

Zero-Sum Traps: The Evolution of Productivity-Stifling Beliefs*

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27 December 2022

ABSTRACT:

We study the evolution of beliefs that discourage productive effort. Such beliefs, which include concerns about the jealousy of others, beliefs in the importance of luck for success, disdain for competitive effort, and traditional supernatural beliefs in witchcraft or the evil eye. We show that when interactions are zero-sum in nature, meaning that the gains from one individual tend to come at the expense of another, demotivating beliefs that reduce effort can arise. These beliefs can make society better off in the short run but inhibit innovation in the long run, causing economic underdevelopment. We present evidence from the Democratic Republic of Congo and the World Values Survey consistent with the assumptions and predictions of the model. We find a relationship between how zero-sum an environment is (or perceived to be) and the presence of demotivating beliefs such as concerns about jealousy and beliefs in witchcraft (in the DRC) or a lower importance placed on success and weaker belief in the importance of hard work for success (globally).

Keywords: Cultural evolution, beliefs, zero-sum, innovation.

JEL Classification: O10; Q55; N10.

*We thank Toke Aidt, Chris Bidner, Meredith Crowley, Gregory Dow, Paola Giuliano, Sriya Iyer, Jonathan Newton, Imran Rasul, Arthur Robson, Michael Sacks, Moses Shayo, Ludvig Sinander, Josh Tasoff, Cole Williams, Peyton Young, and conference/seminar participants at the British Academy Conference on Toward ‘Cohesive’ Societies, the 10th Oxford workshop on Global Priorities, the 2022 ASREC Annual Conference, the 2022 CNEH Conference, the LSE Hayek workshop, Simon Fraser University, and Cambridge University for useful discussions and/or comments on the paper.

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1. Introduction

Beliefs and values that discourage effort and productive activity are surprisingly common across time and space. They take a wide range of forms, but have the common feature of discouraging effort. They often take the form of warnings against and even punishment for personal ambition and success. In the Nordic countries, there are the laws of Jante stating, 'Du skal ikke tro at du er noget,' which literally mean 'don't think that you are anything'. In Australia and New Zealand, a 'tall poppy' syndrome is said to lead others to cut down those who stick out in terms of personal achievement. In Japan, a common phrase warns that 'the nail that sticks out will be hammered down.' Sometimes these beliefs and norms are embedded in class-based status systems that stigmatize aspiration and effort as 'social climbing' (McCloskey, 2010). Accordingly, British Prime Minister Herbert Asquith praised the students of his Oxford College, Balliol, for exhibiting "effortless superiority." Other forms of demotivating belief systems include pessimistic beliefs in an 'unjust world' (Benabou and Tirole, 2006), anti-materialistic beliefs that reduce the enjoyment of consumption (Flouri, 1999), and supernatural beliefs such as the evil eye and witchcraft beliefs that act as a kind of psychic tax on success (Gershman, 2014, 2015). These facts raise the question: If such beliefs reduce productive effort, why are they so prevalent both historically as well as across the world today?

We study this question by formalizing observations and insights from anthropology on the 'image of limited good,' first highlighted by George Foster (Foster, 1962, 1965, 1967, 1972). Here, a belief in the zero-sum nature of economic transactions creates a sense of rivalry and envy that influences economic choices and overall performance. In the smaller-scale traditional societies that he studied, he felt that the dominant belief is that if one person does better, somebody else must do worse and that if someone gets ahead, someone else must fall behind. He hypothesized that this zero-sum worldview directly or indirectly inhibited entrepreneurial activity, innovation, and economic development.

Modeling the cultural evolution of belief systems, we study the emergence and spread of demotivating beliefs in zero-sum environments, which are environments where some of the benefits to one person are obtained at the expense of others. We find that when there is a zero-sum component to economic interactions, demotivating beliefs can emerge and spread, reducing incentives for productive effort and innovation, and thereby inhibiting economic development.

The more zero-sum the economic environment is, the more intense the demotivating beliefs that evolve.

In the model, members of a population are matched and engage in production. While an individual's effort increases their output, the fraction α of their output comes at the cost of their partner. We refer to α as the degree to which the environment is zero-sum. This production function captures a range of economic interactions with different degrees of rivalry, ranging from merchants competing for the same fixed set of customers (a completely zero-sum situation) to business partners working together in an enterprise but also ultimately dividing the profits from their joint endeavor (a partially zero-sum situation).

Individuals can hold one of a number of demotivating beliefs, each of which amounts to an incorrect perception about the individual returns to effort. They can also have a neutral belief system which conforms to the true return to effort. While individuals choose effort based on their subjective beliefs, cultural evolution is based on the (true) material payoffs. Despite the distortion in behavior generated by (incorrect) demotivating beliefs, we show that demotivating beliefs can survive and spread when there is positive assortativity and zero-sumness in economic interactions. The reason is that in such an environment the direct cost of holding a demotivating belief is overwhelmed by the interactive benefit of being matched with other players who hold demotivating beliefs and do not compete aggressively against you. This is a simple but largely overlooked mechanism. A similar logic applies to social efficiency. Where interactions are mainly zero-sum, effort primarily redistributes resources and is thus socially inefficient. Hence demotivating belief systems improve short-run efficiency by limiting excessive competition within groups.

Motivated by Foster's arguments, we connect demotivating beliefs to economic development by allowing for technological innovation through learning by doing. We find that while demotivating beliefs improve short-run efficiency, they can also have deleterious long-term consequences. Since technological innovation arises through productive effort, such beliefs will trap the economy in a low technological state. When this occurs, demotivating belief systems are a *kludge* – an adaptation that compensates for, but does not eliminate and even deepens, the inefficiencies in a system (Ely, 2011).

Having developed a theoretical understanding of Foster's arguments, we then turn to the data. We begin with the analysis of a modern less-industrialized population within the city of Kananga,

located in the Democratic Republic of the Congo. We examine two samples: a 200-person sample collected in 2015 and a 1,000-person sample collected in 2019. The smaller sample was used to validate the measures, including of zero-sum thinking, used in our analysis. The 2019 sample was used to replicate the 2015 findings and to also look at a larger population.

In the samples, we examine the link between zero-sum thinking and the emergence of the specific set of demotivating beliefs that were emphasized by George Foster; namely, beliefs about jealousy and traditional supernatural beliefs (what we in the West commonly call 'witchcraft'). We measure zero-sum thinking through a series of survey questions that ask respondents their views of the link between those who are better off (in terms of wealth, income, business, trade, power, and happiness) and those who are worse off (in those same domains). We measure a person's belief in witchcraft through a series of survey questions, which we validate (in the 2015 sample) using an IAT (implicit association test). We also measure belief in the competing belief system in our sample, Christianity, using similar survey questions and also validate the survey protocol using an IAT.

We find strong and robust evidence that, in both samples, that respondents who have a more zero-sum view of the world report being more jealous about the success of others, are more likely to hold stronger traditional religious beliefs, and are less likely to hold strong Christian beliefs.

In looking at the estimated relationships, we find that the strongest association is between zero-sum views and Christianity. Although Foster was originally motivated by rural pre-industrial society, given the presence of Christianity (and other similar big god religions) in contemporary industrialized societies, our findings raise the possibility that his insights might also be applicable today in the developed world. Motivated by this, we examine these same relationships globally using data from the World Values Survey, which contains measures of zero-sum thinking, religiosity, and demotivating beliefs.

The broader sample provided by the WVS allows us to examine whether a more scarce zero-sum environment, in fact, leads to more zero-sum thinking. In our Congolese samples, everyone was faced with the same environment and they also have very similar levels of income, close to subsistence income. By contrast, in the global sample, where many countries are included, we have far greater variation in the degree to which the respondent's environment is zero-sum. Therefore, the first exercise that we undertake is to verify that survey measures of the extent to which an individual views the world as zero sum do in fact reflect their facing a more zero sum

environment (which is the assumption of the model).

We check for this by estimating the relationship between a respondent's zero sum thinking and the rate of economic growth in their country during the first 20 or 30 years of their life. We find that growing up in an environment of economic scarcity (which is more zero-sum) is associated with more zero-sum thinking in adulthood.

Having provided some verification of the zero sum measure, we then estimate the relationship between zero-sum thinking and a range of demotivating beliefs. We first verify that the same relationship between zero-sum thinking and Christian religious beliefs that we found in the Congolese samples applies to the global WVS sample. We find that in our broader sample, a belief in Christianity rather than traditional indigenous religions is associated with less zero sum thinking. We find that other big god religions (like Islam, Hinduism, etc) are also associated with less zero sum thinking. Relative to these beliefs, not having a religious belief is associated with more zero-sum thinking and the magnitude appears to be roughly similar with having a traditional indigenous belief. In short, we find that the expanded WVS estimates are very much in line with our findings from the Congolese sample.

Because the WVS does not include information on jealousy, we are unable to look at this association with zero-sum thinking. However, we are able to look at a broader set of demotivating beliefs, including those that are particularly relevant to the modern industrialized world. These include belief in the inherent value of work, beliefs about the returns to hard work (e.g., whether incomes determined by luck or effort), whether it is important to be successful in life, and whether receiving help from others is humiliating or not. We find a very strong association between zero-sum thinking and all demotivating beliefs examined.

The broader sample also allows us to test the comparative static prediction made by Foster and our theory regarding equilibrium effort and economic production. Consistent with predictions, we find that at the individual-level less zero-sum thinking is associated with higher incomes, more educational attainment, more savings, and higher occupational status.

In short, by providing a formal theory of Foster's insights and testing the subsequent predictions, we find evidence for the mechanisms he proposes – namely, links between scarcity, zero-sum thinking, demotivating beliefs, and economic activity – not only in a less-industrialized smaller-scale society, but also in more-industrial contemporary samples. In short, our findings suggest that zero-sum thinking is an important factor in understanding the causes and conse-

quences of economic thinking and economic development.

Our analysis of the evolution of demotivating beliefs draws upon the literature on the evolution of preferences (Alger and Weibull, 2019, Newton, 2018), as well as the literature on the cultural transmission of preferences (Bisin and Verdier, 2000, 2017). When preferences are private and individuals are matched uniformly at random in a population, evolution ‘endows’ individuals with subjective payoff functions that match the fitness function governing the reproduction of preferences (Ok and Vega-Redondo, 2001, Ely and Yilankaya, 2001, Robson and Samuelson, 2007). When preferences are observable, they create public *commitment* and thereby shape the behavior of one’s partners in an interaction (Schelling, 1960, Becker, 1976, Frank, 1988). Due to this interactive effect, evolution may select subjective payoff functions that depart from the objective fitness function (Güth and Yaari, 1992, Heifetz, Shannon and Spiegel, 2007). Economists, however, do not typically consider preferences to be observable, but rather revealed through behavior (Robson and Samuelson, 2011). Hence, we follow a more recent approach developed by Alger and Weibull (2013, 2016) in which preferences are private, but there is positive assortativity in matching.

Our theory is also related to a recent literature on games in which players have misspecified subjective models of the environment (Esponda and Pouzo, 2016). Massari and Newton (2020) provide an evolutionary analysis of such games. Misspecification is not assumed in our model, rather (misspecified) demotivating beliefs arise endogenously even when the true beliefs can be learned. Unlike work on evolutionary implementation (Sandholm, 2005), negative externalities are internalized here not through pricing schemes but rather changes in beliefs/preferences, akin to Akerlof, Matouschek and Rayo (2020). Our work is also connected to the literature on the evolution of cooperation, especially under cultural group selection (see Cooper and Wallace, 2004, and references therein).

Finally, and perhaps most importantly, our work is related to the economics literature on social institutions (e.g. Young, 2015). The seminal work on witchcraft beliefs in economics is by Gershman (2015, 2016, 2020). On the theoretical front, Gershman (2015) develops a model in which evil-eye and witchcraft beliefs emerge to reduce an individual’s output and thereby discourage envious destruction. The study fits into a larger literature on second-best institutions (e.g. Carvalho, 2013, Leeson, 2014, Nunn and Sanchez de la Sierra, 2017). Our findings also speak to Bowles (2006), who shows that sharing norms and other forms of reproductive leveling

favor the evolution of cooperation by reducing the gains from defection. Our findings show how a seemingly unproductive cultural trait can improve short-run efficiency and proliferate in zero-sum economic environments, i.e., demotivating beliefs that are equivalent to *incorrect* beliefs that output will be confiscated and burned rather than actually redistributed.

The insights from our findings may help to explain “puzzling” behavior that has been highlighted recently by development economics, namely the reluctance of individuals in developing countries to take up seemingly profitable investment opportunities. For example, Duflo, Kremer and Robinson (2011) examine fertilizer use among farmers in contemporary Kenya. They document that farmers under-invest in fertilizer use, foregoing higher profits. Their explanation is that farmers are not sufficiently patient or forward-looking and, therefore, make sub-optimal decisions. Our line of inquiry does not assume that decision makers behave suboptimally; they behave optimally given their beliefs/preferences, but the beliefs or subjective payoffs that evolve do not necessarily conform to reality.

