Economic Implications of Historically Evolved Self-Efficacy: Agent-Based Modeling and Empirical Evidence from Rural Ghana

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ABSTRACT We argue that self-efficacy is important for economic performance. Self-efficacy is at the psychological core of agency and entrepreneurship. It enables people to learn, and change and act to better their livelihood. In an agent-based model we show how different levels of individual self-efficacy can evolve as a reaction to environmental demands and rewards to human intervention. The basic idea is that people learn how to best survive in their specific environment and teach this knowledge to their children. Because this cultural heritage only adapts very slowly to the current environment, people might have self-efficacy levels that better fit to the context of their ancestors than to their own. With empirical data from Ghana, we defind that different-levels of self-efficacy have developed from different historic environmental conditions and directly influence today´s household incomes, controlling for observable incentives and constraints. Specifically, the historic returns on agricultural investments are found to have shaped the cultural evolution of self-efficacy. In contrast, current returns on investment explain far less variation in self-efficacy. We find that this cultural trait significantly affects income levels through shaping the farmers' investment behavior.

Regarding the measurement of self-efficacy, we find self-efficacy to be a process- rather than a goal-oriented belief and it is mainly culturally transmitted.

Our results identify self-efficacy as important specific target for development policy.

KEYWORDS Self-Efficacy; Economic Performance; Economic Development, Economic History, Cultural Evolution; Smallholder Farming

I. Introduction

Self-efficacy is the belief to have the abilities and capabilities to act according to one´s own decisions and to achieve desired goals. Because self-efficacy assures and motivates people, it increases their persistence, increases their planning horizon, decreases their risk aversion and increases their openness to learning, thereby forming the ground for entrepreneurship. Entrepreneurship in turn is a major determinant of a nation´s economic development. Self-efficacy develops always and everywhere in interaction with the surrounding environment and its evolution is not limited to specific circumstance. Only its strength is: the more positively an environment reacts to human intervention like granting greater harvests after fertilizing, people will develop greater levels of self-efficacy. In environments with high disease pressure or low agricultural potential, a lower average sense of self-efficacy is the natural outcome. Then, low self-efficacy feeds back and makes successful interventions even less likely. The ideal environment to develop a high sense of self-efficacy is a challenging one that can be mastered. Many environments in the temperate zone fulfil this criterion (you might think of Europe, where diseases were mostly weak enough to successfully fight them and where soils and climate allowed the development of an intensive agriculture to feed a large and growing population), whereas this is less common in the tropics and polar regions.

The concept of self-efficacy has been first developed by the Canadian psychologist Alfred Bandura in the 1970s (Bandura, 1977) and extensively tested in several pedagogic and therapeutic settings (Luszczynska, Gutiérrez-Doña, & Schwarzer, 2005; Pajares, 1997; Stajkovic & Luthans, 1998).

Bandura found self-efficacy to be a major human trait controlling and initiating individual and group behavior (Bandura, 1990, 1993, 1997; Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Schwarzer, 2014). He further developed the concept to one of environmental, behavioral and cognitive interaction where he found self-enforcing feedback-loops which he called “triadic reciprocality”: environment influences behavior and personal factors influencing environment and each other (Bandura, 1986; Pajares, 2002).

Based on Bandura´s conception of reciprocal determinism we suggest that self-efficacy is the key factor of individual economic performance, originating from long-term environmental stimuli.

In psychology and behavioral economics, it has been found that most people use more or less crude rules of thumb instead of sophisticated cost benefit calculations in their decision making (Camerer, Loewenstein, & Rabin, 2011; Gigerenzer & Gaissmaier, 2011; Mousavi & Gigerenzer, 2014; Mullainathan, 2005). In evolutionary anthropology is has been established that most of these heuristics are hereditary (Boyd & Richerson, 1985, 1995; Boyd, Richerson, & Henrich, 2011; Richerson & Boyd, 2008; Richerson, Boyd, & Henrich, 2010). Based on these two strands of thought we explore how historical circumstances shaped the evolution of a specific and economically influential rule of thumb so that we can understand why individuals and societies make systematically different decisions even when facing the same incentives and constraints (Nunn, 2012).

Prior research into this direction includes Tabellini (2010), who investigates the effect of historically shaped culture at a regional level in Europe. His selection of cultural traits is based on prior research by others, especially by the American political scientist Edward Banfield (1958) whose visit to Southern Italy inspired his argumentation that certain cultural traits cause the farmers in the South of Italy to be poor. He observed resignation and perceived helplessness, a focus on the immediate family instead of the wider community, and interpersonal distrust. Using an econometric framework to control for omitted variables and reverse causality, Tabellini (2010) investigates whether these aspects of culture have historic roots and matter for current economic development in Europe. He identifies historic institutions as their cause and finds that social capital and confidence in the individual go a long way in explaining economic differences. Welzel (2013) finds a similar relationship between economic performance and natural environment with regard to Northern Europe. One of the contributions of such research is that by understanding the historic origin of cultural differences and by quantifying their economic impact one might be better able to design more efficient, more specifically targeted development policies (see Mullainathan (2005)).

An important feature of self-efficacy is that it is a “mental model”, independent from the actual competence of an individual, her environment and of how realistic her judgement is. What is important for setting ambitious goals and reaching them is the belief to have all what it takes to reach them. It is this belief that enables people to dare to learn new information, try new inventions, set high goals, keep trying for a longer time even when problems arise. Having a high degree of self-efficacy means that a person believes she has influence on her life, she has the internal locus of control and can move from there

to act. She is able to be persistent in her endeavors, master difficulties and keep on trying for a longer time. (Note that while persistence describes the time aspect of self-efficacy, the often mistaken resilience is not; resilience as the ability to spring-back after an external shock and is an independent trait, which may or may not occur in conjunction with self-efficacy). Self-efficacy is the core prerequisite of human agency as it is this belief that enables people to act as an agent for herself and others. Self-efficacy may occur in concert with resilience and entitlement, but while self-efficacy is part of the inward-oriented self-construct, entitlement is outward oriented and part of an individual´s world-view. Asymmetric occurrence of these three connected traits leads to social stress that may adversely affect economic performance: having a sense of entitlement without the self-efficacy to earn the rewards one feels entitled to may lead to a feeling of deprivation which may lead to adverse or maladapted social behavior and to shortcomings in economic activity. Having resilience without self-efficacy may lead to suffering through endurance instead of activity to get out of the adverse situation, again potentially harming economic performance.

Every environment continuously requests and rewards reaction of the inhabitants in the form of information reconciliation, learning, and behavior adaptation. Thus, depending on how much and how positively an environment reacts to human intervention this will lead in turn to changes in the environment, the reference group and the self-perception in self-enforcing feedback loops.

Research has shown that people with higher self-efficacy are more persistent, have a lower incidence of angst and depression, and are more successful in their education and training. Locke and Latham (1990) found what they called a “high performance cycle” in that people with higher self-efficacy tend to have higher expectations, which lead to setting higher goals. In a kind of self-fulfilling prophecy, they will then put in more effort to reach their higher goals which, when accomplished, increases their sense of self-efficacy more.

Our research identifies historical environmentally shaped, and subsequently bequest self-efficacy as the source of entrepreneurial traits. Since the time of Schumpeter (1934) until today Galor and Michalopoulos (2012), entrepreneurial behavior has been linked to economic development. Entrepreneurship is usually described by its symptoms: openness to novelty, explorative, longer planning horizons, greater risk taking, faster in

innovation adaptation and others. But what causes and enables a person to be and act more or less entrepreneurial?

Self-efficacy is generally defined as the belief to be able to reach specific goals; here, this goal will be to better one´s livelihood by increasing household income while the belief concentrates on the ability, not the goal; self-efficacy is process-oriented, not goal-oriented. We research how different environments gave different signals to their inhabitants, either rewarding or discouraging entrepreneurial behavior, thereby shaping their culture which affects today's income distribution.

