The last mile problem: Insights from Cambodian smallholder farmers

by

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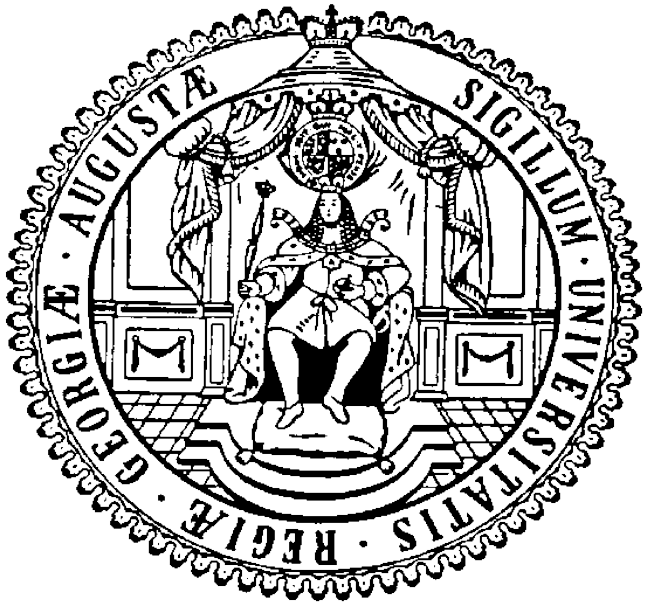
to obtain the degree of
Dr.rer.pol.**



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Contents

1 General Introduction

"So here are some other questions. They're smaller questions, but they are not that small. Immunization, that's the cheapest way to save a child's life. And the world has spent a lot of money on it: The GAVI and the Gates Foundations are each pledging a lot of money towards it, and developing countries themselves have been doing a lot of effort. And yet, every year at least 25 million children do not get the immunization they should get. So this is what you call a "last mile problem." The technology is there, the infrastructure is there, and yet it doesn't happen."

Esther Duflo
March 21, 2013

"Here I have a bunch of other examples, all suffer from the last mile problem. It's not just medicine. Here's another example from technology: agriculture. We think there's a food problem, so we create new seeds. We think there's an income problem, so we create new ways of farming that increase income. Well, look at some old ways, some ways that we'd already cracked. Intercropping. Intercropping really increases income. Sometimes in rice we found incredible increases in yield when you mix different varieties of rice side by side. Some people are doing that, many are not. What's going on? This is the last mile. The last mile is, everywhere, problematic."

Sendhil Mullainathan
Feb 2, 2010

Despite global efforts and substantial progress, 2.1 billion people still live in poverty and 736 million people live off less than 1.90 USD per day, i.e. in extreme poverty (World Bank, 2021, 2018). Over recent decades, the global population has made significant advancement with respect to fighting poverty. While 42.7% of the global population was considered to live on less than 1.90 USD per day in 1982, this percentage share has subsequently decreased to around 10% of the global population (World Bank, 2021). Similar significant improvements can be observed in other welfare indicators[1]: for example, the prevalence of being underweight in children has decreased (20% in 2000 to 12% in 2019,

[1] I chose the following time spans to report the earliest available data point for each indicator, provided by the World Bank (2021).

worldwide), child mortality under the age of 5 years has been reduced (from 9% in 1990 to 3.8% in 2019, worldwide), life expectancy has increased (from 52 years in 1960 to 72.7 years in 2019, worldwide), and the immunization of measles has improved (12.7% in 1980 to 85.6% in 2019, % of children aged 12-24 months, worldwide).

While this progress is remarkable and has changed the economic status of many individuals around the globe, the quest for poverty reduction is ongoing. However, most crucially those still living in poverty are expected to be more difficult to reach by policy measures (Pedrajas and Choritz, 2016; Chandy et al., 2015; World Bank, 2014, 2016a). The World Bank (2016a) estimates that future economic growth will most probably not translate into poverty reduction as easily as it did in the last decades. Instead, those who remain poor are now more enrooted in their economic circumstances (World Bank, 2018). Today, the vast majority of the global poor reside in rural areas, depending on agriculture as their primary source of livelihood, most often as smallholder farmers (World Bank, 2018; FAO, 2017a). These rural areas are often characterized by poor physical infrastructure and a lack of essential services. The United Nations Development Programme (UNDP) refers to this group as *the last mile*, not only referring to "the poorest of the poor, but also to the people, places, and small enterprise levels that are under-served and excluded, where development needs are greatest and resources are most scarce" (Pedrajas and Choritz, 2016, p. 8).