We now turn to the model and its predictions, followed by the empirical analysis. In the following section, we provide an overview of the hypothesis from anthropology about the importance of zero-sum thinking and the ‘image of limited good.’ In Section 3, we translate these arguments and insights into a formal model, which generates predictions that, in Section 4, we then bring to the data, examining a contemporary pre-industrial population in the DRC. In Section 5, we empirically study the generality of the insights by expanding the analysis to include countries across the world. Section 6 concludes.

2. The ‘Image of Limited Good’

Beliefs that discourage effort and productive activity are surprisingly common across time and space. Although they take a variety of forms, they all have the common feature of discouraging individual effort. A common form is as a warning about personal ambition. In the Nordic cultures, there are the laws of Jante stating, ‘Du skal ikke tro at du er noget,’ which means ‘don’t think that you are anything’. In Australia and New Zealand, a ‘tall poppy’ syndrome is believed to lead others to cut down those who stick out in terms of personal achievement. In Japan, the same warning is provided by the analogous phrase ‘the nail that sticks out will be hammered down.’

It has also been common for these beliefs to be embedded in class-based status systems that look positively upon inherited wealth but stigmatize aspiration, effort, and other attempts at social 'social climbing' (McCloskey, 2010). In other cases, demotivating beliefs are embedded within religious values. Gibbon (1996) famously implicated Christianity and its discouragement of worldly endeavors in the decline of the Roman Empire. Of course, this otherworldly orientation was recommended by Augustine (2003)—a witness of Rome's fall—in his distinction between the City of Man and the City of God.

In contemporary society, we continue to find many examples of demotivating belief systems, including beliefs about the extent to which success is primarily outside of one's control (i.e., due to luck) rather than within one's control (i.e., due to hard work), a belief that is the majority view in most countries outside of the United States (Alesina, Glaeser and Sacerdote, 2001, Benabou and Tirole, 2006). Also common are anti-materialistic beliefs that reduce the enjoyment of consumption (Flouri, 1999), supernatural beliefs such as the evil eye and witchcraft beliefs that act as a kind of psychic tax on success (Gershman, 2014, 2015).

At first glance, it is paradoxical that beliefs and value systems that induce individuals to work less hard could evolve and exist in the longer run. This is even more puzzling when one recognizes that many scholars have associated these demotivating beliefs with economic underdevelopment, whether it is connecting the valuing of leisure over work to the fall of the Roman Empire (Finley, 1973) or the elimination of these values being a necessary pre-condition for the Industrial Revolution (McCloskey, 2006, 2010, 2016).

This raises the question of why demotivating beliefs have been so prevalent throughout human history. To answer this question, we start with the work of anthropologist George Foster, which arose from fieldwork in rural Mexico starting in the 1960s (Foster, 1967). Based on his observations, he reached the conclusion that people in most small-scale pre-industrial societies have a "zero-sum" view of the world, which he referred to as the "image of limited good". This model of the world suggests that if one person does better, then somebody else must do worse and that if you yourself get ahead, then someone else must fall behind.

This cognitive orientation (as Foster calls it) arises in a world in which all important resources and assets are in limited supply so that, quite literally, the world is zero-sum. Land is limited and so more land for one individual means less land for another. The same is true for livestock, wives, authority, and social status. In less-developed societies, where markets are not developed

and there is no technological advance, the only way for an individual to get ahead is at the expense of others. Therefore, it is logical that this view of the world would arise in many parts of the world and particularly pre-industrial societies that have not yet experienced rapid economic growth.

Although Foster himself proposed this as a model of rural Mexican society specifically and the root cause of its development problems, the theory was believed to be more general and he gave many other examples from around the world Foster (1962, 1967, 1972). Foster also informally connects a zero-sum world to demotivating beliefs. Foster (1965) noted in his original article that zero-sum societies exhibit an apparent lack of what McClelland (2003) calls a “need for achievement.”

The first goal of the paper is to bring together these insights into a formal model that connects a zero-sum world, demotivating beliefs, effort, innovation, and ultimately economic growth. The second is to take the assumptions of the model and its predictions to the data. In doing so, an important consideration is how one identifies and measures demotivating beliefs. Foster’s writings tend to emphasize jealousy and supernatural beliefs like witchcraft or the evil eye. This was primarily because his interest was in smaller-scale pre-industrial societies.

In contemporary post-industrial societies, the exact nature of the beliefs may differ, although they share the fact that they serve to discourage ambition and effort. Perceptions of jealousy are also common in the developed world and may play an important role. There are also beliefs that explicitly discourage ambition, such as the previously-noted laws of Jante in Nordic countries; the ‘tall poppy syndrome’ in Australia and New Zealand; or the similar belief that ‘the nail that sticks out will be hammered down’ in Japan. We will examine such beliefs in our analysis.

Despite these, our analysis also examines the types of beliefs that Foster had in mind, which continue to be prevalent, especially in the developing world. We consider indigenous supernatural beliefs in the Democratic Republic of the Congo. This bundle of beliefs is commonly given the label of ‘witchcraft,’ particularly by those from Western European cultures. One common feature of such belief systems, which causes them to discourage effort, is that unfortunate events are often linked to the success of others. Success is often perceived to be due to the use of witchcraft. Thus, if you are particularly successful, others may perceive this to have been achieved through the use of witchcraft. This often also generates feelings of jealousy. In these cases, it is also believed that jealous individuals can harm others, even unintentionally through supernatural means, if they

harbor sufficient greed or envy

Holland (2001) explicitly draws a connection between a zero-sum mentality and the ‘Image of Limited Good’ and the function of witchcraft, writing:

The social purpose of witchcraft accusations is to apportion blame for misfortune and to ensure that each member of a community has an equal share in its prosperity – an anthropological concept known as the Image of Limited Good. . .

Although expressed in different ways, the Image of Limited Good prevails throughout Africa and lies at the heart of witchcraft accusations. It is the belief that the pie is limited and one person’s success is always at the expense of another’s. If an individual prospers beyond the expectations of the others in his community, the success one may be labeled a witch because he is believed to have augmented personal progress via witchcraft and to have impoverished others in the process. (Victims of witchcraft are often relatively prosperous individuals.)

This notion breeds constant envy in traditional communities. Africans believe the witch’s damaging hatred comes from her remorseless jealousy of others. And ordinary people are assumed to run a greater risk of being attacked by witchcraft if they become more prosperous than their neighbors because they are inviting not only the jealousy of the village but also of the witch.

Our analysis will examine the relationship between a zero-sum mentality, traditional religious beliefs (e.g., ‘witchcraft’), jealousy, and economic prosperity with the Congolese context.

3. The Model

As described in the introduction, there are a great variety of demotivating belief systems with the common feature being that they reduce incentives for productive effort. Thus, it is a mystery why they are so widely observed in human populations. We turn to a model that examines such beliefs in environments that are more or less zero sum in nature.

A. Basic Set Up

PLAYERS. Consider a population that is a continuum of mass one. The population could be a village, district, or whole society. Time is continuous and denoted by $t \in \mathbb{R}_+$.

BELIEF SYSTEMS. There are a potentially large (but finite) set of belief systems $\Theta = \{\theta_1, \theta_2, \dots, \theta_n\}$, where the intensity of belief i is $\theta_i \in [0,1]$, $i = 1, 2, \dots, n$. As we shall see, $\theta = 0$ is the true belief and any $\theta > 0$ is a demotivating belief. The share of each trait i in the population is denoted by q_i , with the population state denoted by $\mathbf{q} = (q_1, q_2, \dots, q_n)$ and $\sum_{i=1}^n q_i = 1$.

ACTIONS. Individuals are paired and engage in production. The effort exerted in production by type i is denoted by $x_i \in \mathbb{R}_+$. The production function is $A(t)\sqrt{x_i}$, where $A(t) > 0$ is the endogenous level of technology in the economy whose evolution we will specify later. The cost of production is $\frac{1}{2}x_i$. A fraction of tasks $\alpha \in [0, 1]$ are zero-sum in nature, meaning that the benefit to the individual undertaking the task comes at the expense of the player with whom they are paired.¹

PAYOFFS. The true (objective) payoff function to type i when matched with type j is

$$U(x_i, x_j) = \alpha A(t) (\sqrt{x_i} - \sqrt{x_j}) + (1 - \alpha) A(t) \sqrt{x_i} - \frac{1}{2} x_i. \quad (1)$$

If $\alpha = 0$, we have a simple production decision: each individual's payoff is independent of their partner's effort. If $\alpha = 1$, the environment is purely zero-sum: all gains come at the expense of one's partner. This is what Foster (1965) describes as a 'limited good' environment.

Players maximize a potentially distorted version of the true payoff function. Specifically, a type i player chooses production effort x_i to maximize the following subjective payoff:

$$\hat{U}(x_i, x_j) = (1 - \theta_i) A(t) [\alpha (\sqrt{x_i} - \sqrt{x_j}) + (1 - \alpha) \sqrt{x_i}] - \frac{1}{2} x_i. \quad (2)$$

That is, an individual with belief system i discounts the return to effort by a factor $(1 - \theta_i) \in [0, 1]$. This specification captures various kinds of demotivating belief systems. For example, individuals may try to estimate the true return to effort in the economy, as in Benabou and Tirole (2006). In that case, we characterize conditions under which an incorrect belief $\theta_i > 0$, which underestimates the return to effort, can survive and spread. $\theta_i > 0$ could also be the product of a supernatural belief, such as belief in the evil eye, according to which envious individuals cause harm to others through supernatural forces (Gershman, 2014, 2015). Hence, envy exacts a kind of supernatural tax on effort with believers expecting to lose a fraction θ_i of their output. These

¹An alternative interpretation is that there is a probability α that the environment is zero-sum, and whatever type i gains through production their partner j loses. With probability $1 - \alpha$, i 's effort is truly productive and does not come at the expense of j . Under both interpretations, α measures the degree to which the environment is zero-sum.

belief systems reduce perceived returns to effort and are thus demotivating. The higher is the belief intensity θ_i , the more demotivating is the belief i .

Maximizing (2) with respect to x_i , and suppressing time notation, we get optimal production effort for each type i :

$$x_i^* = \arg \max_{x_i \in \mathbb{R}_+} \hat{U}(x_i, x_j) = (1 - \theta_i)^2 A^2.$$

MATCH PAYOFFS. While individual choices are based on their subjective payoff functions given by (2), evolution is determined by the true payoff function (1). Denote the equilibrium (true) payoff to a type i individual matched with a type j individual by

$$U_{ij} = U(x_i^*, x_j^*) \tag{3}$$

$$= (1 - \theta_i - \alpha(1 - \theta_j) - \frac{1}{2}(1 - \theta_i)^2) A^2. \tag{4}$$

By observation, the payoff to i in an i, j match is strictly decreasing in the intensity of i 's belief θ_i and, when $\alpha > 0$, strictly increasing in the intensity of j 's belief θ_j . Therefore, one would ideally wish to hold the true belief $\theta_i = 0$, but be matched with individuals who hold a highly demotivating belief.

ASSORTATIVE MATCHING. The success of trait i is based on its 'fitness', which we denote by $F_i(\mathbf{q}, A)$, and is given by the expected payoff across all possible matches; it is, thus, a function of the population state \mathbf{q} . We assume partial assortative matching as in Cavalli-Sforza and Feldman (1981). Specifically, fraction σ of the population matches with its own type and fraction $1 - \sigma$ is matched uniformly at random with another member of the population. We refer to σ as the index of assortativity.

Another interpretation is that σ is a proxy for group-level selection in the population. For example, consider the population being split into two groups, labeled 1 and 2. Suppose trait i has achieved fixation (i.e., is present in 100% of the population) in group 1 and trait j has achieved fixation in group 2 so that the share of trait i in the population, q_i , is also the share of group 1. The index of assortativity σ is then the likelihood of a within-population match.

Given an index of assortativity σ , the fitness of trait i is

$$\begin{aligned} F_i(\mathbf{q}, A) &= \sigma U_{ii} + (1 - \sigma) \sum_{j=1}^n q_j U_{ij} \\ &= (1 - \theta_i) \left(1 - \frac{1}{2}(1 - \theta_i)\right) A^2 - \sigma \alpha (1 - \theta_i) A^2 - (1 - \sigma) \alpha A^2 \sum_{j=1}^n q_j (1 - \theta_j). \end{aligned} \tag{5}$$

B. Cultural Evolution

We place only a minimal restriction that the distribution of types \mathbf{q} evolves according to a deterministic payoff monotone dynamic. A leading example is the replicator dynamic, which can be the product of natural selection, imitation, or reinforcement learning (Sandholm, 2010). Specifically, for all i, j such that $q_i > 0$ and $q_j > 0$,

$$\frac{dq_i}{dt} \begin{matrix} \geq \\ < \end{matrix} \frac{dq_j}{dt} \iff F_i(\mathbf{q}, A) \begin{matrix} \geq \\ < \end{matrix} F_j(\mathbf{q}, A).$$

That is, if the payoff to type i is higher than the payoff to type j , then i 's population share grows faster.