If the environment does not request or reward human intervention, self-efficacy cannot develop; well–adapted behavior in this case could foster entitlement or resilience as survival strategies, but not self-efficacy. They can occur simultaneously but are independent, their asymmetric occurrence offering ample cause for societal problems. Think of nomadic groups surviving an inhospitable, barren environment only by regular raiding, without ever being able to develop a sense of self-efficacy as their life space does not react to intervention of their capacity like hard work, planning, investment. Or consider communities whose achievements are regularly destroyed by natural catastrophes or lives cut short by uncontrollable diseases like malaria. It is the experience of successful entrepreneurship, like choosing the right crop, employing the right amount of work and capital, doing the right kind of planning for storage, cooperation, and trade, that gives people a higher perception of their own ability to reach their goals, to influence their livelihood. In the following, we provide evidence for historically lower returns on agricultural investments having led to lower levels of self-efficacy and incomes today.

In the next section (II), we discuss the relationship between self-efficacy and economic development. Then, the development of a theoretical model and its simulation in an agent based modelling framework follow (section III). Our first empirical analysis is based on cross sectional data and presented in section IV, followed by our second empirical analysis using panel data in section V. We discuss our research in section VI and conclude in section VII.

II. Self-Efficacy and Economic Development

The term self-efficacy here is defined as a person's subjective belief in her ability to achieve a specific goal. This belief is context and task dependent as people have high/low self-efficacy in some situations and low/high self-efficacy in others. In this study, we are concerned with economic development, therefore using the term self-efficacy as a person´s belief to improve her livelihood. The set goal is to escape poverty by increasing her income. The role of self-efficacy is that depending on what people think they can achieve, they set differently ambitious goals, invest (in its broadest meaning, including effort, energy, time and money) differently into achieving these goals and for different stretches of time.

Analyzing individuals and groups of people, psychologists have collected much evidence so far, that self-efficacy affects almost every area of human endeavor. The reason is that people set different goals for themselves, are differently motivated, and likely to persist and to succeed dependent on their belief of having the ability to achieve their goals.

This mechanism has been found in the realm of developing creativity (Tierney & Farmer, 2011), losing weight (McCarroll et al., 2014), avoiding risky sexual behavior (Bandura, 1990), academic achievement (Bandura et al., 1996), and the performance of a modern agricultural value chain in West Africa (Wuepper & Sauer, 2015), to name just a few examples.

Self-efficacy, or the lack thereof, contributes to a range of phenomena, such as problems of self-control (e.g. when tempted, individuals with low self-efficacy convince themselves that their effort is hopeless either way and thus consume their capital instead of saving/investing), high time preference (e.g. the feeling of helplessness makes individuals with low self-efficacy discount their future stronger), and possibly trustworthiness (if resignation allows individuals to justify bad behavior). Culture and institutions developed in a given environment are impacted by individual self-efficacy as it defines her stand in her life circumstance including her social group. Individuals with low self-efficacy and , a perception of entitlement living in and the environmental conditions apt for it, they will have great incentives for building exploitative institutions, to redistribute the natural resource endowment and gain some kind of power position, whereas individuals with high self-efficacy have a much greater incentive to build

inclusive institutions to safe on the social and material costs of power struggle and hampering development.

The basic premise of this article is that if people use cultural rules of thumb to guide their decisions, it is important to know whether these rules of thumb are well adapted to the current context. The hypothesis is that this is not always given, and in the following sections, we try to answer the questions why and whether it really matters.

Consider table 1, which shows four combinations of the current context and people´s self-efficacy. For much of human history, we know that people had limited abilities to achieve per capita income growth and we assume that they were aware of this (bottom, right). However, in some environments people subsequently learned how to improve their lives, so their ability was actually high and they were probably aware of this too (up, left). It is not clear what would happen to individuals with high self-efficacy but low actual efficacy (bottom, left). Research shows that in many contexts this configuration could be surprisingly successful and hence evolve, despite its mismatch between mental model and reality (Johnson & Fowler, 2011). The combination that is of most interest here is shown in the up-right corner. It is the opposite of the combination before and describes individuals who are foregoing chances because they do not perceive them as such. These people might use an obtained micro credit for consumption, drop out of profitable innovations or continue with an unprofitable business despite better alternatives.

Table 1 here

How could there be people who do not belief in their economic development potential even though they have huge incentives and no other binding constraint than their misconception of their context?

One possible answer is that if the context of people changes enough, their inherited self-efficacy might not fit their changed environment. Interesting examples come from studies of migrants (here, it is not really the context that changed but people moved to a new context). Nisbett and Cohen (1996), e.g. find that people in the South of the USA still carry their culture of honor, that helped their ancestors to defend their cattle in historic

Ireland, even though it is rather disadvantageous in their new environment. People whose ancestors were involved in farming instead of herding have an entirely different culture. Globally, Galor and Özak (2014) find that historic returns on agricultural investments explain the distribution of time preferences today./

In the study at hand, we argue that the historic return on agricultural investment shaped a more fundamental cultural trait, self-efficacy, which in turn is at the root of many cultural and institutional differences between individuals and societies and governs social relationships through the compensative effect of power: power compensates a lack of self-efficacy if the perception of entitlement is large enough to seek it.

Theoretically, self-efficacy is clearly distinguished from self-confidence, locus of control, agency, and many related constructs; empirically, the distinction is less clear. In economics, related studies have focused on self-confidence (Bénabou & Tirole, 2002) and locus of control (Tabellini, 2010). Especially Tabellini (2010) is likely to actually measure self-efficacy or parts thereof with his proxy variable “locus of control".

III. Theoretical Model and Simulation

We develop an agent-based model that captures the evolution of self-efficacy in different subsistence populations. Individuals differ in their propensity to make productive investments depending on their level of self-efficacy, whereas their environment determines the return on such investments. Over time, people learn whether it is more profitable to rely on their natural resource endowments or rather try to improve upon them. Thus, we can assume that different environments were historically more or less profitable for investments with extremes marked by environments were underinvesting was deadly and environments were overinvesting was deadly. The knowledge which strategy works best is then passed on to the next generation culturally, while the genetically inherited inclination for more reward seeking activity as well as present day epigenetic triggers influence the general propensity for more or less activity. Some children would thus inherit information how to adapt to their environment while others would inherit information how to adapt their environment and both would inherit

different levels of employable reward seeking which we assume as evenly spread and therefore not weigh it individually.

At the beginning of each generation, these two survival strategies compete in a weighted lottery.

Formally, the first generation differs in its propensity to invest and this propensity is denoted with α_{it}, which reflect the individuals' level of self-efficacy.

Assume people live for two periods and they choose how much to invest in the first. Then, they will have two incomes y_{it}, y_{it+1}, which differ depending on their investment choice:

$$(y_{it}, y_{it+1}) = \begin{cases} (R_t^L, R_{t+1}^L) & with\ low\ investment \\ (R_t^H, R_{t+1}^H) & with\ high\ investment \end{cases} \quad (1)$$

Thus, higher self-efficacy and a higher (positive) average income difference between high and low investment, determine together the amount of investment and income.

$$(y_{it}, y_{it+1}) = \begin{cases} (R_t^L, R_{t+1}^L) & if\ \alpha_{it} \leq \hat{\alpha}(R^H - R^L) \\ (R_t^H, R_{t+1}^H) & if\ \alpha_{it} > \hat{\alpha}(R^H - R^L) \end{cases} \quad (2)$$

With $R_t^H < R_t^L$ because of the higher investment.

