economic characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: entrepreneurship							
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Disease pathogen	-7.769**	-15.189***	-14.528***	-7.448**	-13.656***	-11.532***	-14.191***	-14.968***
	(3.339)	(3.880)	(3.749)	(3.430)	(3.816)	(3.496)	(3.877)	(3.819)
High income countries	26.047***							
	(3.270)							
Upper middle income countries		-1.816						
		(5.738)						
Lower middle income countries			-7.451*					
			(4.233)					
Low income countries				-25.766***				
				(4.577)				
Least developed countries					-6.251			
					(3.876)			
Small island developing states						-15.710***		
						(3.405)		
Small states							14.544	
							(9.056)	
Fragile and conflicted state								-3.860
								(4.810)
Constant	26.711***	26.520**	30.689**	26.653***	26.882**	23.586**	21.762*	24.149**
	(9.959)	(12.300)	(12.113)	(9.754)	(11.573)	(10.704)	(12.107)	(12.080)
Countries	87	87	87	87	87	87	87	87
R^2	0.80	0.68	0.69	0.76	0.69	0.73	0.69	0.68

*,**,*** denote significance levels at 10%, 5% and 1% respectively.

Source: authors' construction