In sum, we have an n -dimensional dynamical system governing the evolution of (\mathbf{q}, A) on the state space $[0, 1]^{n-1} \times \mathbb{R}_+$. We can say a lot about the cultural dynamic $\mathbf{q}(t)$, independent of the technology dynamic $A(t)$. All we assume at this point is that dA/dt is continuous in (\mathbf{q}, A) .

We single out two belief intensities. The first is $\theta = 0$, which is the (true) non-demotivating belief. The second is $\theta^* = \sigma\alpha$, which is the belief intensity with the highest relative fitness vis-à-vis any other belief intensity. We denote each belief's population share at time t by $q^0(t)$ and $q^*(t)$, respectively.

Proposition 1 . Evolution of Demotivating Beliefs. *Cultural evolution selects a belief system as follows:*

- (i) *If the set of beliefs Θ contains $\theta_i < 2\sigma\alpha$ and the initial state is such that $q^0(0) < 1$, then $q^0(t)$ converges monotonically to zero. Otherwise, $\lim_{t \rightarrow \infty} q^0(t) = 1$.*
- (ii) *If the set of beliefs Θ contains $\theta^* = \sigma\alpha$ and the initial state is such that $q^*(0) > 0$, then $q^*(t)$ converges monotonically to one.*

All proofs are in Appendix A.

Even though incorrect, demotivating belief systems, including the evil eye and witchcraft beliefs, survive and spread through the population. According to part (i) of the proposition, as long as demotivating beliefs are present initially and are not too intense given the degree of zero-sumness $\alpha > 0$ and index of assortativity $\sigma > 0$, the true belief $\theta = 0$ will be driven to extinction. Only demotivating beliefs will survive in the population. Part (ii) tells us that the demotivating belief with intensity $\theta^* = \sigma\alpha$ will win out, driving all other belief systems to extinction. Hence, under positive assortativity ($\sigma > 0$), the belief intensity that is selected is strictly increasing in the degree of zero-sumness α . These results do not depend on the specific form of the technology dynamic or the payoff monotone cultural dynamic.

In addition, even when $q^*(0) = 0$, evolution will select a belief intensity in the support of $\mathbf{q}(0)$ that is approximately equal to θ^* . Defining an interior state $\mathbf{q}(t)$ as one with full support on Θ , we can state the following corollary:

Corollary 1 . Evolution of Optimal Demotivating Beliefs. Let $\Theta = \left\{0, \frac{1}{\Delta}, \frac{2}{\Delta}, \dots, 1\right\}$, where $\Delta \in \mathbb{N}$.

From any interior initial state $\mathbf{q}(0)$ and for Δ sufficiently large, $q_i(t)$ converges monotonically to one for some $\theta_i \in \left(\theta^* - \frac{1}{\Delta}, \theta^* + \frac{1}{\Delta}\right)$, i.e., a belief approximately equal to $\theta^* = \sigma\alpha$.

The intuition behind the survival of (incorrect) demotivating beliefs is as follows. By discounting the return to effort, the belief $\theta > 0$ depresses productive effort below the first-best level. The direct effect of this distortion is to reduce fitness. There is also a second effect that we call the ‘interactive effect,’ which is to increase the likelihood of being matched with another believer who exerts low effort. When interactions are primarily zero sum (α large) and there is a high degree of assortative matching (σ large), the interactive effect dominates the direct effect. The same logic applies to (static) efficiency. Whether the belief system boosts overall efficiency depends on the size of the direct effect relative to the interactive effect. When $\sigma > 0$ and the environment exhibits a high degree of zero-sumness, negative externalities are large and the demotivating belief system increases overall efficiency by mitigating these negative externalities.

C. Comparative Dynamics

We would now like to compare the evolution of demotivating beliefs in two different populations (or subpopulations), A and B . The degree to which the environment faced by population k is zero-sum is α^k , $k = A, B$. To focus on the degree of zero-sumness, the parameter of interest in the empirical analysis, we assume each population has the same index of assortativity σ and set of beliefs Θ .

Define the population k share of belief i at time t by $q_i(k, t)$ and the population k state by $\mathbf{q}(k, t)$. As before, an interior population k state is one with full support on Θ . In addition, define the mean demotivating belief in population k at time t as

$$\bar{\theta}(k, t) = \sum_{i=1}^n q_i(k, t)\theta_i. \quad (6)$$

We can then state the following proposition.

Proposition 2 . Zero-Sum Environments and Demotivating Beliefs. Let $\Theta = \left\{0, \frac{1}{\Delta}, \frac{2}{\Delta}, \dots, 1\right\}$, where $\Delta \in \mathbb{N}$.

Suppose the initial state $\mathbf{q}(k, 0)$ is interior for $k = A, B$ and there is positive assortativity $\sigma > 0$. If $\alpha^A > \alpha^B$ and Δ is sufficiently large, there exists a finite time T such that $\bar{\theta}(A, t) > \bar{\theta}(B, t)$ for all $t \geq T$.

Therefore, where the environment is more zero-sum, a population will eventually hold more intense demotivating beliefs. Again, this applies independently of the initial conditions for each population, as long as they are interior. The result also does not depend on the precise form of the technology dynamic or payoff monotone cultural dynamic. This will be the key proposition for empirical testing.

D. Beliefs and Innovation

While we have shown that demotivating beliefs survive and spread, we are also interested in their co-evolution with and long-term impact on the economic environment. Demotivating beliefs reduce a negative *contemporaneous* externality by limiting zero-sum competition, but can also reduce a positive *intertemporal* externality from knowledge accumulation, trapping the economy in a low-technology state.

To say more about the system (\mathbf{q}, A) , we need to specify a technology dynamic. We assume that technology cannot go below some subsistence level $\underline{A} > 0$. If $A(t) \leq \underline{A}$ for some $t = T$, then $A(t) = \underline{A}$ for all $t > T$. Otherwise, if $A > \underline{A}$, technological development is governed by the following equation of motion:

$$\frac{dA}{dt} = X(\mathbf{q}, A) - \delta A, \quad (7)$$

where $\delta \in (0, 1)$ is the rate of technological depreciation and $X(\mathbf{q}, A)$ is the mean level of effort in the population,² which is given by:

$$\begin{aligned} X(\mathbf{q}, A) &= \sum_{i=1}^n q_i x_i^* \\ &= A^2 \sum_{i=1}^n q_i (1 - \theta_i)^2. \end{aligned} \quad (8)$$

The positive effect of effort on the rate of innovation could arise from learning-by-doing and knowledge spillovers from productive activity, as in Aghion, Caroli and Garcia-Penalosa (1999) and Gershman (2014).³

To examine the long-term effect of demotivating beliefs on development, substitute (8) into (7) to get:

$$\frac{dA}{dt} \begin{matrix} \geq \\ \leq \end{matrix} 0 \iff A \begin{matrix} \geq \\ < \end{matrix} \frac{\delta}{\sum_{i=1}^n q_i (1 - \theta_i)^2} \equiv D^*(\mathbf{q}, \theta). \quad (9)$$

We call $D^*(\mathbf{q}, \theta)$ the development barrier.

As a benchmark, consider a degenerate set of beliefs labeled θ^0 in which $\theta_i = 0$ for all i . In this case, all beliefs are true and not demotivating. The development barrier is $D^*(\mathbf{q}, \theta^0) = \delta$. Starting from $A(0) > \delta$, there is perpetual technological progress and growth. Starting from $A(0) < \delta$ there is technological regress and contraction of the economy until $A(t) = \underline{A}$, the subsistence level. Hence a technological shock of size greater than $\delta - \underline{A}$ is required to transition the economy from the $A = \underline{A}$ steady state to perpetual growth. Now consider a non-degenerate belief system θ . In this case, the development barrier $D^*(\mathbf{q}, \theta)$ depends on \mathbf{q} . In particular, $D^*(\mathbf{q}, \theta) > D^*(\mathbf{q}, \theta^0)$ whenever there exists a belief such that $\theta_i > 0$ and $q_i > 0$.

Now write $(\mathbf{q}, A) \in \Omega(\theta)$ if starting from (\mathbf{q}, A) and given the set of beliefs θ , $dA/dt > 0$ for all $t > 0$ under a payoff monotone cultural dynamic and the technology dynamic (7). That is, $\Omega(\theta)$ is the set of states from which the *co-evolution* of beliefs \mathbf{q} and technology A leads to perpetual growth.

²The results do not change qualitatively if we assume $\frac{dA}{dt} = (1 - \alpha)X(\mathbf{q}, A) - \delta A$, so that effort in zero-sum interactions does not contribute to innovation.

³The effort choices characterized here continue to hold even with forward-looking agents, because agents are non-atomic and thus do not individually affect mean effort.

By Proposition 1(i), for demotivating beliefs to spread under a payoff monotone dynamic from an interior state, there must exist $\theta_i \in \Theta$ such that $\theta_i < 2\sigma\alpha$ (which requires $\sigma\alpha > 0$). When Θ has this property, we refer to the environment as one that supports demotivating beliefs.

To assess the impact of beliefs on long-run economic development, we can compare technological progress in an environment that supports demotivating beliefs to technological progress under the degenerate set of beliefs Θ^0 .

Proposition 3. *Demotivating Beliefs Undermine Technological Progress.* Suppose $\underline{A} < \delta$.⁴ For any environment Θ that supports demotivating beliefs, the set of conditions from which there is perpetual growth is a strict subset of the set of conditions from which there is perpetual growth under the degenerate (non-demotivating) set of beliefs Θ^0 :

$$\Omega(\Theta) \subsetneq \Omega(\Theta^0).$$

That is, removing demotivating beliefs expands the set of conditions that lead to perpetual growth. In this sense, demotivating belief systems can be viewed as a kludge (Ely, 2011). While they reduce wasteful zero-sum competition, they also create productive inefficiencies that can trap the economy in a low-technology state.

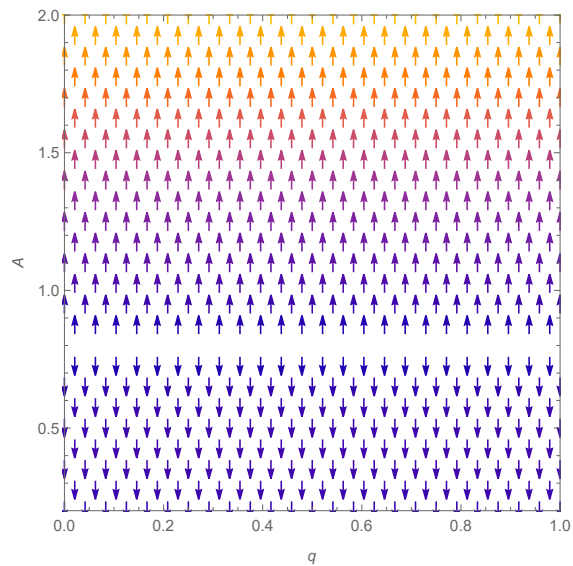
To illustrate visually, consider the binary case $\Theta = \{0, \theta\}$. Let q be the population share of the demotivating belief θ and let the cultural dynamic dq/dt be the replicator dynamic. Vector plots are presented in Figure 2. Panel (a) depicts the case of the degenerate belief system Θ^0 , i.e., with $\theta = 0$. In this case, we know the development barrier is $D^*(q, \Theta^0) = \delta$ for all $q \in [0, 1]$. An increase in the intensity of the demotivating belief θ in panels (b)-(d) shifts the development barrier up and to the right. Thus, it is harder for the economy to escape low levels of development in an environment that supports the demotivating belief.

E. Alternative Formulation: Leader-directed beliefs

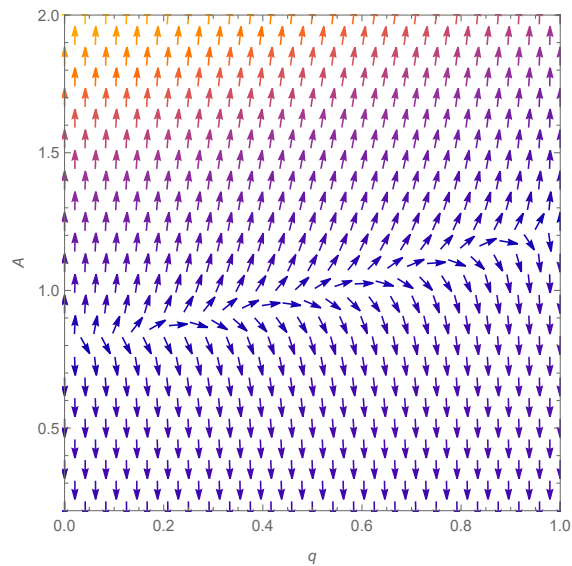
Rather than the distribution of demotivating beliefs being determined by cultural evolution in a bottom-up manner, it could be directed by a community leader or institution. We examine this alternative formulation of our model in Appendix B.