The *last mile problem* arises in the quest to understand why the last mile exists and how to approach its various facets. From a prescind perspective, reasons for the existence of the last mile can be attributed to the inequalities faced by those left behind (Pedrajas and Choritz, 2016). The UNDP categorizes these inequalities as being economic, social, political, or cultural in nature, all of which can lead to an individual being stuck in poverty. For example, a lack of asset ownership (economic) or access to education (social) can lead to severe disadvantages (Pedrajas and Choritz, 2016). However, Duflo (2013) and Mullainathan (2010) add another dimension, namely the human dimension. Even if a useful technology and the infrastructure are present, some individuals will simply not use it (Banerjee and Duflo, 2011; Mullainathan and Shafir, 2013).

While inequalities with respect to socio-economic characteristics are quite commonly studied, those with respect to the human dimension are rather understudied (Dean et al., 2019; Schilbach et al., 2016; Banerjee and Duflo, 2011; Nuthall, 2001). However, further research critically relates to the Sustainable Development Goals (SDGs), in particular

Goal 1 to *End poverty in all its forms everywhere* (United Nations, 2015). Understanding cognitive processes, decision-making, traits, preferences and overall behavior of individuals living in poverty is crucial to designing effective policy interventions and overall support systems.

In this study, I offer five chapters that shed light on different questions concerning the human dimension of persistent poverty in the lives of smallholder farmers, while aiming to generate a better understanding of the dimension and how to approach it. In the first chapter, I investigate cognitive capacity as a driver of persistent poverty (Dean et al., 2019). Financial scarcity can temporarily tax the cognitive capacities of an individual, leaving little mental power left for other important realms of life and thus potentially perpetuating poverty. In the second chapter, I focus on myopic spending behavior, which is particularly harmful in the lives of the poor due to the little income that they possess (Banerjee and Mullainathan, 2010). In the third chapter, I focus on learning processes. As individuals learn differently (Wan et al., 2008; Biggs, 1979, 1978), education modules that are not well tested a-priori might not properly reach the target group (Aker et al., 2016). Therefore, I look at the effectiveness of different didactic channels for e-extension products for smallholder farmers. Finally, in chapters V and VI, I focus on risk attitudes. Being highly risk averse can be one reason for an individual to be stuck in poverty, as the need for security potentially impedes individuals from making crucial investments to grow their business (Mosley and Verschoor, 2005).

1.1 Study area

I study smallholder farmers from north-eastern Cambodia. With a gross national income per capita of 1,075 USD, Cambodia is clustered as a least developed country (LDC) (United Nations, 2018). The United Nations has clustered LDCs as the "poorest and weakest segment" of the global population, with particular need for global support (United Nations, 2011, p. 7). For Cambodia, experts rate especially SDG Goal 1 as holding particular importance for graduation from the LDC category (United Nations, 2016). Thus, while experiencing economic growth over recent years, Cambodia is still facing challenges in combating poverty (World Bank, 2021), and thus it reflects a reasonable area in which to conduct this study. Furthermore, the country presents itself as a suitable area to study the life of smallholder farmers as approximately 82 percent of Cambodians are farmers, most of them rural smallholder farmers (Sotha, 2019), with each household having on average less than 2 hectares (Sotha, 2019).

Furthermore, we selected the poorest province - Ratanakiri (Royal Government of Cambodia, 2018; Asian Development Bank, 2014) - in which to undertake our data collection (see Figure 1.1). We visited villages south of the capital city of Ban Lung. While the capital is a rather modern city, the villages surrounding it are rather traditional and inhabited by ethnic minorities (Padwe, 2020). The inhabitants are grouped into twelve ethnic groups, including Jarai, Lao, Tompoen, and Khmer. Of the 150,000 citizens of Ratanakiri, 88 percent live in rural areas and they predominantly depend on smallholder agriculture (Ritzema et al., 2019; Asian Development Bank, 2014). Typically, the farmers in the province cultivate rice for self-consumption. Cassava, cashew and rubber are the main cash crops (Ritzema et al., 2019).