Note: There are environments, in which the people cannot improve their productivity ($R^H - R^L < 0$. Think of hunter-gatherers in Egypt before irrigation was invented and before getting into contact with farmers from the fertile crescent; however, there are also environments in which people could improve their productivity ($R^H - R^L > 0$) – but only if they believe in it. Think again about the hunter-gatherers in Egypt, but now directly after they have been brought into contact with irrigation and the idea of farming. Now, individuals have to decide whether and how much they want to invest into this new technology. Finally, there are environments in which people must invest in order to survive: for example people who migrated to places with harsh winters. In these environments, lack of investments into shelter and storage facilities was likely a one-time mistake.

The number of children raised with high self-efficacy (n^{HSE}) and the number of children raised with low self-efficacy (n^{LSE}) depends on the relative return on investment for high (R^H) and low (R^L) investments and the culture of the parents (α_{it}):

$$n_{i,t+1} = \begin{cases} R^H \equiv n^{HSE} \ if \ \alpha_{it} \leq \hat{\alpha}(R^H - R^L) \\ R^L \equiv n^{LSE} \ if \ \alpha_{it} > \hat{\alpha}(R^H - R^L) \end{cases} \quad (3)$$

The question then is what happens if culture is not optimally adapted to the environment. This should be a common feature of culture, as it is mostly persistent and not constantly optimized, which means it can be "outdated" and there might be strong incentives for change. A possible simplification to the process of cultural change is to model it as a function of the stability of a cultural "equilibrium". The incentives and constraints that determine the stability of the cultural equilibrium are not only externally given but mediated and affected by a society's institutions, which reinforce the culture that shaped them. This might be expressed as follows:

$$\alpha_{it} = \delta_1 \alpha_{jt-1} + \delta_2 \, I_{kt}\left(\sum \beta_{kt}\right) + \delta_3 Z_{it} \quad (4)$$

Where α_{it} represents the culture of an individual, which depends on the culture of her parents α_{jt-1}, as well as the current institutions I_{kt} of her society, which are in turn determined by the culture of the other members of society $\sum \beta_{kt}$, and culture is impacted by a vector of context variables Z_{it} that are assumed independent from culture and institutions. The influences are weighted by δ_1, δ_2, and δ_3. Holding the first term constant across individuals, the ration between δ_2 and δ_3 determines whether institutions enforce the status quo culture or whether the context leads to cultural change.

To explore these ideas, below the model is simulated in the agent-based modeling software Netlogo.

The start is a population of subsistence farmers, of which some are naturally more entrepreneurial (high self-efficacy, blue) than others (low self-efficacy, red). Unpopulated land is shown in green. Depending on the context, high and low self-efficacy are differently fit (in a Darwinian sense), which determines the reproductive success of the two groups of farmers in time. The example in figure 1 shows an environment in which high self-efficacy is the better adapted to the environment and hence dominates low self-efficacy after a while.

Figure 1 here

Exogenous variables are investment costs, profit, risk-probability and risk-impact, as well as institutional persistence, which captures how fast institutions adapt to economic incentives. (The investment risk can take on negative values, which captures the idea that sometimes, not investing is the riskier alternative.) These variables determine the modeling outcome.

Endogenously evolving variables are the relative fitness of the two survival strategies and thus the developing population shares of farmers with high and low self-efficacy.

Figure 2 here

With a rather low return on investment in context A, low self-efficacy evolves.

Figure 3 here

With a rather high return on investment in context B, high self-efficacy evolves.

Figure 4 here

Because in context C institutions are more persistent than in context B, cultural change is slow.

The first testable hypothesis suggested by the model is that the descendants of individuals in high return on investment environments have a higher level of self-efficacy than the descendants of individuals in low return on investment environments (cultural evolution hypothesis).

The second hypothesis is that individuals with higher self-efficacy now generally generate higher incomes because technological change has turned most environments into high return on investment contexts (income hypothesis).

The third hypothesis suggested by the model is that individuals with higher self-efficacy would generate higher incomes because they invest more (effort, work, capital)(investment hypothesis).

The fourth hypothesis is that individuals also generate higher incomes because they persist longer in the face of adversity (persistence hypothesis). Please note that persistence is a part of self-efficacy, it is the ability to try harder for a longer time span. It should not be mistaken for resilience which is an independent trait: resilience is the ability to withstand severe drawbacks, and spring back after having suffered through external shocks. Resilience may independently accompany self-efficacy, but may also, however, occur without self-efficacy in the form of endurance.

IV. Empirical Analysis

The data for the following analysis was collected in a household survey in six different districts of the Central, Eastern and Greater Accra regions of Southern Ghana amongst smallholder pineapple farmers in 2013. For export-certified farmers, the sampling was based on the strategy of Kleemann and Abdulai (2013), who used stratified random sampling with the support of development agencies and the Pineapple Exporters Association of Ghana in 2011. Starting out with the main pineapple growing districts in Ghana, they randomly selected groups of certified farmers from lists of all certified farming groups to then randomly select a farm group-proportional number of farmers for the survey.

For this study, roughly 200 of the farmers were surveyed again in 2013 and about 200 non-certified farmers were interviewed for the first time. For the non-certified farmers there were no lists available. Thus, development agencies and extension agents were asked to identify representative groups of non-certified farmers, of whom 200 farmers were surveyed. It is acknowledged that this sampling strategy is not fully random. While the certified farmers were determined by stratified random sampling, the non-certified farmers were chosen by their adjacency to the sampled certified farmers. The crucial assumption here is that by using a representative sample of certified farmers and by sampling non-certified farmers who live nearby, the whole sample is representative. This seems plausible as the certification process is determined highly idiosyncratic and does

not show any pattern that would suggest that non-certified farmers close to our sampled communities to be significantly different from non-certified farmers further away.

Table 2 shows the variables that will be used in the empirical analysis. Most importantly, several rather similar questions were asked, all aiming at how much the farmers believe to have the ability and capability to improve their farm income. As it turns out it, slight differences in these questions matter a great deal. The variable "nature" captures whether the farmers have the feeling that nature provides for them or whether they feel it is their own task to make nature productive. Many farmers reported that in their region, it is not necessary to use fertilizer or to invest into the fields, as the soil is very rich and pineapples grow well without additional investments. It was interesting to note how often many of these farmers used the word "providing" also during small talk, which might hint at a distinct more passive world view. Alternatively, the farmers were also asked with an "open-end goal" about the first two factors influencing their income that came to their mind. The large variety of answers ranged from not drinking alcohol to "hard work", "bad weather" and "improved production technology". We rated internal factors with a score of 3 ("improved", "learned", "changed", etcetera), ambiguous answers with a 2 (including "hard work" as it is not clear whether this is understood as mere surviving or working towards an improvement) and external answers with a 1 ("weather", "prices", "costs", etcetera). Yet another question provided the variable "ability" - whether the farmer believes that his current income has been more influenced by his own decisions and abilities or rather not - which is close to the open ended question, with the difference that perhaps it is more suggestive what the question aims at.

Table 2 here

The question "control" - whether the farmer feels to make his life or that life happens to him - sought to identify resignation, rather aiming at the lower end of the spectrum from perceived helplessness to strongly developed self-efficacy. In contrast, "responsibility" - whether the farmer feels responsible for the success of his farm or whether the success is mostly determined by factors he cannot influence - has a stronger normative and suggestive focus than the other questions. The question on "work" - whether the basis

of economic success is hard work and creativity or rather connections and/or luck - aims at a general perception rather than a specific attitude.

The variable "planning" is somewhat distinct from the others but also captures an aspect of self-efficacy, as one would expect a person with greater self-efficacy to discount her future less and plan for longer time stretches.

The main dependent variable is the natural logarithm of the income from pineapples (which is the main source of cash-income, often indeed the only one). To control for potential *confounders* a set of control variables is always included, with the bio-geography of the farmer, his market context and the relationship to the local chief, amongst them. We do not want to control for production technology, pineapple variety, input use, credits and similar variables, which are plausibly results of culture ("bad controls" in the words of Angrist and Pischke (2008)). In fact, after the investigation of whether historic production systems predict self-efficacy levels and whether this explains income differences, control for the per area harvest of the farmers allows us to probe whether this could be the channel through which self-efficacy increases income. If our hypothesis is correct - that self-efficacy leads the farmers to invest more work, effort and inputs into their fields – and conditional to controlling for soils, rainfall and prices, per area harvest should explain a good share of the pineapple income and if it is the main or sole channel through which self-efficacy affects income, the per area harvest should completely take away the significance from self-efficacy.