In particular, suppose the set of beliefs is binary, $\Theta = \{\theta_1, \theta_2\}$. Let $\theta_1 = 0$, i.e., the true belief, and $\theta_2 = \theta(t)$, which could be a demotivating belief. We assume a community leader or institution tunes $\theta(t)$ over time to maximize the spread of the demotivating belief.

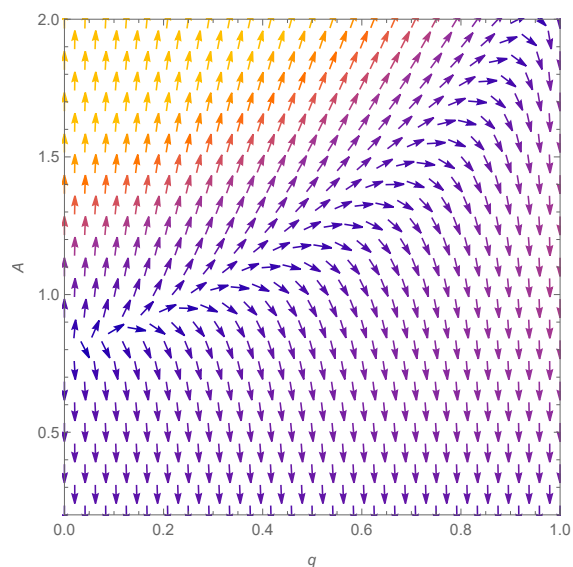
⁴Note that $\underline{A} > \delta$ is a trivial case, in which there is perpetual technological progress from every initial condition regardless of θ .



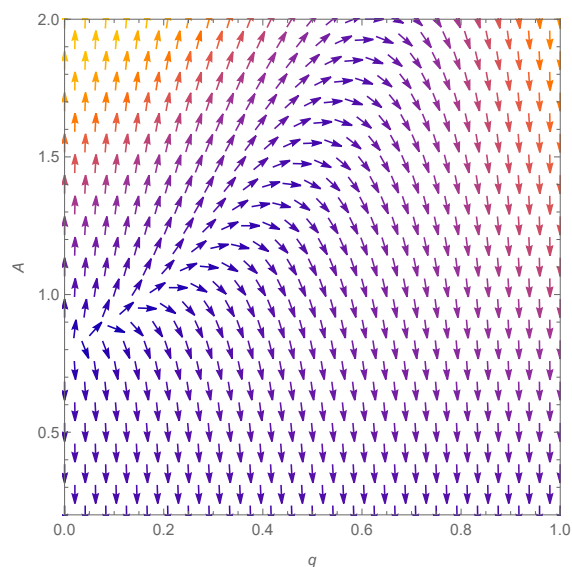
(a) $\theta = 0$



(b) $\theta = 0.2$



(c) $\theta = 0.4$



(d) $\theta = 0.8$

Figure 1: Vector plot of (q, A) under belief set $\Theta = \{0, \theta\}$, where q is the population share of the demotivating belief θ . Parameter values: $\alpha = 0.9$, $\sigma = 0.75$, $\delta = 0.8$, $\underline{A} = 0.2$.

When it comes to shaping perceptions of returns to effort or anti-materialistic preferences, one can think of a political or religious leader setting the intensity of beliefs $\theta(t)$ (e.g., Verdier and Zenou, 2018, Carvalho and Sacks, 2021). When considering supernatural beliefs such as the evil eye and witchcraft beliefs, the relevant leaders are chiefs, shamans, and witchdoctors.

Remarkably, we find that the demotivating belief chosen by the leader each period is $\theta^* = \sigma\alpha$, precisely the belief intensity selected by cultural evolution. In addition, as with cultural evolution, the demotivating belief spreads from all interior initial states and achieves fixation. Once again, we find that a population in which interactions are more zero sum (larger α) will have more intense demotivating beliefs on average.

4. Testing Foster in the Developing World: Evidence from the DRC

We now examine the primary predictions that arise from our theory. Proposition 2 highlights the link between a zero-sum environment and the presence of demotivating beliefs, such as jealousy and witchcraft, which were the focus of Foster’s original studies. Proposition 3 identifies the link between demotivating beliefs and innovation.

A. Data

Our empirical analysis studies two samples taken from the city of Kananga in the Democratic Republic of the Congo (DRC). The city is the capital of the Kasai-Central province and is situated at the center of the Kasai region.⁵ The first sample is from 2015 and has a sample size of approximately 200 individuals. The second sample is from 2019 and has a sample size of over 1,000 individuals. While the first sample is smaller, the set of questions is more extensive. In addition, for this sample, we were also able to implement the implicit association test (IAT) and experimental measures that can help to verify and cross validate the survey measures used in both samples.

For the 200-person sample, the data were collected from June to September of 2015. Sampling occurred in several steps. First, we conducted a screening survey in 85 neighborhoods across the city of Kananga: 60 of these neighborhoods were randomly sampled, and the remainder were intentionally sampled because they were thought to contain ethnic minorities (of interest chiefly for a different project). The randomly selected neighborhoods were chosen with probabilities proportional to their estimated populations (without replacement). In each randomly selected neighborhood, enumerators sampled 33 households by walking along each street and counting houses according to a neighborhood-specific skip pattern. GIS coordinates confirm that houses are spread homogeneously throughout neighborhoods. In non-randomly selected neighborhoods, enumerators similarly sampled households by following a skip

⁵The city, formerly known as Luluabourg, was created by colonial administrators in 1884 and, therefore, consists primarily of migrants from surrounding areas.

pattern. In total, enumerators conducted 2,496 screening surveys, of which 1,964 came from the 60 randomly chosen neighborhoods (“random sample”) and the remaining 532 came from the non-randomly chosen neighborhoods (“targeted sample”).

From this screening survey sample, we then selected the sub-sample for this project. We first excluded three types of individuals: (1) those who had participated in a previous study, (2) those who were planning to travel during the study period, and (3) ethnic groups with fewer than 10 individuals in the random screening survey sample. We then randomly sampled up to 18 individuals per remaining ethnic group. We always prioritized the random sample, but if we did not reach 18 for a particular ethnic group, we supplemented the respondents from the random sample with those from the targeted sample. Finally, we also chose an additional 34 individuals with high-paying jobs, that is we chose all lawyers, shopkeepers, NGO workers, government personnel, and diamond miners. The final sample includes 227 individuals, 193 of whom were from the random sample and 34 of whom were from the targeted sample.

Each respondent was invited to participate in a set of activities that would occur at their home and a separate set of activities that would occur in a lab we set up in downtown Kananga. Concerning the home activities, individuals received three visits from enumerators. During the first visit, they conducted a 90-minute survey from which most of the outcomes discussed in this paper are based. They also conducted an implicit association test (IAT) about animals. In the second home visit, participants played several iterations of the dictator game, an IAT about religion, and a short survey module about inequality. In the third home visit, they played the money burning/creating game, they completed an IAT about wealth and business, and they completed a short survey module evaluating the success of various people in Kananga. Of the 227 individuals we selected to participate, 224 completed the first home visit; 221 completed the second visit; and 213 completed the third visit.

In the lab visits, participants began with an activity that created different endowments across individuals as a function of skill (a French test) or by luck (a game of chance). Each participant was invited to the lab twice, and the endowment-creation activity varied across these two visits. Subsequently, participants played versions of the dictator game and the money burning/creation game. Finally, they played one of two tablet games: either the card game or the drawing game. Of the total participants, 172 visited the lab twice, and 26 visited the lab only once.

For the 1,000-person sample, the data were collected between June and September of 2019. As there is no census available for the DRC, we created a sampling frame for Kananga using Google satellite imagery from 2016. We divided Kananga into 363 polygons and estimated the number of households in each polygon. We selected polygons to visit using two-stage clustered sampling. The probability of selecting a particular polygon was proportional to its estimated population. The sampling of respondents inside a selected polygon occurred in two steps. First, enumerators conducted a short screening survey

of 15 surveys per neighborhood for a total of 3,372 respondents in 225 polygons.⁶ Second, we selected 1,1019 respondents to receive a second visit, during which the main survey module was implemented. Respondents were selected to receive the second visit if their village of origin was in one of the five provinces of the Kasai region and if their self-reported ethnicity was one of the four main ethnicities in their province of origin.⁷

Central to our analysis is measuring the extent to which the world faced by an individual is zero sum, which is α in the model. We proxy for this by an individual's self-reported perception of the world they face. We measure this using survey questions that provide respondents with two contrasting statements, which we call statement 1 and 2. Respondents are then asked which they agree with, choosing one of the following options: 'agree strongly with statement 1', 'agree with statement 1', 'agree with statement 2', 'agree strongly with statement 2'.

The six statement pairs are as follows.

- Statement 1: Gaining happiness requires taking it away from others.
Statement 2: It is possible for everyone to be happy.
- Statement 1: A person can only gain power by taking it away from others.
Statement 2: A person can gain power without taking it away from others.
- Statement 1: In trade, if one party gains the other party loses.
Statement 2: In trade, it is possible for both parties to gain at the same time.
- Statement 1: If one person in a village gets very wealthy, other people in the village will become poorer.
Statement 2: If one person in a village gets very wealthy, other people in the village will not necessarily become poorer.
- Statement 1: In Kananga, people only make money when others lose money.
Statement 2: In Kananga, no one need lose money for others to make money.
- Statement 1: In Kananga, businesses only make money when others lose money.
Statement 2: In Kananga, no one need lose money for businesses to make money.

⁶The total number of screening survey is not equal to 3,375 because in fifteen polygons 1–4 too many respondents were surveyed by mistake, in five polygons 1–2 respondents were not surveyed by mistake and in one polygon the enumerator did not manage to find 15 respondents to work with and only implemented 9 surveys.

⁷The five provinces of the Kasai region are Kasai Central, Kasai, Kasai Oriental, Sankuru and Lomami. The main ethnicities in the Kasai Central province are Luluwa, Luntu, Bindi and Kete; in the Kasai province, they are Luluwa, Kete, Kuba, Lele and in the Kasai Oriental; and in both Sankuru and Lomami provinces the main ethnicities are Luba, Tetela, Songe.

For each survey question, we create a variable that take on an integer values from 1–4 and is increasing in how zero-sum the choice of the respondent is. We then use principal components analysis to distill an index of a zero-sum mentality, which is based on the first principal component of the factor analysis. In the 200-person sample, the first principal component loads positively on all six variables with the following coefficients (respectively): 0.45, 0.47, 0.34, 0.28, 0.49, 0.38. In the 1,000-person sample, the first principal component loads positively on all four variables with the following coefficients (respectively): 0.34, 0.36, 0.41, 0.38, 0.47, 0.47.

B. Findings

We begin the analysis by first examining the relationship between zero sum and an individual’s beliefs in witchcraft and Christianity. We do this by estimating the following equation:

$$y_i = \alpha_{e(i)} + \beta \text{Zero Sum}_i + \mathbf{X}_i \boldsymbol{\Omega} + \epsilon_i \quad (10)$$

where i indexes individuals, e indexes ethnic groups. The dependent variable y_i captures one of our outcomes of interest, either indigenous religious beliefs or jealousy. The vector \mathbf{X}_i includes demographic controls for age, age squared, a gender indicator and its interaction with age.

While we do not have a measure of the extent to which individuals face a zero sum environment – α in the model – we do have our measure of the extent to which they view the world in zero-sum terms. This is our independent variable of interest. We expect a more zero sum view to be associated with stronger beliefs in jealousy and witchcraft.

Estimates of equation (10) are reported in Tables 1 and 2. We begin by looking at jealousy as an outcome of interest. In column 1, we control for age, age squared, gender, and gender interacted with age and age squared. In column 2, we also control for ethnicity fixed effects. We find a strong positive relationship between the two in both samples.

In columns 3 and 4, we look at the intensity of witchcraft beliefs as an outcome. These are measured as the first principal component of four questions that ask about strength of belief in traditional religion, frequency of prayer to ancestors, frequency of participation in rituals, and how close they feel to non-Christians who live in Kananga. The exact wording of the questions is provided in Appendix C. We also find a positive relationship between zero-sum thinking and witchcraft beliefs in both samples. Within the context of the model, our interpretation of these relationships is that they are showing that α results in demotivating beliefs θ . Individuals who view the world as more zero sum also experience jealousy more strongly and are more likely to believe in witchcraft.