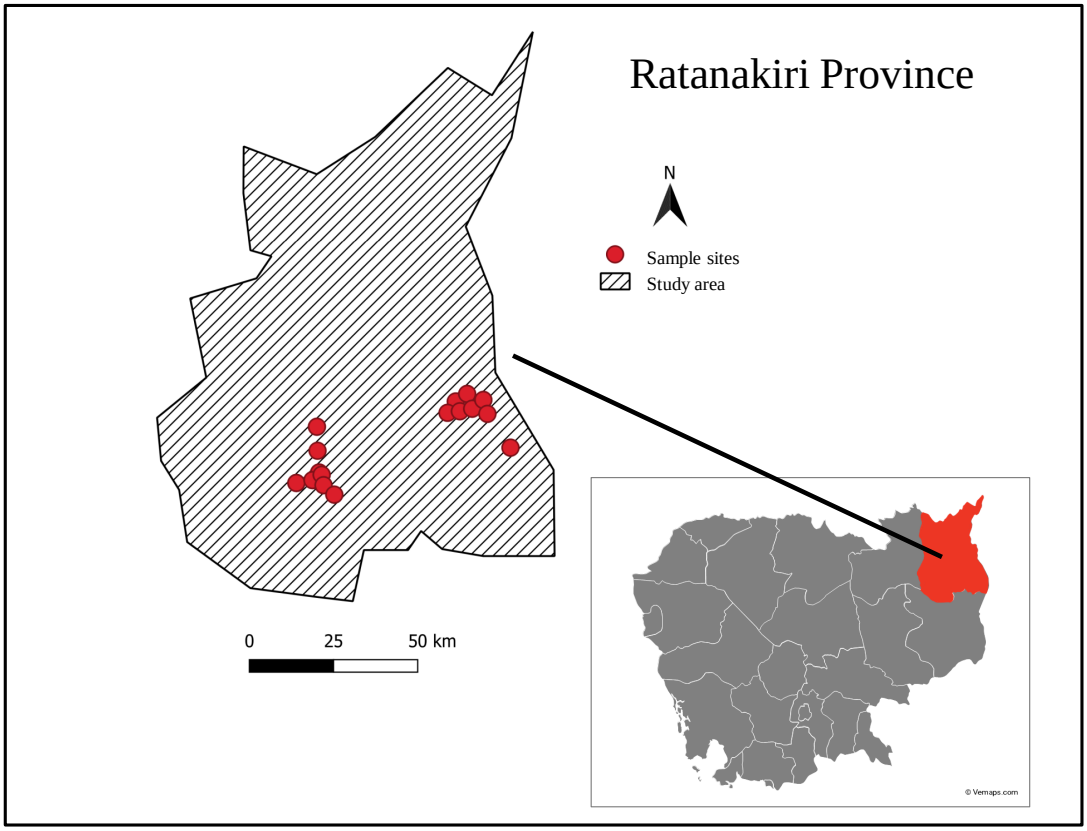

Figure 1.1: Illustration of the study region

Map of study sites complied by author, map of Cambodia retrieved from Vemaps (2019)

The study was conceptualized through an exploratory field visit in 2018. During this first stay, I conducted 18 qualitative interviews with smallholder farmers as well as other regional experts such as village chiefs, commune chiefs, extension officers and researchers. Furthermore, I visited local markets and observed local circumstances and infrastructure. Based on the insights from the pre-field visit and further desk research, a concise quantitative questionnaire was developed as well as different experiments and tests. These were tested in Cambodia again during a pilot phase among both students and smallholder farmers. After undertaking final adjustments, the questionnaire for this study was finalized.

The final data collection took place from August to October 2018. The sample spreads over sixteen villages in the province of Ratanakiri. The sample comprises 310 smallholder farmers household heads. Every participant needed to have at least basic skills in speaking and understanding the national language of Khmer. Since there are no household lists for the region available to researchers, we relied on the expert knowledge of the extension workers from the regional government. Together with the respective village officials, they carefully selected participants to generate a cross-section of the village, devoting strong attention to randomizing characteristics such as age, gender, education, and income level. Local enumerators privately guided the participants throughout the research session. Each participant first answered the questions from the questionnaire and then participated in the experimental session. After approximately three hours, the participants received a payout equivalent to a day's wage.