Table 3 ranks the farmers into three income groups and shows their descriptive statistics. The income ranking is reflected in the variables "nature", "income factor", "planning", "responsibility", "work" and the principal components of "income factor", planning" and "nature", which is supposed to erase measurement errors and capture the underlying concept of self-efficacy. For the variables "control" and "ability", the ranking does not show. As the current context is more beneficial of farmers with a higher income (less malaria, more rain and larger farms), we need to control for omitted variables and reverse causality: the cultural variables could erroneously capture more self-efficacy because of a more business conducive context – not historically but currently.

Table 3 here

Prior to our main analysis, we have to test the variable "income factor", which is constructed from whether the stated income factors of the farmers aim at internal or external determinants. By definition, this variable only captures the subjective self-efficacy of a farmer if it is sufficiently independent from her objective context. Thus, we have to test whether the farmers who describe their income to be altered by learning or the adoption of an innovation, received more training from development organizations in the past; in this case, they would have received more external help and their reported income factor would not necessarily reflect their distinct world view. Specification (1) in table 4 actually shows the opposite. Farmers who state a more internal income factor received less training in the past, not more. Similarly, asking whether farmers who describe their income to be more externally determined (e.g. weather or prices) actually live in more difficult environments; specification (2) establishes that non-farm income is not significant and both specifications (1) and (2) show that prices are insignificant too, while rainfall quantity is interestingly negative and not positive, and only rainfall variability has the expected negative sign while also being significant. As last piece of evidence, current variables only explain 21 - 25% of the variation in the income factor variable, leaving much unexplained variation to our hypothesized historic channel.

Table 4 here

To establish baseline empirical relationships, table 5 presents the results of OLS estimations, always controlling for the same list of control variables (biogeography, prices, local chiefs, farm size), but with alternating measures of self-efficacy. Except for the variable "work", all measures of self-efficacy are significantly and positively correlated with the logarithm of the annual farm income. In line with the expectation that we measure self-efficacy with a large error, specification (5) which uses the extracted principal components of three different measures, has the highest explanatory power. It should be noted that we omit some of the most obvious explanatory variables, because any variables related to investment are the main hypothesized intermediate effect of self-efficacy and would hence bias our self-efficacy variable.

Table 5 here

Having seen the robust empirical relationship between self-efficacy and income, we can now turn to the question of whether this relationship is a causal one, from self-efficacy to income.

Our agent-based model is built on the idea that historic returns on investment determined the evolution of self-efficacy. When the Portuguese introduced maize in Ghana in the 16th century, the regions that were most suitable to its cultivation saw a large increase in their return on investment. Thus, based on FAO's GAEZ-database, we used information on the regional suitability for rain-fed maize production in Ghana and created a dummy variable indicating the areas in Ghana where maize had a comparative advantage over other crops. We assume that a historic advantage in maize production is unlikely to affect the current income of pineapple farmers other than through the self-efficacy channel as suggested by the agent-based model. This assumption might seem strong at first sight. Even though we control for the current pineapple suitability of the farms, and hence for any potential correlation between historic maize advantage and current pineapple suitability, there are still more or less plausible channels which could invalidate our exclusion restriction. First of all, what if the advantage in maize translated into higher incomes and regional development? Or perhaps the advantage in maize correlated with advantages in other crops than maize or pineapple that somehow affected incomes and/or culture? And finally, how well do we actually identify self-efficacy? It is quite possible that such a fundamental characteristic as regional crop suitability affected a whole range of cultural traits, e.g. social capital or time preferences.

Table 6 here

We sort these concerns into two groups: The "income concern" and the "other trait concern".

Table 6 shows that the advantage in maize does neither predict social capital (F value of the excluded instrument is 2.3) nor non-farm income (F value of the excluded instrument is 0.2 and 0.7). We can assume that economically better-off regions would offer more non-farm income possibilities, as a lack thereof is a common development indicator in Sub-Saharan Africa. Especially, non-farm income might be an indicator for market distance, as places that offer non-farm income might also be places where pineapples can be sold at higher quantities or prices.

Table 7 here

The finding that the historical advantage for maize production does not predict social capital is reassuring, as this suggests that our instrument affects an individual cultural trait. Of course, there are still several cultural traits that are individual but as shown in table 7, from the tested measures of culture, it is the aspects that are closest to our definition of self-efficacy that are significant, while related but slightly differently nuanced aspects are insignificant. This should make us confident that self-efficacy is identified and not a different cultural trait.

The first specification in table 7 shows whether the farmer believes that her current income has been mostly determined by her decisions and abilities is neither clearly predicted by our instrument nor does it significantly affect the farmer's income. The same is true for whether the farmer feels that she is responsible for her current income (specification 7) or whether she believes hard work and creativity to be the cause of economic success (specification 8).

In contrast, table 7 shows that farmers have higher incomes if they name income determinants that they can control (in contrast to income determinants that they cannot control), if they have longer planning horizons, and if they believe it is their task to make nature more productive. Recall that with table 4, it is established that farmers who name external or internal income determinants do not describe objectively different context but simply interpret them differently.

Except for the planning horizon, we are concerned about the strength of our instrument, being careful with interpreting the estimated coefficients. However, using

the principal components of our significant self-efficacy measures, we are able to avoid measurement errors (specification 5) to a large extent, which shows in a sufficiently strong F-statistic for the excluded instrument and a higher R^2 in the second stage.

Reassuringly, the principal components, which can be seen as our best approximation to farmers' self-efficacy, explain significantly more income than the farmers´ planning horizon, which up to this point could still have been a plausible alternative (instead of seeing the planning horizon as a byproduct of self-efficacy, the alternative channel could have been that the advantage in maize increased the farmers' patience, which increased their income via persistence, which in turn increased their self-efficacy).

Thus, we conclude that we cannot reject our first two hypotheses, that higher historical returns on investment selected a higher cultural equilibrium of self-efficacy than lower historical returns on investment and that this cultural distinction is reflected in different income levels.

Figure 5 graphically displays how the world-view of many farmers differs from what we would observe under instantaneous cultural adaptation. Consider farmers A and B. They both live in a mildly adverse environment with suboptimal rainfall, low prices, etc. However, farmer A believes to have the ability to achieve a higher income and is hence highly motivated to find solutions to obstacles in his way (which we find above is a self-fulfilling prophecy). Farmer B on the other hand, lives in the same environment but does not feel to have the ability to achieve a higher income and is hence less likely to put much effort into his job or keep his attempts up for a long period of time (which would reassure him in his view of not being fully in control, which again, is a self-fulfilling prophecy). The same difference can also be seen in a more beneficial environment. Farmers C and D share a similarly enabling environment but interpret it differently, just as the farmers A and B do.

Figure 5 here

The third hypothesis that would corroborate the first and the underlying model, is that invested effort, work and capital are the causal channel through which self-efficacy increases incomes. Given our data, we cannot observe the investment of the farmers and

asking about them does not seem sufficiently reliable. However, we can observe a proxy; that is, conditional to controlling for soil and rain, as well as the pineapple price, the per-area harvest should reliably reflect how much the farmers invest. As shown in table 8, the variables found to best capture self-efficacy in table 6 all become insignificant when we control for the per area harvest, which is robustly significant in all specifications. Furthermore, the suggested effect of the per-area harvest is about four times as large as the effect of price, which could possibly be an underestimation, if the price reflects a better quality achieved by farmers who invest more.