In the DRC, as is the case for the rest of Africa in general, and also for much of the world outside of Africa, there has been a rapid rise in Christianity. Interestingly, this wave of religious adoption has occurred, to a large extent, following own research. Christianity provides a striking contrast to indigenous

Table 1: Zero sum, jealousy, and witchcraft in the DRC: 200 person sample

	Principal-Component Based Measures of Strength of Beliefs							
	Self Reported Jealousy Of Others		Witchcraft		Christianity		Difference btw Witchcraft & Christianity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Zero Sum	0.328*** (0.070)	0.325*** (0.078)	0.204*** (0.044)	0.174*** (0.046)	-0.149** (0.063)	-0.146** (0.067)	0.128*** (0.030)	0.115*** (0.031)
Gender, age, age squared	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity FEs	No	Yes	No	Yes	No	Yes	No	Yes
Observations	204	204	197	197	197	197	193	193
R squared	0.112	0.205	0.059	0.127	0.027	0.110	0.059	0.133

Table 2: Zero sum, jealousy, and witchcraft in the DRC: 1,000 person sample

	Principal-Component Based Measures of Strength of Beliefs							
	Self Reported Jealousy Of Others		Witchcraft		Christianity		Difference btw Witchcraft & Christianity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Zero Sum	0.191*** (0.031)	0.188*** (0.031)	0.059** (0.029)	0.059** (0.029)	-0.108** (0.041)	-0.110** (0.041)	0.062** (0.028)	0.062** (0.028)
Gender, age, age squared	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity FEs	No	Yes	No	Yes	No	Yes	No	Yes
Observations	985	985	985	985	985	985	985	985
R squared	0.043	0.046	0.009	0.013	0.013	0.016	0.014	0.017

witchcraft beliefs. Compared to witchcraft, which tends to view any benefits as coming at the expense of others, Christianity teaches that everyone can receive blessings from God (they are not zero sum) and also that God rewards hard work and economic ambition. These beliefs are particularly strong from Pentecostal denominations which had spread rapidly in the past decades in the DRC and across the African continent in general.

Motivated by this, we also examine the relationship between zero-sum thinking and one's own belief in Christianity. This is measured using four questions that ask about the strength of one's belief in the Christian God, frequency of prayer, frequency of attending church, and how close you feel to non-Christians who live in Kananga. Thus, the questions, and the variable construction, mimic the questions asked about indigenous spiritual (i.e., witchcraft) beliefs. The exact wording of the questions is provided in Appendix C. The estimates are reported in columns 5 and 6. We find that a zero sum view is negatively associated with a belief in Christianity. Again this is true in both samples.

Given the divergent relationships between zero-sum thinking and witchcraft versus Christianity, we next create a measure that is the difference in the respondent's beliefs in witchcraft relative to Christianity. As reported in columns 7 and 8, zero-sum thinking is highly predictive of the difference in these beliefs.

5. Testing Foster Globally: Evidence from the WVS

We now provide evidence that is consistent with our theoretical predictions, especially the connection between zero-sum economic environments and demotivating beliefs.

A. Data

We measure zero sum thinking using a question from the World Values Survey (WVS). Respondents are given two opposing statements, one that is zero sum and the other positive sum. The zero sum statement is: "People can only get rich at the expense of others." The positive sum statement is: "Wealth can grow so there's enough for everyone." The respondents are asked to report their view on a ten point scale, which lies between the two extremes. We measure the variable so that it is increasing in how zero sum the view is. For ease of interpretation, we also normalize it to lie between zero and one.

The distribution of the zero sum measure is shown in Figure 2. The figure shows the distribution of respondent answers for each of the four waves of the WVS, and for the aggregate sample. As shown, there is a fair amount of dispersion in the answers provided. The most common answer is for individuals to agree fully that "Wealth can grow so there's enough for everyone." The next most common is the intermediate position between the two statements. Beyond this, all other points on the ten point scale are fairly common and there's a substantial proportion of individuals who agree fully with the statement

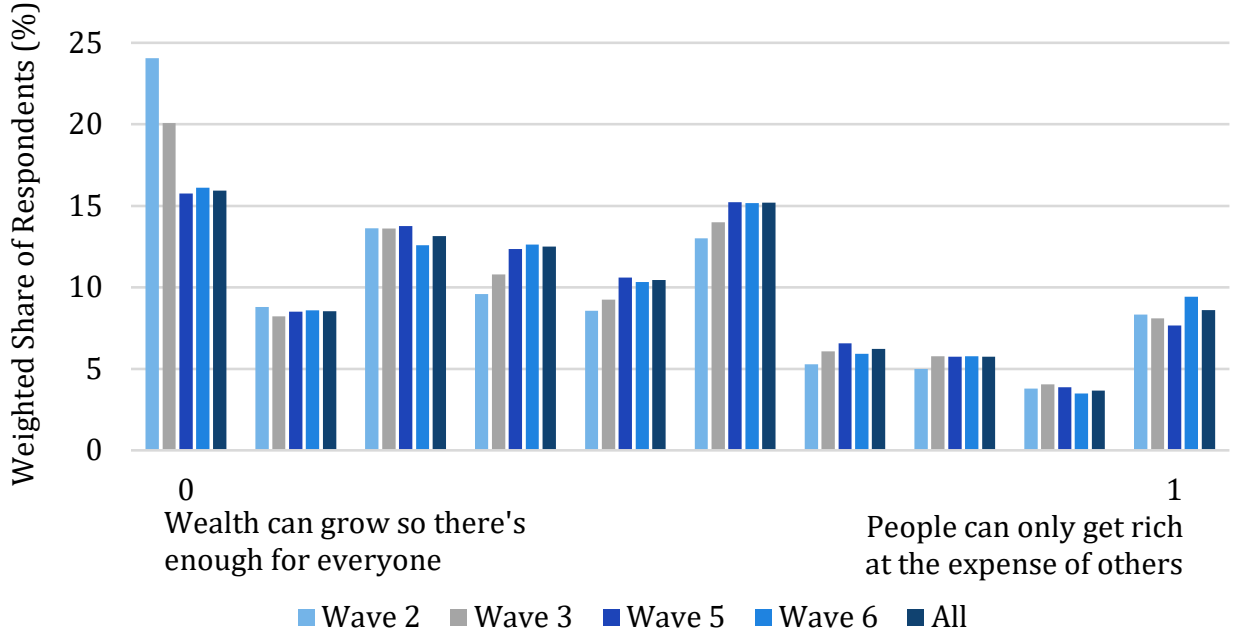


Figure 2: Distribution of the zero sum measure across waves of the WVS.

“People can only get rich at the expense of others.” In short, there appears to be a rich amount of variation in the extent to which individuals view wealth as zero sum.

B. Validating zero-sum thinking as a reflection of a zero-sum environment

We now test one of the basic premises of the model that a zero-sum worldview is associated with properties of the economic environment, especially low development, i.e., low rates of past economic growth. We estimate the following equation:

$$\text{Zero Sum}_{i,c,t} = \alpha_c + \alpha_t + \beta \text{Growth}_{c,t} + \mathbf{X}_{i,c,t}\boldsymbol{\Gamma} + \varepsilon_{i,c,t} \quad (11)$$

where i indexes individuals, c indexes countries, and t indexes person i 's year of birth. The variable $\text{Growth}_{c,t}$ is the average annual growth rate of economic growth during the first 20 or 30 years of person i 's life given that they are from country c and were born in year t . According to the theory, we should obtain a negative estimate of β : weaker economic growth early in one's life should be associated with a more zero-sum view of the world in adulthood.

The vector $\mathbf{X}_{i,c,t}$ includes the following controls: individual i 's age, age squared, an indicator for their gender, and this interacted with both age and age squared. In less-parsimonious specifications, we also include education fixed effects, income fixed effects, and employment fixed effects. All estimates are clustered at the country level.

Table 3: Zero Sum Thinking and Economic Growth: Baseline Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Scale ranging from zero to one with one corresponding to zero-sum beliefs								
GDP 20 year growth (constant \$)	-0.383*** (0.106)	-0.379*** (0.103)						
GDP 30 year growth (constant \$)			-0.538** (0.241)	-0.615** (0.242)				
GDP per capita 20 year growth (constant \$)					-0.429*** (0.105)	-0.421*** (0.101)		
GDP per capita 30 year growth (constant \$)							-0.611** (0.235)	-0.696*** (0.233)
Age, age ² , gender, age*gender, age ² *gender controls	Y	Y	Y	Y	Y	Y	Y	Y
Education and income controls	N	Y	N	Y	N	Y	N	Y
Wave-country FE	Y	Y	Y	Y	Y	Y	Y	Y
Birth-year FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	102,234	87,710	95,368	81,219	102,175	87,653	95,368	81,219
Number of clusters/countries	74	74	70	70	74	74	70	70
Mean dependent variable	0.406	0.403	0.406	0.403	0.406	0.403	0.406	0.403
Std. dev. dependent variable	0.305	0.303	0.305	0.303	0.305	0.303	0.305	0.303
Mean independent variable	0.038	0.038	0.038	0.038	0.020	0.020	0.021	0.021
Std. dev. independent variable	0.022	0.022	0.019	0.019	0.021	0.022	0.018	0.019

Notes: The table reports OLS estimates in columns 1 and 2 and ordered logit estimates in columns 3 and 4. An observation is an individual, weighted to make the sample nationally representative. All specifications include wave-country and birth-year fixed effects. The dependent variable is a scale variable ranging from zero to one with one representing "People can only get rich at the expense of others" and zero representing "Wealth can grow so there's enough for everyone." GDP growth rates are estimated as GDP growth for the first 20 or 30 years of a respondent's life. Education and income are categorical variables. Income identifies an individual's household income decile (self-identified). Education is the highest education completed (e.g., secondary). Coefficients are reported with standard errors clustered at the country-level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Estimates of equation (12) are reported in Table 3. The odd numbered columns report estimates with only the age and gender controls, while the even numbered columns also add fixed effects for contemporaneous education, income, and employment status. Columns 1–4 use total real GDP growth rates, while columns 5–8 use per capita real GDP growth rates.

We find a consistent negative relationship between the economic conditions an individual faces in the first 20 or 30 years of their life and the extent to which they view the world as zero sum today. Consistent with expectations, worse economic conditions are associated with a more zero sum view in adulthood. The estimated relationships appear strong and are highly significant. This can also be seen in the partial correlation plot shown in Figure 3, which is for the specification reported in column 5.

If early economic conditions are associated with later economic conditions, then we'd expect that such a relationship could arise because the world is in fact more zero sum today. However, we find that even conditioning on current education, income, and employment status, each measured finely and estimated flexibly, we continue to find a relationship between early life economic conditions and a zero sum view of the world in adulthood. In addition, as reported in Table 4, the magnitude of the estimated effect is very similar with or without the additional controls and if we account for fixed effects for finely defined subnational districts (and wave), we obtain estimated effects that are very similar. The fixed effects should,

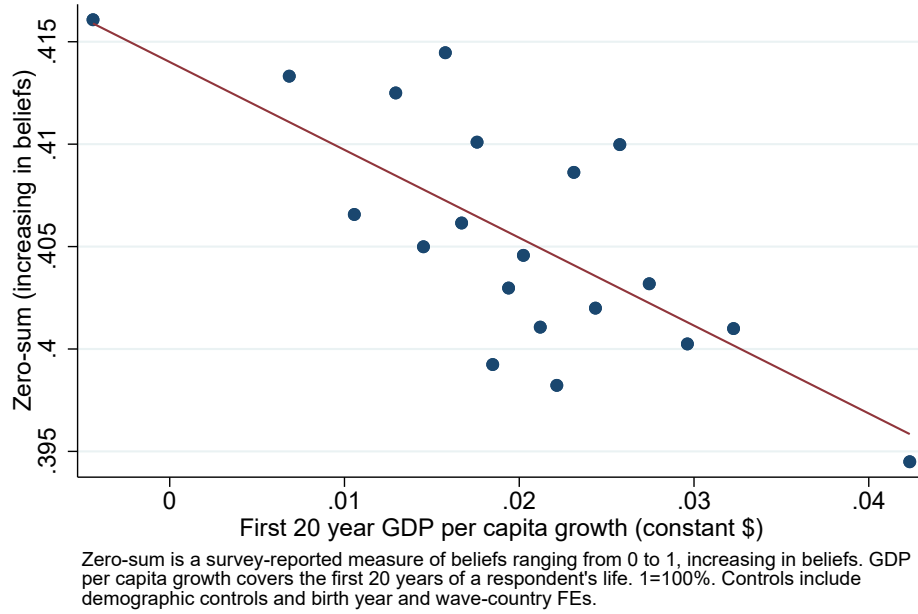


Figure 3: Binscatter partial correlation plot. Column 5 of Table 3.

to a large extent, capture the external setting of respondents, including how zero-sum their environment was at the time they were completing the survey.

C. Zero-sum thinking and religious beliefs

While the WVS has no information on jealousy and limited data on traditional beliefs, we do have information on religious beliefs with traditional religions being one category. When examining the DRC, consistent with the arguments of George Foster, we found that individuals who held stronger traditional beliefs tended to be more zero sum and those who held stronger Christian beliefs tended to be less zero sum.