1.2 Research objectives

Chapter II focuses on the cognitive capacities of smallholder farmers and how these translate into economic performance. Cognitive capacities could be at the heart of the last mile problem, as they offer an explanation for the puzzling observation that some smallholder farmers use new technologies or farming practices - making them more productive - while others do not. Mullainathan and Shafir (2013) present an interesting suggestion for why this might be the case: poverty creates its own unique mindset and behaviors, as it forces the individual to mentally tunnel on their financial problems. In other words, financial scarcity temporarily taxes cognitive skills, thus leaving less capacities for all other realms of life. At the same time, Schilbach et al. (2016) highlight an inherent paucity of evidence on the relationship between cognitive function and economic performance. Put differently, while there is first evidence on the relationship between financial scarcity

and cognitive capacities (Mani et al., 2013; Mullainathan and Shafir, 2013; Haushofer and Fehr, 2014; Schilbach et al., 2016; Dean et al., 2019), it is rather unknown how this translates into economic performance especially regarding to smallholder farm managers (Dean et al., 2019; Schilbach et al., 2016).

Therefore, the first paper explores *whether the level of cognitive function can help to explain differences in economic performance – measured as technical efficiency – of smallholder farmers.* To answer the research question, we (i) measure the level of cognitive function of smallholder farmers using the Ravens Progressive Matrix test (Raven, 1938; Raven and Rust, 2008), (ii) identify and model the production process of farm output of the smallholder farmers, and (iii) estimate their efficiency and the effect of cognitive function to explain differences in economic performance. Our methodological approach relies on stochastic frontier analysis.

Chapter III addresses the consumption habits of smallholder farmers, including which goods and services are tempting to the rural population in Cambodia. In light of the last mile problem discussion, shedding light on what is perceived as a temptation good - typically defined as goods that satisfy oneself in the moment but do not benefit one's future self (Banerjee and Duflo, 2011) - is an interesting avenue to explore, as myopic spending holds the potential to trap an individual in poverty (Banerjee and Mullainathan, 2010). The reason being is that money spent on temptation goods is unavailable for spending on investments, which is especially important for individuals living in poverty. Thus far, the definition of a temptation good has mostly been predefined by researchers (Banerjee and Mullainathan, 2010). Typical candidates include alcohol and tobacco (Jumrani and Birthal, 2017; Evans and Popova, 2017), although some studies also consider sweets and sweet drinks (Aker, 2017; Dasso and Fernández, 2014), money spent on gambling (Banerjee et al., 2015) or food from restaurants (Dasso and Fernández, 2014). However, empirical definitions of temptation goods from people living in poverty are scarce, while implications can be meaningful for a wide area of research, e.g. accurate impact analyses of cash transfers.

Thus, this paper explores *what smallholder farmers view as a temptation good and whether there is a difference in the perception of a temptation good among the farmers.* For the analyses, we rely on standard socio-economic information as well as specific data collected on farmers' perception of temptation goods and their spending behavior. We analyze the data descriptively and employ a hierarchical cluster analysis to identify

homogeneous groups of individuals who recognize certain goods and services as tempting.

Chapter IV focuses on information needs and effective didactic channels to convey complex information to smallholder farmers. One prominent avenue to combat poverty is to focus on smallholder farmer business development by training farmers to engage in more efficient farm management practices or use new inputs (FAO, 2017b; Cui et al., 2018; Fabregas et al., 2019). However, farmers in rural areas are relatively costly and difficult to reach by extension workers due to the remoteness of the settlement (Davis et al., 2020; Anderson and Feder, 2007). Owing to the recent spread of mobile devices (Aker, 2011; World Bank, 2021; Demirguc-Kunt et al., 2018), information and communication technologies (ICTs) can hold the potential to complement or replace traditional extension agents by training farmers digitally (Davis et al., 2020; De Silva and Ratnadiwakara, 2008; Aker, 2011). Nonetheless, while there are increasingly more services emerging using ICTs for extension programs (Aker, 2011; Fabregas et al., 2019), their impact on the lives of rural residents is mixed (Aker et al., 2016). Thus, more rigorous ground work is needed to understand which digital extension services actually effectively reach the target population.

Therefore, this study explores *how smallholder farmers can best be served with information by ICT so that they can grow their farm business.* For the investigation, we rely on data on information needs and hardware accessibility as well as the availability of smallholder farmers. Furthermore, to investigate effective delivery channels, a framed-field experiment was conducted. The farmers were asked to build a tower with building bricks, while the instructions were communicated differently. The farmers could receive either an audio, visual, audio-visual, or demonstrative treatment. For the analysis, we employ a multiple linear regression analysis and for robustness checks a negative binominal model as well as propensity score matching.