In conclusion, we also cannot reject our third hypothesis that the entire effect of higher self-efficacy runs through higher investments of various kinds.

Table 8 here

To summarize this section, we find that historical environments shaped the regionally distinct evolution of self-efficacy, which makes farmers try differently hard to increase their income, which in turn explains a significant share of their actual income.

V. Further Tests of the Causal Channel

The fourth and final hypothesis is that farmers with high self-efficacy are more persistent. For this last hypothesis we use a second dataset from Ghana. As mentioned in the beginning, the export-certified pineapple farmers of our survey have been surveyed in 2010 by Kleemann and Abdulai (2013). Thus, for these farmers, we can combine the 2013 dataset with the 2010 dataset to create a (smaller) panel data set of 173 farmers in two periods. The sampling procesure of Kleeman and Abdulai (2013) was stratified randomized sampling, representative for export certified pineapple farmers in Ghana, whereas the cross sectional dataset used above is representative for the whole population of Ghanaian pineapple farmers. All of these farmers are however smallholders, living in the same communities.

Using panel data, we can observe (at least short-term) adoption and dis-adoption dynamics of agricultural innovations. We consider chemical fertilizer, agro-ecological practices (AEP) and mulching, all of which have been found profitable for the

farmers but at the same time dynamically adopted and dis-adopted at rather low levels. Table 9 establishes basic observations for farmers with different levels of self-efficacy. It can be seen that fertilizer is generally most diffused already, followed by mulching, followed by AEPs. For fertilizer, the relationship with self-efficacy does not seem to be strong. In contrast, for AEP and mulching, there could be a meaningful relationship. Regarding the question whether we can observe farmers with higher self-efficacy to be more resilient, table 9 shows that farmers with high self-efficacy seem unlikely to dis-adopt fertilizer and mulching, and farmers with low self-efficacy seem likely to dis-adopt AEPs. Whether this is actually true is shown in table 10.

Table 9 here

Table 10 shows that farmers with higher self-efficacy are less likely to dis-adopt mulching or fertilizer. The coefficient for the dis-adoption of AEPs has the expected sign but is not significant, which might be because of the low initial diffusion of AEPs. The adoption of AEPs and mulching is significantly affected by self-efficacy. The coefficient for the adoption of fertilizer has the expected sign but is not significant, which might be because of the wide diffusion of fertilizer.

Table 10 here

In summary, the panel data shows that self-efficacy is important to start the diffusion of innovations and to avoid dis-adoption of once adopted innovations. This is consistent with our fourth hypothesis that self-efficacy makes farmers more likely to keep their investments up, even when they are tempted to dis-invest.

VI. Discussion

How can we know that it is self-efficacy that we are finding and how can we distinguish it from related concepts? And is it simply genetically inherited?

Compare self-efficacy to the big-bang and its causing today´s cosmic background radiation: we cannot measure it directly but we can measure its short- and long-term effects. We asked a range of questions that reveal related but not identical constructs. According to our theoretical considerations, it is self-efficacy that has a significant effect on the economic success of individuals, because it increases motivation to act by increasing belief in the abiltity to act appropiately. Consistent with this expectation, we find that questions that measure self-efficacy have the suggested, significant effect on economic outcomes via changing people's investment behavior, whereas questions that measure related but different concepts here are insignificant.
The revealing pattern we detect is that process-oriented questions identify self-efficacy, whereas result-oriented questions do not.
Questions on

- whether nature provides what the farmer needs or whether it is the task of the farmer to make nature productive;
- the most important income determinants, i.e. whether external factors were named (e.g. weather), or internal factors (e.g. learning, while controlling for peoples' observable environment (weather, training, market prices, etcetera);
- how far ahead the farmer plans (from a day to the life of his children);

as well as the principal components of the above three (to reduce the measurement error) measure self-efficacy, as we define it, well. Important is the individual believe to be able to do what is necessary to reach a certain goal, which is interestingly not much related to peoples' external context. The weight here lies on the process about which the individual feels confident.. A person with self-efficacy believes that whatever goal she sets herself or has set for her she will be able to tackle. The goal as such is not the important thing, important are her abilities and her believe in them. When problems arise on the way, she is likely not to give up easily as she is able to adjust to changes and may well adjust the goal itself, which is a self-fulfilling prophecy.

Simple rephrasing can shift the focus from the process to the result. We found that questions only slightly differently worded did not find self-efficacy.

Asking

- whether the farmer´s current income had been mostly determined by his decisions and abilities or rather not;

- whether the farmer felt to “make his life” or whether “life happens to him”;
- whether the farmer feels responsible for the success of his farm or whether the success was mostly determined by factors he could not influence;
- whether the basis of economic success is hard work and creativity or rather connections and/or luck

do not measure self-efficacy. Possibly hidden in the answers could be information on agency and locus of control. The concept of agency does indeed carry the responsibility not for the process but for the result, it identifies the person who takes on the responsibility for reaching a certain task and thereby carries a moral aspect as much as the danger of burdening the agent. Locus of control refers to a person´s notion of being the one who makes the decisions, to be indeed the one who is in control of his own matters. Further research must be aware and careful about what aspect of the economic process the wording of a question is aiming at as much as the suggestive identity of the one asking.

Some scientists have linked entrepreneurial behavior to novelty seeking which was then thought to be genetically conditioned and inherited (Galor and Michalopoulos (2012); on genetic inheritance of self-efficacy, Waaktaar and Torgersen (2013) on genetics versus environment). It was assumed that a certain genetic polymorphism was correlated to novelty seeking (Benjamin et al., 1996; Ebstein et al., 1996). Extensive research could not verify this (Faraone, Doyle, Mick, & Biederman, 2014; Munafò, Yalcin, Willis-Owen, & Flint, 2008; Wu, Xiao, Sun, Zou, & Zhu, 2012), the link between novelty seeking and genes was found to have been a mislead interpretation and would have carried the danger of falsly regarding it as historic and genetic heritage, unchangeable by policy measures. Entrepreneurship is in any case much more than novelty seeking. Though it does take interest and openness for novelty to be a successful entrepreneur, it also takes less adventurous, but pragmatic and complex qualities like planning, high frustration tolerance, hard work, learning, cooperation, decision making.

Complex human behavior like entrepreneurial can be assumed to be the result of interaction and feedback loops of genetic disposition, epigenetic triggers, education and example, and personal and environmental circumstance (Chakraborty, Thompson, & Yehoue, 2015). Merely the disposition for a brain´s reactiveness to certain stimuli in its complex electro-chemical interaction can be discovered in the genes. If and how this translates into actual behavior depends on the opportunities, rewards and restrictions

of personal life conditions, natural surrounding and on the culture and institutions adaptively developed by its inhabitants. If an environment neither requests nor rewards a certain behavior it will usually not persist or spread (except of those odd cases where a special feature developed as useful in certain conditions and was not given up as useless after these conditions changed when it was not harmful). Regularly, only what is needed and pays off the effort in will be repeated in acts of individual and collective learning, and respective genetic changes passed on and spread if the gained advantage is also one in reproduction. Phenomena like the absence of wide-spread entrepreneurial traits within the ranks of 19th century nobility as suggested by Galor and Michalopoulos (2012) could for example not be explained except by environmental triggers: especially the existence of wealth inheritance and status-quo conservative culture made entrepreneurial behavior neither necessary nor desirable, and left the system of rewards for hard, risky and environmentally adapted entrepreneurial work to those who needed it.