We now test the generality of this finding using information from the WVS on the religious beliefs of the respondents.

$$\text{ZeroSum}_{i,c,v} = \alpha_{c,v} + \beta^r I_{i,c,v}^r + \mathbf{X}_{i,c,v} \boldsymbol{\Gamma} + \varepsilon_{i,c,v} \quad (12)$$

where i indexes individuals, c indexes countries, and v survey waves. The indicators $I_{i,c,v}^r$ equal one if individual i reports belonging to religion t . The omitted category is for no religious belief. We expect the coefficient, β^r to be larger for Christianity and other moralizing high god religions that are also less-zero sum in nature, such as Islam or Hinduism, relative to traditional/indigenous religions, which are more zero sum in nature.

The estimates are reported in Table 5. All specifications include country by survey wave fixed effects. In column 2, we also include our set of demographic covariates, and column 3 include fixed effects for the respondent's income and education. While potentially endogenous to religion, they also may affect both

Table 4: Zero Sum Thinking and Economic Growth: Conditioning on Subnational District FEs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Scale ranging from zero to one with one corresponding to zero-sum beliefs							
GDP 20 year growth (constant \$)	-0.345*** (0.095)	-0.322*** (0.088)						
GDP 30 year growth (constant \$)			-0.490** (0.227)	-0.523** (0.224)				
GDP per capita 20 year growth (constant \$)					-0.387*** (0.096)	-0.354*** (0.089)		
GDP per capita 30 year growth (constant \$)							-0.563** (0.222)	-0.592*** (0.217)
Age, age ² , gender, age*gender, age ² *gender controls	Y	Y	Y	Y	Y	Y	Y	Y
Education and income controls	N	Y	N	Y	N	Y	N	Y
Wave-region FE	Y	Y	Y	Y	Y	Y	Y	Y
Birth-year FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	99,173	85,255	92,530	78,979	99,116	85,199	92,530	78,979
Number of clusters/countries	73	69	73	69	73	69	73	69
Mean dependent variable	0.405	0.402	0.405	0.403	0.405	0.403	0.405	0.403
Std. dev. dependent variable	0.306	0.303	0.306	0.304	0.305	0.303	0.306	0.304
Mean independent variable	0.038	0.038	0.038	0.038	0.019	0.019	0.021	0.021
Std. dev. independent variable	0.021	0.022	0.019	0.019	0.021	0.022	0.018	0.019

Notes: The table reports OLS estimates in columns 1 and 2 and ordered logit estimates in columns 3 and 4. An observation is an individual, weighted to make the sample nationally representative. All specifications include wave-region and birth-year fixed effects. The dependent variable is a scale variable ranging from zero to one with one representing "People can only get rich at the expense of others" and zero representing "Wealth can grow so there's enough for everyone." GDP growth rates are estimated as GDP growth for the first 20 or 30 years of a respondent's life. Education and income are categorical variables. Income identifies an individual's household income decile (self-identified). Education is the highest education completed (e.g., secondary). Coefficients are reported with standard errors clustered at the country-level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

zero sum thinking and one's religious beliefs. The results indicate that the findings from the DRC are also present in the global sample (and are similar across the three specifications). Relative to individuals who do not believe in a religion, we see that Christians tend to hold beliefs that are less zero sum. The same is also true for the other big god religions; namely, Islam and Hinduism, as well as Buddhism/Confucianism. We find that Indigenous beliefs, which would contain beliefs that the West would call 'witchcraft,' do not exhibit lower zero-sum thinking and actually tend to hold slightly higher zero sum beliefs, although this is not statistically significant. Interestingly, we see no effect for Jewish beliefs. The estimate for the 'other' category, which primarily comprises unspecified religions, but also Jains, Sikhs, Zoroastrians, etc, is negative and statistically significant. A breakdown of the religions within the 'other' category is provided in Appendix Table A1.

Thus, consistent with our findings from the DRC, we see that traditional smaller-scale religious beliefs, like witchcraft, tend to be associated with more zero-sum thinking while big god religions, like Christianity, are associated with less zero-sum thinking. This provides some indication that the mechanisms highlighted by Foster may be more general. In addition, because of the prevalence of big god religions in the developed world, his theory may also be as applicable to those living in industrialized nations today not just those living in small scale societies in the past.

Table 5: Religion and Zero Sum Thinking in the WVS

	(1)	(2)	(3)
	Dependent variable:		
	Scale ranging from zero to one with one corresponding to zero-sum beliefs		
Christian	-0.020*** (0.005)	-0.017*** (0.005)	-0.019*** (0.006)
Muslim	-0.017* (0.009)	-0.016* (0.009)	-0.018** (0.009)
Hindu	-0.030*** (0.010)	-0.028*** (0.010)	-0.031*** (0.008)
Buddhism/Confucianism	-0.032*** (0.010)	-0.030*** (0.010)	-0.035*** (0.011)
Jewish	0.002 (0.015)	0.003 (0.016)	0.004 (0.023)
Native	0.030 (0.020)	0.032 (0.020)	0.015 (0.013)
Other	-0.032*** (0.010)	-0.031*** (0.010)	-0.035*** (0.010)
Income			-0.044*** (0.008)
Education			-0.013** (0.006)
Age, age ² , gender, age*gender, age ² *gender controls	N	Y	Y
Wave-country FE	Y	Y	Y
Number of clusters/countries	74	74	72
Observations	157,089	156,636	121,849
Mean dependent variable	0.402	0.402	0.398
Std. dev. dependent variable	0.309	0.309	0.307

Notes: The table reports OLS estimates in columns 1, 2 and 3. An observation is an individual, weighted to make the sample nationally representative. All specifications include wave-country fixed effects. The dependent variable is a scale variable ranging from zero to one with one representing "People can only get rich at the expense of others" and zero representing "Wealth can grow so there's enough for everyone." Education and income are categorical variables. Income identifies an individual's household income decile (self-identified). Education is the highest education completed (e.g., secondary). Coefficients are reported with standard errors clustered at the country-level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.).

As noted, when thinking about the contemporary setting, the most-relevant consequence of zero-sum thinking may be demotivating beliefs, which reduce industriousness and effort. We now turn to an explicit examining of this using the WVS data.

D. Zero-sum thinking and demotivating beliefs

Our analysis is guide by the model’s predicted associations between an individual’s zero sum view, the presence of demotivating beliefs, and measures of economic effort such as income and education. The model predicts that a zero sum view of the world is associated with demotivating beliefs that serve to reduce effort. In different countries, the specifics of these beliefs will be different. In some countries, they may take the form of beliefs in witchcraft or the evil eye. In others, they may take the form of norms of sharing and a dislike for greed and individual accumulation. In others, it may take the form of a belief that hard work does not result in success.

To examine this we estimate the following equation:

$$Y_{i,c,t} = \alpha_{c,t} + \beta \text{Zero Sum}_{i,c,t} + \mathbf{X}_{i,c,t}\mathbf{\Gamma} + \varepsilon_{i,c,t} \quad (13)$$

where i indexes individuals, c country of residence, and t the year of the survey. $\text{Zero Sum}_{i,c,t}$ is our measure of zero sum for individual i . $\alpha_{c,t}$ denote country and survey year fixed effects. $Y_{i,c,t}$ denotes a measure of the extent to which person i holds a particular demotivating belief.

We begin by first considering the belief of whether or not hard work brings success. Respondents report their answer on a 1 to 10 integer scale. We reorder and normalize the variable such that zero equals full agreement with “hard work doesn’t generally bring success” and one equals full agreement with “in the long run, hard work usually brings a better life.” (The exact wording of this and all other WVS questions from the analysis is provided in Appendix C.)

The estimates, which are reported in column 1 of Table 6 show that a zero sum belief is associated with less of a belief that hard work bringing success. Within the context of the model, we interpret this as showing that a more zero sum environment α (as reflected by a perception of the world as being more zero sum) is positively associated with demotivating beliefs θ .

We next look at two closely-related measures that capture respondents’ views of whether people’s effort can keep them from poverty. The first variable captures the respondents view about whether the poor can escape poverty through effort. This is based on the question: “In your opinion, do most poor people in this country have a chance of escaping from poverty, or is there very little of chance escaping?” We create a variable that takes on the value of zero if the respondent chooses the answer “There is very little chance” and one if they choose “They have a chance” equal to one. The second measure, similar to the first, captures the extent to which the respondent feels that the poor are poor because of a lack of effort. The original survey question is: “Why, in your opinion, are there people in this country who live in need?” We create a

Table 6: Zero Sum and Demotivating Values/Beliefs

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable:					
	Hard work brings success, 0 = disagreement to 1 = agreement	People are poor because of laziness, 0 = disagreement to 1 = agreement	People have a chance to escape poverty, 0 = disagreement to 1 = agreement	Humiliating to receive money without working for it, 0 = disagreement to 1 = agreement	Important to me to be successful, 0 = disagreement to 1 = agreement	How important is work: 0 = not at all to 1 = very important
Zero-sum beliefs, 0-1	-0.113*** (0.015)	-0.074*** (0.013)	-0.120*** (0.015)	-0.021** (0.010)	-0.025*** (0.005)	-0.032*** (0.004)
Demographic controls	Y	Y	Y	Y	Y	Y
Wave-country FE	Y	Y	Y	Y	Y	Y
Observations	246,408	55,871	59,052	60,856	151,270	242,255
Number of clusters/countries	92	50	49	47	78	92
Mean dependent variable	0.637	0.302	0.397	0.648	0.609	0.840
Std. dev. dependent variable	0.320	0.459	0.489	0.296	0.290	0.247
Mean independent variable	0.406	0.393	0.395	0.406	0.417	0.408
Std. dev. independent variable	0.309	0.317	0.315	0.297	0.304	0.309

Notes: The table reports OLS estimates. An observation is an individual, weighted to make the sample nationally representative. Specifications either include wave-country fixed effects or year-country fixed effects depending on whether the sample includes multiple waves. The independent variable is a scale variable ranging from zero to one with one representing "People can only get rich at the expense of others" and zero representing "Wealth can grow so there's enough for everyone." The dependent variables are categorical variables appearing as column heads. Demographic controls include age, age squared, gender, and their interactions. Coefficients are reported with standard errors clustered at the country-level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

variable that takes on the value of 0 if they chose the answer: "Poor because of an unfair society," and the value of one if they choose the answer "Poor because of laziness and lack of will power." Respondents can also choose "Other answer," which we code as a missing value. Thus, both questions measure the belief that effort and hard work (or lack thereof) is responsible for relative wealth differences. The estimates with these two measures as the outcomes are reported in columns 2 and 3. We find that if an individual has a more zero sum view of the world, then they have a weaker belief in the effect that hard work / laziness has on economic success.

We next consider three additional measures of demotivating beliefs. The first is the extent to which people get disutility from asking others for money. In a setting where it is shameful to be helped by others, individuals will be more motivated to exert effort to ensure that they can provide for themselves. The survey question asks respondents if they agree with the statement "It is humiliating to receive money without having to work for it?" Respondents can choose strongly agree, agree, neither, disagree, or strongly disagree. We normalize the measure to lie between zero and one and be increasing in the agreement with the statement. The estimates, which are reported in column 4, show that a more zero sum view of the world is associated with individuals feeling less humiliation when they receive money from others.

The last two questions measure individuals self-reported importance of success and work. The first question asks the respondent whether they agree that it is important to be "very successful...to have people recognize one's achievement". The second question asks the respondent how important work is to them. Respondents choose responses ranging from not at all important to very important. Both measures are coded to be increasing in the importance of work. The first is an indicator variable and the second ranges from 0 to 1. The estimates, reported in columns 5 and 6, show that individuals with a more zero-sum world view place less importance in their being successful and also in their work. In all the estimates suggest that zero-sum thinking is associated with beliefs that demotivate and lead to less

Table 7: Zero Sum Thinking and Economic Wellbeing

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable:					
	Educational attainment, 0 =					
	Income decile, 0 = bottom decile to 1 = top decile	Family savings, 0=borrowed to 1=saved	primary school or less to 1 = university or more	Cognitive vs. manual work tasks, 0>manual to 1=cognitive	Supervising someone at work, 0=no to 1=yes	Class, 0 = lower class to 1 = upper class
Zero-sum beliefs, 0-1	-0.038*** (0.005)	-0.033*** (0.005)	-0.030*** (0.005)	-0.049*** (0.007)	-0.044*** (0.008)	-0.045*** (0.005)
Demographic controls	Y	Y	Y	Y	Y	Y
Wave-country FE	Y	Y	Y	Y	Y	Y
Observations	229,719	203,716	219,524	116,885	119,888	207,165
Number of clusters/countries	92	90	91	79	79	90
Mean dependent variable	0.403	0.623	0.513	0.439	0.322	0.416
Std. dev. dependent variable	0.257	0.309	0.336	0.345	0.467	0.245
Mean independent variable	0.405	0.407	0.406	0.416	0.416	0.410
Std. dev. independent variable	0.309	0.308	0.309	0.300	0.302	0.307

Notes: The table reports OLS estimates in columns 1 through 6. An observation is an individual, weighted to make the sample nationally representative. Specifications either include wave-country fixed effects since the sample includes multiple waves. The independent variable is a scale variable ranging from zero to one with one representing "People can only get rich at the expense of others" and zero representing "Wealth can grow so there's enough for everyone." The dependent variables are categorical variables appearing as column heads. Demographic controls include age, age squared, gender, and their interactions. Coefficients are reported with standard errors clustered at the country-level in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

economic effort.