Chapters V and VI are concerned with risk attitudes. Smallholders operate under particularly risky conditions, as they tend to live in unstable environmental, market, and household conditions (World Bank, 2016b, 2020). At the same time, the risk involved in economic decision-making is extraordinary for poor small farm managers, as investments with respect to e.g. crop cultivation and input use can be pivotal for the economic survival of the entire household. However, to interrupt the downward spiral of poverty, individuals need to take the risk of investing in human, physical or social capital, which can be a difficult endeavor without any safety net. Individuals who are risk averse to the

extent that they refuse to invest in new technologies will be less able to cope with shocks and hence might find themselves in chronic poverty (Mosley and Verschoor, 2005). Thus, risk attitudes can be a key element in the human dimension of the last mile problem.

Chapter V investigates measurement techniques of risk attitudes among low-numeracy subjects. To assess risk attitude, various methods such as stating one's own risk attitude (Dohmen et al., 2011; Weber et al., 2002), playing easy risk games (Eckel and Grossman, 2002; Gneezy and Potters, 1997; Crosetto and Filippin, 2013) or complex lotteries (Holt and Laury, 2002; Tanaka et al., 2010) have been employed. However, the most commonly used complex lotteries, revolve around abstract tasks. For example, praised as the *gold standard*, the Holt and Laury (HL) task (a very precise, yet complex binary lottery (Charness et al., 2013)) is often used by researchers, even when measuring risk attitudes among low-numeracy subjects (Verschoor et al., 2016). However, the HL task incorporates an indicator for irrational choice patterns, namely the inconsistency rate. While the inconsistency rate among high-literacy subjects is between 10-15% (Charness and Viceisza, 2016), the rate tends to be crucially higher (up to around 50%) among low-numeracy subjects from low-income countries (Jacobson and Petrie, 2009; Galarza, 2009). Given the relatively high inconsistency rates, it is suggested that complex tasks are not well suited for the poor as the data can be flawed (Brick et al., 2012). The literature hypothesizes the reason for the divergence in inconsistency levels as being due to different levels of cognitive capacity (He et al., 2018; Dave et al., 2010), although this has not yet been investigated with low-numaracy subjects.

Therefore, this essay investigates *whether cognitive skills can help to explain inconsistency levels in the HL task.* For this purpose, we conducted the HL task and the Ravens Progressive Matrix test (Raven, 1938; Raven and Rust, 2008) with the farmers in our sample from rural Cambodia. To analyze the data, we use a logit regression model, which we further split by gender.

Chapter VI investigates the role of risk attitude when choosing a microfinance institution. More precisely, this essay sheds light on the determinants to source credits from microfinance institutions (MFIs) and its competitor, namely licensed informal moneylenders. Since the microcredit market in Cambodia today is well served (Javoy and Rozas, 2015; World Bank, 2019) and reaches remote rural areas, with their substantially lower price for credits MFIs should be pushing harmful money lenders out of business. However, strikingly informal money lenders remain in the market. Researchers aiming to under-

stand the persistent demand for informal lenders have identified several advantages for the clients such as the provision of short-term loans to repay formal credits (Arnold and Booker, 2013; Phlong, 2009) or fast and discrete access to loans (Renzenbrink, 2013). However, due to the risk involved, we assume that the risk attitude of a farmer has a stronger impact on their credit choice than expected.

Therefore, this study explores *the effect of individual risk attitude on the choice between MFIs and informal commercial money lenders.* To approach this question, we draw on the Dohmen scale (Dohmen et al., 2011) to capture risk attitudes as well as socio-economic and especially credit information stated in the questionnaire. For the analysis, we employ binary and multinominal logit models.

2 The effect of cognitive function on the poor's economic performance: Evidence from Cambodian smallholder farmers

Authors: Selina Bruns, Bernhard Dalheimer, and Oliver Mußhoff

Published in: Agricultural Economics DOI:10.1111/agec.12686

Abstract

Despite manifold policy interventions, poverty still exists. Those most harshly affected are people living in rural areas of low-income countries. A seminal strand in the literature presents a promising avenue for analyzing the lives of the poor by suggesting that poverty impedes cognitive function. However, the real-world consequences of impeded cognitive function are yet to be discovered. We ask whether the level of cognitive function can help to explain the differences in economic performance of the poor. We conducted a field study in rural Cambodia using the well-established Raven's Progressive Matrix to elicit cognitive function. Employing stochastic frontier analysis, we find that the level of cognitive function of poor smallholder farmers helps in explaining differences in economic performance. Our findings suggest that impeded cognitive function results in a negative economic performance feedback loop, which can be a reason why some farmers appear to be stuck in poverty while others manage to escape it.