The genetic correlation we believe to have found was one of merely better reproductive success of those who developed greater levels of self-efficacy through better livelihood (cmp. Chakraborty et al. (2015)). And this effect works two-fold: People with higher self-efficacy will be more affluent and thereby healthier, and be more attractive as reproductive partners. Their better livelihood can be expected to raise more and healthier off-spring. This genetic effect of increased reproduction of people with higher self-efficacy causes more children to grow up under more promoting conditions with individual and possibly collective cultural learning in a community of adults with greater self-efficacy. Children learn from their parents to form their self-images not only by conscious association through speech, education, stories, but also unconsciously and thereby highly resistant to change as a meme (Kandel, 2007). As parenting has been found to have a significant influence (Bandura, 1993; Whitbeck et al., 1997) another line of genetic influence via greater self-efficacy suggests a positive influence on the development of entrepreneurial traits: parents tend to actively teach their children to follow their survival strategies and pass on especially their entrepreneurial knowledge which tends to accumulate over the generations (Chakraborty et al., 2015). The sense of entitlement passed by generations of professionals of any trade as well as a higher level of resilience of generations that were able to cope in their environment, altogether the traits of an empowered person well-prepared for successful economic behavior, can be expected to be culturally bequest but biologically made possible through family bonds..

VII. Conclusion

Our research suggests that self-efficacy forms the core of entrepreneurial human behavior by enabling an individual to believe in her abilities to set the right goals and to reach them. This belief being distinctly different from formerly discussed concepts of self-confidence, locus of control or agency positively influences people´s risk taking, time preferences with planning horizons and discounting, and openness to innovations. We developed a theoretical model showing how self-efficacy develops in an ongoing process at all times and everywhere. It is culturally bequest via individual and collective learning and fostered through genetic and epigenetic reproductive advantages of better adaptation to environmental stimuli. We test the model on self-efficacy with 2013 cross sectional data and 2009-2013 panel data from smallholder farmers in Ghana and find that farmers with greater levels of self-efficacy have higher incomes today than those with lesser levels of self-efficacy and that they show a higher innovation adoption dynamic. This suggests that development policy measures should target to increase self-efficacy of farmers.. Present developmental policy measures like microcredits, providing infrastructure, or training would greatly profit in their effectiveness as they are presently tailored only for people who are ready to make use of the opportunities offered, but leave out those who would need support in building the self-efficacy to be able to do so.

References

Angrist, J. D., & Pischke, J.-S. (2008). *Mostly harmless econometrics: An empiricist's companion*: Princeton university press.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review, 84*(2), 191.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*: Prentice-Hall, Inc.

Bandura, A. (1990). Perceived self-efficacy in the exercise of control over AIDS infection. *Evaluation and program planning, 13*(1), 9-17.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational psychologist, 28*(2), 117-148.

Bandura, A. (1997). Self-efficacy: The exercise of control: New York: Freeman.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (1996). Multifaceted impact of self-efficacy beliefs on academic functioning. *Child development, 67*(3), 1206-1222.

Banfield, E. C. (1958). *The moral basis of a backward society*: Free Press.

Bénabou, R., & Tirole, J. (2002). Self-confidence and personal motivation. *Quarterly journal of economics*, 871-915.

Benjamin, J., Li, L., Patterson, C., Greenberg, B. D., Murphy, D. L., & Hamer, D. H. (1996). Population and familial association between the D4 dopamine receptor gene and measures of novelty seeking. *Nature genetics, 12*(1), 81-84.

Boyd, R., & Richerson, P. J. (1985). Culture and the evolutionary process. *University of Chicago, Chicago*.

Boyd, R., & Richerson, P. J. (1995). Why does culture increase human adaptability? *Ethology and sociobiology, 16*(2), 125-143.

Boyd, R., Richerson, P. J., & Henrich, J. (2011). The cultural niche: Why social learning is essential for human adaptation. *Proceedings of the National Academy of Sciences, 108*(Supplement 2), 10918-10925.

Camerer, C. F., Loewenstein, G., & Rabin, M. (2011). *Advances in behavioral economics*: Princeton University Press.

Chakraborty, S., Thompson, J. C., & Yehoue, E. B. (2015). Culture in Development. *The World Bank Economic Review*, lhv018.

Ebstein, R. P., Novick, O., Umansky, R., Priel, B., Osher, Y., Blaine, D., . . . Belmaker, R. H. (1996). Dopamine D4 receptor (D4DR) exon III polymorphism associated with the human personality trait of novelty seeking. *Nature genetics, 12*(1), 78-80.

Faraone, S. V., Doyle, A. E., Mick, E., & Biederman, J. (2014). Meta-analysis of the association between the 7-repeat allele of the dopamine D4 receptor gene and attention deficit hyperactivity disorder. *American Journal of Psychiatry*.

Galor, O., & Michalopoulos, S. (2012). Evolution and the growth process: Natural selection of entrepreneurial traits. *Journal of Economic Theory, 147*(2), 759-780.

Galor, O., & Özak, Ö. (2014). DP10122 The Agricultural Origins of Time Preference.

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual review of psychology, 62*, 451-482.

Johnson, D. D., & Fowler, J. H. (2011). The evolution of overconfidence. *Nature, 477*(7364), 317-320.

Kandel, E. R. (2007). *In search of memory: The emergence of a new science of mind*: WW Norton & Company.

Kleemann, L., & Abdulai, A. (2013). Organic certification, agro-ecological practices and return on investment: Evidence from pineapple producers in Ghana. *Ecological Economics, 93*, 330-341.

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting & task performance*: Prentice-Hall, Inc.

Luszczynska, A., Gutiérrez-Doña, B., & Schwarzer, R. (2005). General self-efficacy in various domains of human functioning: Evidence from five countries. *International Journal of Psychology, 40*(2), 80-89.

McCarroll, M., Armbruster, S., Frasure, H., Gothard, M., Gil, K., Kavanagh, M., . . . von Gruenigen, V. (2014). Self-efficacy, quality of life, and weight loss in overweight/obese endometrial cancer survivors (SUCCEED): A randomized controlled trial. *Gynecologic oncology, 132*(2), 397-402.

Mousavi, S., & Gigerenzer, G. (2014). Risk, uncertainty, and heuristics. *Journal of Business Research, 67*(8), 1671-1678.

Mullainathan, S. (2005). *Development economics through the lens of psychology.* Paper presented at the Annual World Bank Conference in Development Economics 2005: Lessons of Experience.

Munafò, M. R., Yalcin, B., Willis-Owen, S. A., & Flint, J. (2008). Association of the dopamine D4 receptor (DRD4) gene and approach-related personality traits: meta-analysis and new data. *Biological psychiatry, 63*(2), 197-206.

Nisbett, R. E., & Cohen, D. (1996). *Culture of honor: the psychology of violence in the south*: Westview Press.

Nunn, N. (2012). Culture and the historical process. *Economic History of Developing Regions, 27*(sup1), S108-S126.

Pajares, F. (1997). Current directions in self-efficacy research. *Advances in motivation and achievement, 10*(149), 1-49.

Pajares, F. (2002). Overview of social cognitive theory and of self-efficacy.

Richerson, P. J., & Boyd, R. (2008). *Not by genes alone: How culture transformed human evolution*: University of Chicago Press.

Richerson, P. J., Boyd, R., & Henrich, J. (2010). Gene-culture coevolution in the age of genomics. *Proceedings of the National Academy of Sciences, 107*(Supplement 2), 8985-8992.

Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle* (Vol. 55): Transaction publishers.

Schwarzer, R. (2014). *Self-efficacy: Thought control of action*: Taylor & Francis.

Stajkovic, A. D., & Luthans, F. (1998). Self-efficacy and work-related performance: A meta-analysis. *Psychological bulletin, 124*(2), 240.

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

Tierney, P., & Farmer, S. M. (2011). Creative self-efficacy development and creative performance over time. *Journal of Applied Psychology, 96*(2), 277.

Waaktaar, T., & Torgersen, S. (2013). Self-efficacy is mainly genetic, not learned: a Multiple-Rater Twin Study on the causal structure of general self-efficacy in young people. *Twin Research and Human Genetics, 16*(03), 651-660.

Welzel, C. (2013). *Freedom rising*: Cambridge University Press.