An additional prediction of the model is that more demotivating beliefs held by individuals, θ , should result in less effort and therefore lower incomes. We now turn to an examination of this prediction. We begin by first measuring income using the respondents self-reported income on a 1-10 integer scale that we normalize to range from 0-1. We supplement this question with another that provides a measure of the net savings of the respondent's family. Details of the underlying survey question (and all others in the analysis) are provided in the Appendix. We normalize the variable to lie between 0 and 1 and to be increasing in savings. As reported in columns 1 and 2 of Table 7, individuals with a more zero-sum view of the world, report having lower incomes and, consistent with this, less savings. Thus, consistent with the model, zero-sum is associated with lower material payoffs.

An important form of productivity enhancing effort is education. Consistent with the model's prediction that zero-sum is associated with less effort, as reported in column 3, we find that zero sum thinking is associated with less educational attainment.

We next turn to an examination of aspects of one's career that is affected by education and also important for the income one earns. In column 4, we measure the extent to which the respondent is employed in a cognitively demanding occupation rather than manually intensive occupation. The original question asks respondents to report this aspect of the task of their job on a 1-10 scale. Along similar lines, we also examine whether the respondent supervises someone at their work. We find that individuals with more zero sum thinking are less likely to be employed in cognitively demanding tasks and are less likely to have a supervisory role (columns 4 and 5).

The last outcome we examine is a measure of the socioeconomic class that the respondent reports belonging to, either: (1) Lower class; (2) Working class; (3) Lower middle class; (4) Upper; (5) Upper class. We use integer values reported for each category and normalize the index to lie between 0 and 1. As

reported in column 6, we find that zero sum thinking is associated with a lower self-reported socioeconomic class.

Overall, in the individual-level global WVS data, we find evidence consistent with our theory. Zero-sum thinking is associated with demotivating beliefs, less effort, and less economic success.

6. Conclusions

We have studied the evolution of demotivating belief systems, which can take a wide variety of forms ranging from the belief that success is primarily determined by luck rather than hard work to concerns about adverse consequences of envy from others to witchcraft beliefs that cast suspicion on the origins of one's success. We have examined how these are formed and shaped by the nature of production and how they affect entrepreneurial activity, innovation, and ultimately economic development.

Motivated by the seminal work of George M. Foster and his 'image of limited good', we first formalized the effects of a zero-sum view of the world on demotivating beliefs. Our analysis showed that demotivating beliefs can spread in environments in which the production process and the resulting economic interactions tend to be zero-sum in nature, meaning that the gains from one individual tend to come at the expense of another.

The effects of zero-sum production are very different depending on whether one looks at their static or dynamic consequences. We find that, statically, demotivating beliefs reduce the negative externalities that arise from effort in a zero-sum environment. Dynamically, the belief systems inhibit learning-by-doing and can thereby trap an economy in a low state of low innovation and under development. Thus, the demotivating beliefs that arise from a view of the world as zero sum can be an important cultural barrier to long-run economic development.

Having developed a theoretical understanding of Foster's arguments, we then turn to the data, first examining two samples from the Democratic Republic of the Congo. We find strong and robust evidence that, in both samples, respondents who have a more zero-sum view of the world report more jealousy about the success of others, stronger traditional religious beliefs, and weaker Christian beliefs.

We then turned to a global analysis using data from the World Values Survey. This more diverse sample allowed us to examine whether a more scarce zero-sum environment, in fact, leads to more zero-sum thinking. We found that growing up in an environment of economic scarcity (which is more zero-sum) is associated with more zero-sum thinking in adulthood.

Having provided some verification of the zero sum measure, we then estimated the relationship between zero-sum thinking and a range of demotivating beliefs. We first verified that the same relationship between zero-sum thinking and Christian religious beliefs that we found in the Congolese samples applies to the global WVS sample. We found that a belief in Christianity rather than traditional indigenous

religions is associated with less zero sum thinking and that other big god religions (like Islam, Hinduism, etc) are also associated with less zero sum thinking.

We looked at a broader set of demotivating beliefs, including those that are particularly relevant to the modern industrialized world, such as belief in the inherent value of work, beliefs about the returns to hard work (e.g., whether incomes determined by luck or effort), whether it is important to be successful in life, and whether receiving help from others is humiliating or not. We found a very strong association between zero-sum thinking and all demotivating beliefs examined.

The broader sample also allowed us to test the comparative static of Foster and our theory about equilibrium effort and economic production. Consistent with predictions, we find that at the individual-level zero-sum thinking is associated with higher incomes, more educational attainment, more savings, and higher occupational status.

By providing a formalization of Foster's insights and testing the resulting predictions, we were able to assess the validity of the mechanisms he proposed; namely, of relationships between scarcity, zero-sum thinking, demotivating beliefs, and ultimately economic activity. Our findings suggest that zero-sum thinking is an important factor in understanding the causes and consequences of economic thinking and economic development.

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Online Appendix (Not for Publication)

Appendix A. Mathematical Proofs

Proof of Proposition 1. Under a payoff monotone dynamic for two traits i and j that are present in the population, $\frac{d}{dt} \left[\frac{q_i}{q_j} \right] > 0$ if and only if $F_i(\mathbf{q}, A) > F_j(\mathbf{q}, A)$.

The fitness of trait i is given by (5). Thus,

$$\begin{aligned} F_i(\mathbf{q}, A) &> F_j(\mathbf{q}, A) \\ \iff (1 - \theta_i) \left(1 - \frac{1}{2}(1 - \theta_i) \right) A^2 - \sigma\alpha(1 - \theta_i)A^2 &> (1 - \theta_j) \left(1 - \frac{1}{2}(1 - \theta_j) \right) A^2 - \sigma\alpha(1 - \theta_j)A^2. \end{aligned} \tag{A1}$$

(i) Setting $\theta_j = 0$, (A1) becomes $\theta_i < 2\sigma\alpha$. Since this is independent of the state, part (i) follows immediately.

(ii) If θ_i is chosen to maximize the left-hand side of (A1), then the growth rate of trait i will be higher than any other trait. The unique maximizer is $\theta^* = \sigma\alpha$. Since this is independent of the state, the share of such types will converge monotonically to one as long as $q^*(0) > 0$. \square

Proof of Proposition 2. By Corollary 1, for any interior initial state and Δ sufficiently large, $q_i(k, t)$ converges monotonically to one, where θ_i is approximately $\sigma\alpha^k$. Therefore, $\bar{\theta}(k, t)$ converges to approximately $\sigma\alpha^k$. The result follows immediately. \square

Proof of Proposition 3. By (9), for Θ^0 , i.e., $\theta_i = 0$ for all i , the development barrier is $D^*(\mathbf{q}, \Theta^0) = \delta$. As this is independent of \mathbf{q} ,

$$\Omega(\Theta^0) = \{(\mathbf{q}, A) \in [0, 1] \times \mathbb{R}_+ : A > \delta\}. \tag{A2}$$

More generally, by (9), $\frac{dA}{dt} < 0$ in all states (\mathbf{q}, A) such that $A < D^*(\mathbf{q}, \Theta)$. We have established $D^*(\mathbf{q}, \Theta) \geq D^*(\mathbf{q}, \Theta^0) = \delta$, and strictly so if there exists i such that θ_i and $q_i > 0$.

Hence, as with Θ^0 , if $A(0) < \delta$, then $\frac{dA}{dt}|_{t=0} < 0$. By induction then, $\frac{dA}{dt}|_{t=\tau} < 0$ for all τ until the lower bound \underline{A} is reached.

In addition, we claim that there is perpetual technological regress from an open set of initial conditions $(\mathbf{q}, A(0))$ such that $A(0) > \delta$ for any Θ that supports demotivating beliefs. This would imply $\Omega(\Theta) \subsetneq \Omega(\Theta^0)$.

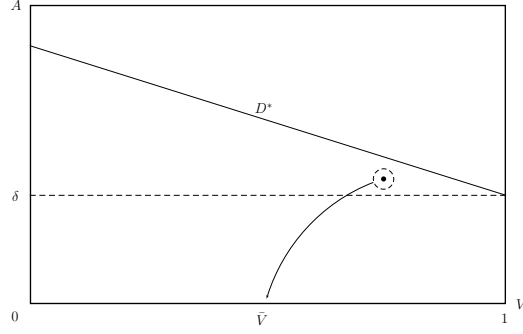


Figure A1: Plot of two-dimensional system (V, A) , where D^* is the development barrier, δ is the technology depreciation rate, and \bar{V} is the value of V under the limiting distribution of beliefs $\lim_{t \rightarrow \infty} q(t)$.

To establish the claim, plot the development barrier D^* as a function of $V \equiv \sum_{i=1}^n q_i(1 - \theta_i)^2$ as in Figure A1. By (9), D^* is strictly decreasing in V on $[0, 1]$. At $V = 1$, $D^* = \delta$, as in the degenerate set of beliefs. We know from Proposition 1(i) that $\mathbf{q}(t)$ converges to a state in which $\lim_{t \rightarrow \infty} q_i(t) > 0$ for some $\theta_i > 0$ as long as $\theta_i < 2\sigma\alpha$, i.e., in an environment that supports demotivating beliefs. Therefore, $V(t)$ converges to some value denoted by $\bar{V} < 1$ in an environment that supports demotivating beliefs.

Hence for $A(0)$ close to but larger than δ and $V(0)$ close to but less than 1 (as shown in the figure), $\frac{dA}{dt}|_{t=0} < 0$ and $\frac{dV}{dt}|_{t=0} < 0$, and the solution path never crosses the development barrier D^* . As shown in the figure, there exists an open set of such initial states. This establishes the claim and the proposition. \square

Appendix B. Alternative Formulation: Leader-directed beliefs

Suppose the set of beliefs is binary, $\Theta = \{\theta_1, \theta_2\}$. Let $\theta_1 = 0$, i.e., the true belief, and $\theta_2 = \theta(t)$, which could be a demotivating belief. We assume a community leader or institution tunes $\theta(t)$ over time to maximize the spread of the demotivating belief. Given the binary case, we can rewrite $q(t) = q_2(t)$ and refer to it as the share of ‘believers’. We find that the demotivating belief chosen by the leader is the same as the belief selected by cultural evolution in a bottom-up manner.

Proposition B1 Consider a leader who sets $\theta(t)$ to maximize $q(t)$ at each time t .

- (i) The leader chooses belief intensity $\theta^* = \sigma\alpha$ for all t .
- (ii) From every initial state $q(0) > 0$, if $\sigma\alpha > 0$, the share of believers $q(t)$ converges monotonically to one.

Proof. (i) Under a payoff monotone cultural dynamic, maximizing the spread of belief 2 from an interior state is equivalent to maximizing

$$\begin{aligned} F_2(q, A) - F_1(q, A) &= A^2 \left\{ [\sigma + (1 - \sigma)q](1 - \theta) \left(1 - \alpha - \frac{1}{2}(1 - \theta)\right) + (1 - \sigma)(1 - q) \left((1 - \theta) - \frac{1}{2}(1 - \theta)^2 - \alpha\right) \right\} \\ &\quad - A^2 \left\{ [\sigma + (1 - \sigma)(1 - q)] \left(\frac{1}{2} - \alpha\right) + (1 - \sigma)q \left(\frac{1}{2} - \alpha(1 - \theta)\right) \right\} \\ &= A^2 [\theta\sigma\alpha - \frac{1}{2}\theta^2]. \end{aligned} \tag{A3}$$

Hence the maximizer is $\theta^* = \sigma\alpha$.

- (ii) Evaluating $F_2 - F_1 = A^2 [\theta\sigma\alpha - \frac{1}{2}\theta^2]$ at θ^* yields

$$F_2(\theta^*) - F_1(\theta^*) = A^2 [(\sigma\alpha)^2 - \frac{1}{2}(\sigma\alpha)^2] = \frac{1}{2}A^2(\sigma\alpha)^2, \tag{A4}$$

which is positive for $\sigma\alpha > 0$, independently of the state. Hence, in a payoff monotone cultural dynamic, $q(t)$ converges monotonically to one from any initial state $q(0) > 0$. \square

First, the familiar belief $\theta^* = \sigma\alpha$ is independent of the state (q, A) .^{A1} Therefore, θ^* can be set by the leader once and for all at time $t = 0$ without having to be dynamically tuned as (q, A) evolves. Second, only a weak belief system (low θ^*) is optimal when the degree of zero-sumness α is low, because the negative externalities in the system are weak compared to the direct effect

^{A1}Since $A(t)$ is a linear transformation of each player’s payoffs, θ^* does not depend on the state of technology. In addition, θ^* also does not depend on the current population state because the negative externality imposed on player i from j ’s effort is independent of i ’s type.

of demotivating individuals. Third, the design of belief intensity by the leader guarantees the spread and eventual fixation of the demotivating belief system from all interior states, whenever $\sigma\alpha > 0$. All of this mirrors the results of bottom-up cultural evolution.