Keywords: Cambodia; Raven's Progressive Matrix; Stochastic Frontier Analysis; Smallholders; Cognitive Load

JEL Codes: Q10, Q12, D91

3 An empirical identification of temptation goods: Perceptions of Cambodian smallholder farmers

Authors: Selina Bruns and Oliver Mußhoff

Published in: Applied Economics, DOI:10.1080/00036846.2021.1983147

Abstract

Spending money on goods that satisfy oneself at the moment but not necessarily in the future – temptation goods – is a bothersome habit that applies to most people. However, with very low income, spending on temptation goods can potentially trap a household in chronic poverty, as such spending further minimizes the little financial resources crucially needed. Yet, although studies have included temptation goods into their household analysis, there is no empirical in-depth investigation of what exactly is perceived as a temptation good by one of the most marginalized groups: smallholder farmers residing in the Global South. Therefore, employing descriptive statistics and hierarchical cluster analysis, this paper presents an empirical definition of temptation goods provided by 277 smallholder farmers from rural Cambodia. Our findings partly differ from those found in the literature. For example, while farmers most frequently perceive alcohol, tobacco, and sweets as tempting, they also define unexpected items such as communication, recreation and entertainment, fruit, clothes, and going to the hairdresser as temptation goods. The results hold strong importance for accurate calculations and to understand the often puzzling spending behavior of the poor, as well as coming up with custom-fit policy interventions that promote long-term welfare-increasing consumption behavior.

Keywords: Cambodia; Alcohol; Smoking; Poverty; Cluster Analysis

JEL Codes: O53, P46, I30

4 Information Needs and Delivery Channels: Experimental Evidence from Cambodian Smallholders

Authors: Selina Bruns, Oliver Mußhoff, and Pascal Ströhlein

Published in: The International Federation of Library Associations and Institutions (IFLA) Journal, DOI: 10.1177/03400352211057148

Abstract

Despite manifold policy interventions, poverty still exists. Those most harshly affected are people living in rural areas of low-income countries, regions that are often characterized by information asymmetries leading to market failure. The widespread growth of information and telecommunication technologies (ICTs) in remote areas across the world holds immense potential for lifting information barriers of the rural poor. However, there is little evidence on the effectiveness of delivery channels, which might be one reason why digital advisory differs in its impact. Seeking to ascertain how smallholders can best be served by ICT, we investigate information needs and effective ICT delivery channels. We collected sociodemographic and ICT-related data and conducted a framed field experiment with smallholders in Cambodia, asking them to build an object, while using varying delivery channels for the instruction. Employing different regression techniques and matching algorithms, the experiment reveals that multi-sensory instructions trump all others.

Keywords: Extension Services, Didactics, Pictures, Audio, Multisensory Learning, Poverty

JEL Codes: Q10, Q12, I24

5 Investigating inconsistencies in complex lotteries: The role of cognitive skills of low-numeracy subjects

Authors: Selina Bruns, Daniel Hermann, and Oliver Mußhoff

Published in: Journal of Behavioral and Experimental Economics, DOI:10.1016/j.socec.2022.101840

Abstract

Comprehension in risk elicitation tasks is crucial, as otherwise the results are rather noisy than reliable. One prominent risk-elicitation tool, the Holt and Laury task (HL-task), is particularly prone to a noisy outcome - indicated by high inconsistency levels - when used among low-literacy subjects. Yet, it is unclear what drives inconsistencies. In this note we investigate the HL-task inconsistency levels of 247 smallholder farmers from rural Cambodia. Cognitive skills, measured through Raven's Progressive Matrices (RPM), are a statistically significant determinant of inconsistency levels. A second step in the analysis reveals that cognitive skills are a statistically significant explanation for inconsistency levels for men, but not for women. Our results suggest that researchers should conduct a comprehensive pre-test when aiming at using abstract risk-elicitation methods among low-numeracy subjects in the field.