Whitbeck, L. B., Simons, R. L., Conger, R. D., Wickrama, K., Ackley, K. A., & Elder Jr, G. H. (1997). The effects of parents' working conditions and family economic hardship on parenting behaviors and children's self-efficacy. *Social Psychology Quarterly*, 291-303.

Wu, J., Xiao, H., Sun, H., Zou, L., & Zhu, L.-Q. (2012). Role of dopamine receptors in ADHD: a systematic meta-analysis. *Molecular neurobiology, 45*(3), 605-620.

Wuepper, D., & Sauer, J. (2015). *Experiences in the Gold Coast and Contract Farming in Ghana: A Cultural Evolution of Self-Efficacy and Social Capital* Paper presented at the 2nd Conference of the International Association for Applied Econometrics

Table 1: Taxonomy of Self-Efficacy

	Self-Efficacy High	Self-Efficacy Low
Actual Efficacy High	Development	Unused Opportunities
Actual Efficacy Low	Ambiguous	Stagnation in Poverty

Figure 1. The Evolution of Self-Efficacy (blue) in a population of differently entrepreneurial farmers

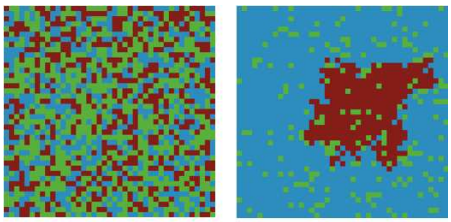
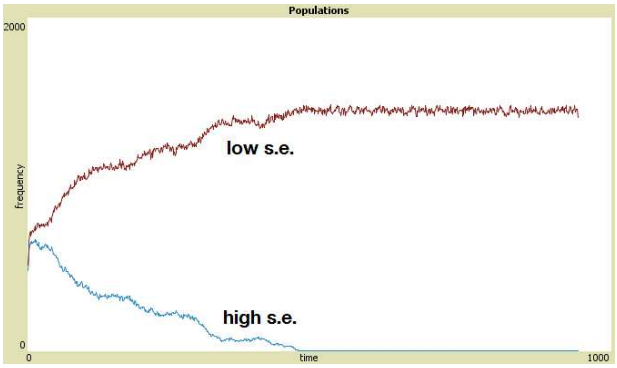
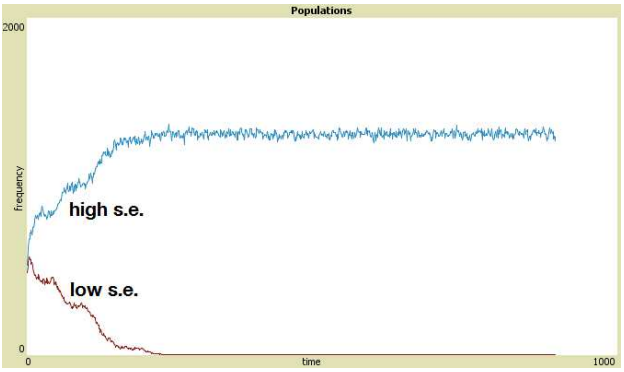


Figure 2. The Evolution of Self-Efficacy (Context A)



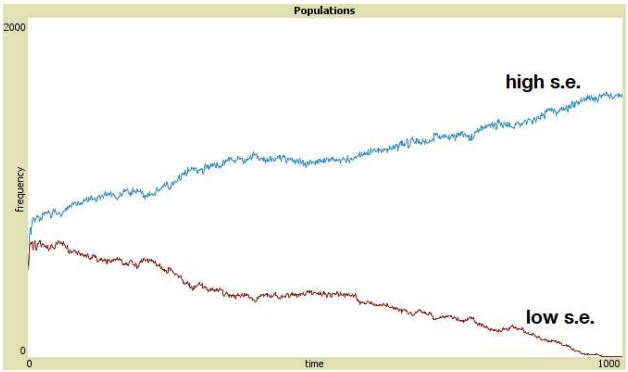
Cost=0.3 Benefit=0.4 Risk probability=0.1 Risk impact=0.5 Institutional persistence=0.5

Figure 3. The Evolution of Self-Efficacy (Context B)



Cost=0.44 Benefit=0.66 Risk probability=0.2 Risk impact=0.4 Institutional persistence=0.2

Figure 4. The Evolution of Self-Efficacy (Context C)



Cost=0.44 Benefit=0.66 Risk probability=0.2 Risk impact=0.4 Institutional persistence=0.8

Table 2. Variable Definitions

Variable	Definition
nature	Whether nature provides what the farmer needs or whether it is the task of the farmer to make nature productive (1-4).
income factor	Open question about the most important income determinants. The answers were coded as one when a purely external factor was named (weather), three for purely internal factors (learning), and two for answers in between.
planning	How far ahead the farmer plans (from a day to the life of his children).
ability	Whether his current income has been mostly determined by his decisions and abilities or rather not.
control	Whether the farmer feels to “make his life” or whether “life happens to him”.
responsibility	Whether the farmer feels responsible for the success of his farm or whether the success is mostly determined by factors he cannot influence.
work	Whether the basis of economic success is hard work and creativity or rather connections and/or luck.
pc_culture	Principal components of income factor, planning and nature.
non-farm inc A	Whether the farmer has non-farm income.
non-farm inc B	How much non-farm income the farmer has.
harvest	Natural logarithm of the annual per hectare harvest of the farmer.
adv. maize	Whether the region of the farmer had a comparative advantage in producing maize.
topography	Standard deviation of the regional elevation.
rain var	Inter annual change in rainfall.
soils	The farmers rated how much their soils limited production from one to six.
chief	The farmers rated how open their chief is for new ideas from one to four.
malaria	Malaria ecology index, capturing the Malaria risk of different regions.
farm size	Size of the farms in hectares.
price	Regional price for pineapples.
rain zone	General rainfall zone (1-4).
rain q	Reported quantity of rain on the farm from one to six.
rain t	Reported timing of rain on the farm from one to six.

Table 3. Descriptive Statistics

income_class	low		medium		high	
	mean	st.dev.	mean	st.dev.	mean	st.dev.
nature	1.78	(1.07)	2.18	(1.33)	2.77	(1.37)
income factor	1.81	(.76)	1.95	(.81)	2.29	(.75)
planning	2.63	(1.63)	3.40	(1.81)	4.13	(1.93)
ability	3.55	(.88)	3.54	(.95)	3.83	(.56)
control	3.55	(.90)	3.49	(.98)	3.80	(.60)
responsibility	3.70	(.64)	3.77	(.61)	3.82	(.57)
work	3.77	(.52)	3.84	(.42)	3.86	(.48)
non-farm inc A	.18	(.39)	.19	(.39)	.34	(.47)
non-farm inc B	.15	(.09)	.14	(.098)	.17	(.11)
pc culture	-.20	(.63)	.06	(.75)	.51	(.80)
adv. Cereals	.23	(.10)	.31	(.10)	.31	(.08)
Adv. cocoa	.10	(.10)	.10	(.09)	.10	(.10)
rain var	.18	(1.30)	-.19	(.41)	-.22	(.31)
soils	1.67	(.74)	1.65	(.82)	1.56	(.82)
chief	5.02	(1.32)	5.44	(.88)	5.59	(1.00)
malaria	.05	(.94)	-.47	(.84)	-.28	(1.00)
farmsize	2.70	(2.50)	2.89	(2.78)	4.52	(4.93)
price	.40	(.11)	.39	(.09)	.39	(.09)
rain zone	2.30	(.83)	2.42	(.82)	2.49	(.68)
rain q	4.42	(1.43)	4.48	(1.24)	4.64	(1.05)
rain t	3.93	(1.53)	3.98	(1.46)	4.46	(1.22)