Appendix C. Data: Sources and Measurement

A. Surveys Conducted in Kananga, DRC

- Age: How old were you at your last birthday?
- Tribe: Bindi, Tshokwe, Kete, Kongo, Kuba, Lele, Luba, Luluwa, Luntu, Sala, Songe, Tetela
- Zero sum 1: Which Statement do you agree with? Statement 1: Gaining happiness requires taking it away from others. Statement 2: It is possible for everyone to be happy. 1 Agree strongly with statement 1; 2 Agree with statement 1; 3 Agree with statement 2; 4 Agree strongly with statement 2; 9999 Agree with neither statement; 8888 Don't want to say
- Zero sum 2: Which Statement do you agree with? Statement 1: A person can only gain power by taking it away from others. Statement 2: A person can gain power without taking it away from others. 1 Agree strongly with statement 1; 2 Agree with statement 1; 3 Agree with statement 2; 4 Agree strongly with statement 2; 9999 Agree with neither statement; 8888 Don't want to say.
- Zero sum 3: Which Statement do you agree with? Statement 1: In trade, if one party gains the other party loses. Statement 2: In trade, it is possible for both parties to gain at the same time. 1 Agree strongly with statement 1; 2 Agree with statement 1; 3 Agree with statement 2; 4 Agree strongly with statement 2; 9999 Agree with neither statement; 8888 Don't want to say.
- Zero sum 4: Which Statement do you agree with? Statement 1: If one person in a village gets very wealthy, other people in the village will become poorer. Statement 2: If one person in a village gets very wealthy, other people in the village will not necessarily become poorer. 1 Agree strongly with statement 1; 2 Agree with statement 1; 3 Agree with statement 2; 4 Agree strongly with statement 2; 9999 Agree with neither statement; 8888 Don't want to say.
- Zero sum 5: Which Statement do you agree with? Statement 1: In Kananga, people only make money when others lose money. Statement 2: In Kananga, no one need lose money for others to make money. 1 Agree strongly with statement 1; 2 Agree with statement 1; 3 Agree with statement 2; 4 Agree strongly with statement 2; 9999 Agree with neither statement; 8888 Don't want to say.

- Zero sum 6: Which Statement do you agree with? Statement 1: In Kananga, businesses only make money when others lose money. Statement 2: In Kananga, no one need lose money for businesses to make money. 1 Agree strongly with statement 1; 2 Agree with statement 1; 3 Agree with statement 2; 4 Agree strongly with statement 2; 9999 Agree with neither statement; 8888 Don't want to say.
- Envy 1: It is so frustrating to see some people succeed so easily. 1 strongly disagree; 2 moderately disagree; 3 slightly disagree; 4 slightly agree; 5 moderately agree; 6 strongly agree
- Envy 2: It somehow doesn't seem fair that some people seem to have all the talents. 1 strongly disagree; 2 moderately disagree; 3 slightly disagree; 4 slightly agree; 5 moderately agree; 6 strongly agree
- Envy 3: Frankly, the success of my neighbors makes me resent them. 1 strongly disagree; 2 moderately disagree; 3 slightly disagree; 4 slightly agree; 5 moderately agree; 6 strongly agree
- Envy 4: I sometimes wish that rich and powerful people lose their advantage. 1 strongly disagree; 2 moderately disagree; 3 slightly disagree; 4 slightly agree; 5 moderately agree; 6 strongly agree
- Witchcraft beliefs 1: What is the strength of your belief in the existence of other gods and spirits, including ancestor spirits? 1 With no strength at all; 2 With a little bit of strength; 3 With strength; 4 With a lot of strength; 5 With all my heart
- Witchcraft beliefs 2: How often do you pray other gods and spirits including ancestor spirits? 1 never; 2 very rarely; 3 a few times per year; 4 a few times per month; 5 a few times per week.
- Witchcraft beliefs 3: How often do you participate in rites devoted to other gods and spirits, including ancestor spirits? 1 never; 2 very rarely; 3 a few times per year; 4 a few times per month; 5 a few times per week.
- Witchcraft beliefs 4: Using the figures provided, which set of figures best represents how close you feel to non Christians in Kananga?

- Christian beliefs 1: What is the strength of your belief in the existence of the Christian God?
1 With no strength at all; 2: With a little bit of strength; 3 With strength; 4 With a lot of strength; 5 With all my heart
- Christian beliefs 2: How often do you pray the Christian God or Jesus? 1 never; 2 very rarely; 3 a few times per year; 4 a few times per month; 5 a few times per week.
- Christian beliefs 3: How often do you attend church? 1 never; 2 very rarely; 3 a few times per year; 4 a few times per month; 5 a few times per week.
- Christian beliefs 4: Using the figures provided, which set of figures best represents how close you feel to Christians in Kananga?

B. World Values Survey

- Income decile: 0 = bottom decile to 1 = top decile [X047_WVS]^{A2} On this card is an income scale on which 1 indicates the lowest income group and 10 the highest income group in your country. We would like to know in what group your household is. Please, specify the appropriate number, counting all wages, salaries, pensions and other incomes that come in.
- Family savings: 0=borrowed to 1=saved [X044] During the past year, did your family: 1 Save money; 2 Just get by; 3 Spent some savings and borrowed money; 4 Spent savings and borrowed money; -1 Don't know; -2 No answer
- Educational attainment: 0 = primary school or less to 1 = university or more [X025 and X025A_01]^{A3} 1 Inadequately completed elementary education; 2 Completed (compulsory) elementary education; 3 Incomplete secondary school: technical/vocational type/(Compulsory) elementary education and basic vocational qualificat; 4 Complete secondary school: technical/vocational type/Secondary, intermediate vocational qualification; 5 Incomplete secondary: university-preparatory type/Secondary, intermediate general qualification; 6 Complete secondary: university-preparatory type/Full secondary, maturity level certificate; 7 Some university without degree/Higher education - lower-level tertiary

^{A2}In waves 1 through 4, the question text also instructed respondents to count income before taxes and other deductions.

^{A3}These education codes changed noticeably in Wave 7 (not listed here). For analysis, we collapse the education groups into the smallest yet not overlapping groups as possible.

certificate; 8 University with degree/Higher education - upper-level tertiary certificate; -5 Missing; Unknown; -4 Not asked in survey; -3 Not applicable; No formal education; -2 No answer; -1 Don't know

- Cognitive vs. manual work tasks: 0=manual to 1=cognitive [X053]^{A4} Are the tasks you perform at work mostly manual or mostly cognitive? If you do not work currently, characterize your major work in the past. Use this scale where 1 means "mostly manual tasks" and 10 means "mostly cognitive tasks." 1 Mostly manual tasks to 10 Mostly non-manual tasks
- Supervising someone at work: 0=no to 1=yes [X031] Do you or did you supervise other people at work? 0 No; 1 Yes
- Class: 0 = lower class to 1 = upper class [X045] People sometimes describe themselves as belonging to the working class, the middle class, or the upper or lower class. Would you describe yourself as belonging one of them? 1 Upper class; 2 Upper middle class; 3 Lower middle class; 4 Working class; 5 Lower class; -5 Missing or Unknown
- Hard work brings success: 0 = disagreement to 1 = agreement [E040] Now I'd like you to tell me your views on various issues. How would you place your views on this scale? 1 means you agree completely with the statement on the left; 10 means you agree completely with the statement on the right; and if your views fall somewhere in between, you can chose any number in between. Hard work brings success? 1 In the long run, hard work usually brings a better life; 10 Hard work doesn't generally bring success - it's more a matter of luck and connections; -5 Missing or Unknown; -4 Not asked in survey; -3 Not applicable; -2 No answer; -1 Don't know
- People are poor because of laziness: 0 = disagreement to 1 = agreement [E131] Why, in your opinion, are there people in this country who live in need? Here are two opinions: Which comes closest to your view? 1 Poor because of laziness and lack of will power; 2 Poor because society treats them unfairly; 3 Other answer; -1 Don't know; -2 No answer; -4 Not asked
- People have a chance to escape poverty: 0 = disagreement to 1 = agreement [E132] In your opinion, do most poor people in this country have a chance of escaping from poverty, or is

^{A4}Wave 5 used the word "cognitive" while wave 6 used the word "intellectual."

there very little of chance escaping? 1 They have a chance; 2 There is very little chance; 3 Other answer; -1 Don't know; -2 No answer; -4 Not asked

- Humiliating to receive money without working for it: 0 = disagreement to 1 = agreement [C037]^{A5} Wave 5 changed the wording to "It is humiliating to receive money without working for it." Do you agree with "Humiliating to receive money without having to work for it"? 1 Strongly agree; 2 Agree; 3 Neither agree or disagree; 4 Disagree; 5 Strongly disagree; -1 Don't know; -2 No answer; -4 Not asked; -5 Missing or Unknown
- Important to me to be very successful and have achievements recognized: 0 = disagreement to 1 = agreement [A194] Now I will briefly describe some people. Using this card, would you please indicate for each description whether that person is very much like you, like you, somewhat like you, not like you, or not at all like you? "Being very successful is important to this person; to have people recognize one's achievements." 1 Not at all like me; 2 Not like me; 3 A little like me; 4 Somewhat like me; 5 Like me; 6 Very much like me; -1 Don't know; -2 No answer; -4 Not asked; -5 Missing or Unknown
- How important is work: 0 = not at all to 1 = very important [A005]^{A6} For each of the following aspects, indicate how important it is in your life. Would you say it is very important, rather important, not very important or not important at all: Work. 1 Very important; 2 Rather important; 3 Not very important; 4 Not at all important; -1 Don't know; -2 No answer; -4 Not asked; -5 Missing or Not available
- Important for job to have good pay: 0 = disagreement to 1 = agreement [C011] Here are some aspects of a job that people say are important. Please look at them and tell me which ones you personally think are important in a job? Good pay. 0 Not mentioned; 1 Mentioned; -1 Don't know; -2 No answer; -4 Not asked; -5 Missing or Unknown; -10 multiple answers Mail; -9 no follow-up; -8 follow-up non response; -7 matrix not applied; -6 na (survey break-off)

^{A5}:

^{A6}In wave 2, work was put as the first of a list of five things that people could rate as important. The ordering changed for the following waves, such that work was listed towards the end.

- Important that a child saves money and things: 0 = not mentioned to 1 = important [A038]^{A7} Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially important? Please choose up to five. Thrift saving money and things. 0 Not mentioned; 1 Important; -1 Don't know; -2 No answer; -4 Not asked.
- Important to me to be rich: 0 = disagreement to 1 = agreement [A190] Now I will briefly describe some people. Using this card, would you please indicate for each description whether that person is very much like you, like you, somewhat like you, not like you, or not at all like you? "It is important to this person to be rich; to have a lot of money and expensive things." 1 Not at all like me; 2 Not like me; 3 A little like me; 4 Somewhat like me; 5 Like me; 6 Very much like me; -1 Don't know; -2 No answer; -4 Not asked; -5 Missing or Unknown
- Work is a duty toward society: 0 = disagreement to 1 = agreement [C039] Do you agree or disagree with the following statements? Work is a duty towards society. 1 Strongly agree; 2 Agree; 3 Neither agree or disagree; 4 Disagree; 5 Strongly disagree; -1 Don't know; -2 No answer; -4 Not asked; -5 Missing or Unknown
- Competition is good: 0 = disagreement to 1 = agreement [E039]^{A8} Now I'd like you to tell me your views on various issues. How would you place your views on this scale? 1 means you agree completely with the statement on the left; 10 means you agree completely with the statement on the right; and if your views fall somewhere in between, you can choose any number in between. Competition, good or harmful? 1 Competition is good. It stimulates people to work hard and develop new ideas; 10 Competition is harmful. It brings out the worst in people. ; -5 Missing or Unknown; -4 Not asked in survey; -3 Not applicable; -2 No answer; -1 Don't know

^{A7}Ordering and number of qualities changes throughout the waves.

^{A8}Wave 7 changes the wording to only "competition is good" and "competition is harmful."

Appendix D. Tables and Figures

Table A1: Religions in the WVS 'other' category

Religion	N
Bahai	10
Cao Dai	11
Essid	4
Jain	55
Other	2,557
Other: Brasil: Espirit,candomblé,umbanda	3
Other: Oriental	12
Other: Philippines (less 0.5%)	19
Sikh	49
Spiritista	33
Spiritualists	4
Zoroastrian	8
Yiguan Dao	39
Total	2,804