Keywords: risk measurement, risk attitude, Raven's Progressive Matrices, binary lottery, South-East Asia

JEL Codes: Q10, Q12, D81, C91, C93

6 A Cambodian smallholder farmer's choice between microfinance institutes and informal commercial moneylenders: the role of risk attitude

Authors: Annkathrin Possner, Selina Bruns, and Oliver Mußhoff
Published in: Agricultural Finance Review, DOI: 10.1108/afr-07-2020-0105

Abstract

The purpose of this paper is to examine the extent to which individual risk attitude determines a Cambodian smallholder's choice between a commercial informal loan and a credit from a licensed microfinance institution. The paper analyzes a sample of smallholder farmers in the Ratanakiri province in northeastern Cambodia, a country with a long history of microfinance and a saturated microcredit market. Employing a binary and a multinomial logit model, this paper assesses the effect of individual risk attitude on the choice of a financial instrument. The results reveal a statistically significant relationship between the choice of a credit source and an individual's risk attitude: On average (c.p.) the less risk averse the smallholder is, the more they tend to prefer an unlicensed commercial lender. The findings suggest that less risk averse individuals tend to take up riskier and generally more expensive informal loans. Measures to increase the safe access to financial services for less risk averse borrowers as well as improvements in financial literacy should be undertaken to protect smallholders from taking risky choices. Although existing studies have examined the importance of risk attitudes between credit provider and borrower, they focus mainly on the lender's perspective. This paper provides new insights on how risk attitude influences the borrower's choice in Cambodia. Thus, this study is relevant for policymakers in countries with over-saturated microcredit markets and a high prevalence of informal lenders.

Keywords: Microcredit, Developing country, Risk aversion, Borrowing

JEL Codes: Q10, Q12, Q14

7 General Conclusion

Over recent decades, the world community has made tremendous achievements in the fight against poverty. Nonetheless, poverty still exists and it is becoming increasingly difficult to tackle. Understanding why some individuals are still living in poverty and which instruments are needed to combat poverty is a complex endeavor that falls under the umbrella term of the last mile problem. Smallholder farmers in the Global South are particularly prone to be vulnerable despite the knowledge and many existing innovations that could potentially be welfare increasing. Thus, understanding the human dimension of the last mile problem seems crucial to make supporting products, services, and systems useful to the people living in poverty.

This dissertation contributes to providing novel empirical evidence on selected issues to the existing literature on the last mile problem, relying on primary data from rural Cambodian smallholder farmers. The analysis relies on a comprehensive quantitative questionnaire as well as two experiments and one test, namely a directly incentivized complex lottery to capture risk attitudes, a framed-field experiment to elicit effective learning channels, as well as a test to record cognitive capacity.

7.1 Summary of results and policy recommendations

The first essay (chapter II) explores whether cognitive capacity can help to explain the economic performance – expressed as technical efficiency – of smallholder farmers. While many studies use technical efficiency to understand economic performance, psychological explanatory factors are seldom included when it comes to explaining the determinants of a farmer's efficiency level. However, especially cognitive capacity is an interesting, previously-omitted determinant of the efficiency of a farm manager, as literature suggests it to be an important capacity that can be taxed by financial scarcity. To approach this question, the Ravens Progressive Matrix test was used to measure cognitive function as well as primary data on sociodemographic and farm production characteristics. We model technical efficiency using stochastic frontier analysis. The main finding is that

both the level of cognitive capacity as well as technical efficiency are relatively low. Furthermore, we find that the level of cognitive capacity of poor smallholder farmers helps in explaining differences in economic performance.

More generally, our results emphasize that the level of cognitive capacity influences economic performance. Many of the policy interventions to address poverty focus on factors that are exogenous to individuals, such as education and infrastructure. However, our study suggests that such measures could partly be off target if vulnerable individuals are experiencing impeded cognitive capacity. Furthermore, when incorporating the possibility of cognitive load caused by financial scarcity as a reason for impeded cognitive capacity, our results suggest that cognitive impairment can be a reason why some farmers appear to be stuck in poverty while others manage to escape it. Nonetheless, if cognitive capacity is not accounted for when designing interventions for smallholder farmers, those most mentally burdened might be left behind. We suggest accounting for low cognitive power by providing unconditional cash transfers or safety nets such as insurance for the poor to fall back on and including defaults such as regular input deliveries to avoid further taxing the limited cognitive resources of the poor. By carefully designing policy interventions to meet the need of those with low cognitive capacity, small farm managers will gain opportunities to engage in new business activities rather than being excluded from even making such a choice.