Table 4. Income Factor Falsification Test

	(1) Income factor	(2) Income factor
training	-0.252***	
	(0.0729)	
non-farm A		0.0485
		(0.0577)
rain var	-0.150**	-0.150**
	(0.0671)	(0.0697)
prices	-0.0665	-0.0648
	(0.0568)	(0.0586)
rain zone	0.274	0.324
	(0.204)	(0.210)
rain q	-0.241***	-0.266***
	(0.0782)	(0.0819)
rain t	0.0889	0.142
	(0.0765)	(0.0895)
N	398	398
R-sq	0.25	0.21

Standard errors in parentheses are clustered by farm groups * p<0.1, ** p<0.05, *** p<0.01

Table 5. OLS Estimation

	(1) income	(2) income	(3) income	(4) income	(5) income	(6) income	(7) income	(8) income
ability	0.140**							
	(0.057)							
nature		0.243***						
		(0.0724)						
inc factor			0.201**					
			(0.0804)					
planning				0.220**				
				(0.0881)				
pc_culture					0.303***			
					(0.0868)			
control						0.184***		
						(0.0539)		
responsibility							0.0532*	
							(0.0314)	
work								0.00434
								(0.0522)
controls	yes	yes	yes	yes	yes	yes	yes	yes
district fe	yes	yes	yes	yes	yes	yes	yes	yes
N	398	398	398	398	398	398	398	398
R-sq	0.20	0.23	0.22	0.22	0.25	0.21	0.19	0.19

Standard errors in parentheses are clustered by farm groups * p<0.1, ** p<0.05, *** p<0.01

Table 6. Falsification Test

	(1)	(2)	(3)
2nd stage	ln income	ln income	ln income
social capital	-0.964		
	(0.971)		
non-farm A		5.594	
		(12.02)	
non-farm B			2.457
			(3.599)
1st stage	social capital	nonfarm A	nonfarm B
adv maize	-0.314	0.0541	0.123
	(0.207)	(0.116)	(0.150)
controls	yes	yes	yes
district fe	yes	yes	yes
N	398	398	398
R-sq 2nd stage			
R-sq 1st stage	0.28	0.12	0.11
F excluded	2.30	0.22	0.67

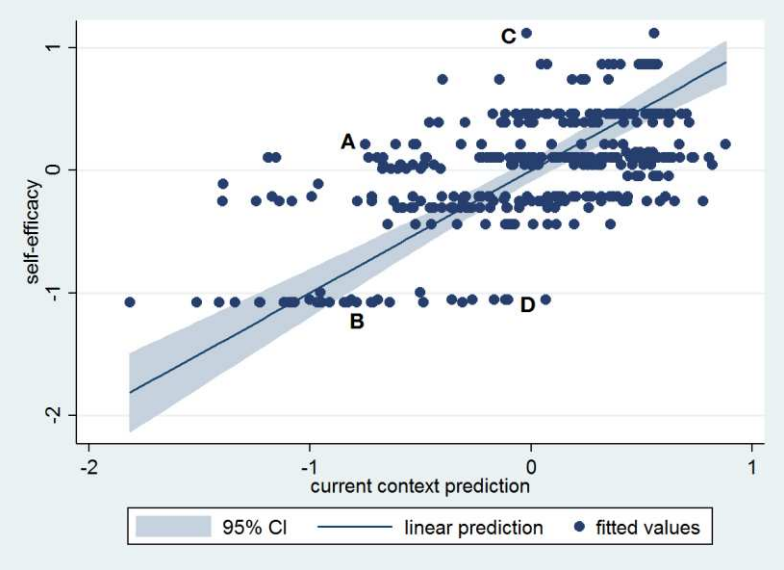
Standard errors in parentheses are clustered by farm groups * p<0.1, ** p<0.05, *** p<0.01

Table 7. Instrumental Variables Estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2nd stage	income	income	income	income	income	income	income	income
ability	0.454							
	(0.285)							
nature		0.569**						
		(0.249)						
inc factor			0.661**					
			(0.313)					
planning				0.536**				
				(0.246)				
pc_culture					0.367**			
					(0.162)			
control						0.459		
						(0.289)		
responsibility							3.668	
							(9.566)	
work								-3.564
								(10.22)
1st stage	ability	nature	inc fact	planning	pc_culture	control	Respons.	work
adv maize	0.667**	0.532**	0.458**	0.565***	0.824***	0.659**	0.0825	-0.0849
	(0.284)	(0.212)	(0.204)	(0.167)	(0.233)	(0.310)	(0.233)	(0.233)
controls	yes	yes	yes	yes	yes	yes	yes	yes
district fe	yes	yes	yes	yes	yes	yes	yes	yes
N	398	398	398	398	398	398	398	398
R-sq 2nd	0.12	0.15	0.05	0.15	0.25	0.15		
R-sq 1st	0.21	0.29	0.23	0.36	0.34	0.22	0.11	0.10
F excluded	5.51	6.32	5.03	11.37	12.49	4.53	0.13	0.13

Standard errors in parentheses are clustered by farm groups * p<0.1, ** p<0.05, *** p<0.01

Figure 5. The Current Context and the Level of Self-Efficacy



Notes: the current context prediction is based on the control variables included in all specifications. These include weather, soils, prices, farm-size and malaria pressure. Self-efficacy is the variable pc_culture, which are the principal components of "nature", "income factor" and "planning".

Table 8: Causal Channel

	(2)	(3)	(4)	(5)
2nd stage	income	income	income	income
harvest	0.405**	0.398**	0.411***	0.412***
	(0.169)	(0.199)	(0.145)	(0.139)
prices	0.120***	0.125***	0.119***	0.121***
	(0.0327)	(0.0424)	(0.032)	(0.0329)
nature	0.101			
	(0.474)			
income factor		0.123		
		(0.584)		
planning			0.084	
			(0.406)	
pc_culture				0.0589
				(0.283)
1st stage	nature	inc fact.	planning	pc_cult.
adv maize	0.315*	0.257	0.377***	0.539***
	(0.169)	(0.188)	(0.124)	(0.166)
controls	yes	yes	yes	yes
district fe	yes	yes	yes	yes
N	398	398	398	398
R-sq 2nd	0.32	0.32	0.32	0.32
R-sq 1st	0.35	0.28	0.40	0.46
F excluded	3.48	1.87	9.28	10.53

Standard errors in parentheses are clustered by farm groups * p<0.1, ** p<0.05, *** p<0.01

Table 9. Descriptive Statistics for Adoption and Dis-adoption of Innovations

Self-efficacy	low		ambiguous		high	
	mean	sd	mean	sd	mean	sd
adoption fertilizer	.576	(.495)	.767	(.427)	.614	(.488)
Dis-adoption fertilizer	.110	(.314)	.139	(.350)	.014	(.119)
adoption AEP	.079	(.271)	.162	(.373)	.192	(.395)
Dis-adoption AEP	.233	(.424)	.093	(.293)	.114	(.319)
adoption mulching	.337	(.474)	.372	(.489)	.514	(.501)
Dis-adoption mulching	.220	(.416)	.372	(.489)	.014	(.119)

Table 10. Probit Results Adoption and Dis-Adoption Dynamics

	(1) adoption fertilizer	(2) Dis-adoption fertilizer	(3) adoption AEP	(4) Dis-adoption AEP	(5) adoption mulching	(6) Dis-adoption mulching
Self-efficacy	0.0159	-0.495***	0.265***	-0.155	0.223***	-0.648***
	(0.0928)	(0.123)	(0.0895)	(0.142)	(0.0852)	(0.170)
Controls	Yes	Yes	yes	Yes	yes	Yes
Regional FE	yes	Yes	Yes	yes	Yes	yes
N	346	346	346	346	346	346
pseudo R-sq	0.12	0.20	0.06	0.37	0.12	0.19

Standard errors in parentheses are clustered by farm groups * p<0.1, ** p<0.05, *** p<0.01