The second essay (chapter III) investigates the perception of temptation goods from the viewpoint of the smallholder farmers. While temptation goods are often included in impact analysis studies – for example, when assessing the effect of cash transfers – these temptation goods are most commonly not empirically defined. Therefore, researchers most often tend to consider alcohol and cigarettes in their analyses. Similarly, when debating about taxing or subsidizing goods to incentivize welfare-increasing spending behavior, empirical evidence on what is actually tempting to the specific target population is key. For investigating temptation goods empirically, this essay relies on primary data on socio-demographics, consumption behavior and the perception of temptation goods in rural Cambodia. For the analysis, descriptive statistics as well as a hierarchical cluster analysis was employed. Our main findings reveal that a temptation good is much more than only alcohol and cigarettes, whereby it can be anything from fruit to celebrations and funerals and it appear to involve items on which the individual already spends a fair share of her income. Furthermore, synergies can be found between certain temptation goods such as alcohol, tobacco, and communication or sweets, sweet beverages, and fruits.

Popular policy interventions to address chronic poverty include conditional and unconditional cash transfers, i.e. the provision of cash to low-income individuals, which can be used by the recipient as wished. However, policy-makers might also aim for incentivizing consumption patterns that lead to long-term welfare for an individual and society as a whole. Thus, it is crucial to understand how additional cash distributed to people living in poverty is spent and impact analyses of these policies need to be accurate. When only considering spending on alcohol and tobacco as spending on temptation goods – as is widely the case – then our results suggest that this will not cover the perception of temptation among people living in poverty. We show that the perceptions of temptation goods from our respondents can be rather different from the conventional definitions and thus can contribute to deriving better estimates of actual temptation spending. Moreover, theoretically-defined work mostly considers alcohol and tobacco to be tempting for the poor, which leads to the straightforward policy intervention of taxing temptation goods to reduce consumption. However, our results suggest that some individuals do not even perceive alcohol and tobacco as a temptation good, or they have an array of alternative temptations to purchase in case the price of alcohol or tobacco rises. Our results even suggests that it can be beneficial to policy makers to substitute certain goods due to synergies within the clusters.

The third essay (chapter IV) investigates how smallholder farmers can best be served with information by ICT, as to date it is unclear how to effectively communicate information to them. In north-eastern Cambodia – like in many remote rural areas – the smallholder farmers are in major need of more information to grow their business. This information can be split into less complex information (e.g. price or weather data) and more complex information (e.g. how to apply fertilizer). While there is a strong demand for information, supply is weak. Traditionally, farmers are reached by extension officers to provide help, training, and information. However, due to the high transaction costs and scarce human resources, the ratio of farmers to extension workers is extremely low. With the rise of mobile phone coverage around the world, many operators have emerged providing information to smallholders digitally, aiming to close that information gap. However, the effect of digital information on the economic lives of the smallholders is ambiguous, and research on effective didactic channels – especially for conveying complex information – is scarce.

We set up a framed-field experiment to understand the effectiveness of different informa-

tion delivery channels. The farmers were asked to build a tower from building bricks. For the instruction, they randomly received one of the four treatments: 1) audio treatment, 2) visual treatment, 3) audio-visual treatment, or 4) demonstrative treatment. After having completed the building process, the team counted the number of mistakes, which was then later used to assess the effectiveness of the treatment. Furthermore, we also collected information on information needs, hardware and mobile network availability, and household preferences. Our main findings include the notion that farmers' highest information demand relates to crop cultivation and they demand more information on prices, weather, pesticide and fertilizer application. Moreover, with respect to our experiment, we find that information delivery works best when multiple senses are addressed.

Taken together, we thus recommend to the Cambodian government to initiate an IVR system to inform farmers on cultivation practices. For this purpose, policy-makers can start off by running a marketing campaign to advertise to farmers the number they can call for cultivation information on the most typical crops, and perhaps also new, promising crops. Once the farmers know where to call, they can reach out to the IVR system whenever needed and be automatically informed about the most frequent questions. The advantage of the IVR system is that it can support multiple callers at the same time and it only requires human resources and expertise during set-up and not on a daily basis. The IVR system can further be complimented by a radio or TV cultivation information campaign and extension workers reaching out to the villages.

More generally, we recommend that policy-makers should aim for hybrid extension services where extension agents as well as digital information delivery provide information to farmers. Moreover, we recommend aiming for multi-sensory learning material and material that can be stored and thus revisited by the farmer whenever she needs the respective information. Furthermore, while in our specific region there were no farmer associations reported, these structures could be utilized to provide information without the need for every farmer to possess a mobile phone or any other hardware. The groups could receive printed material to hand out and organize public viewing events of – for example – videos of farming practices.

The fourth essay (chapter V) assesses the appropriateness of a complex risk elicitation method – the HL lottery – for low-numeracy samples. While it holds strong importance to understand risk attitudes of smallholder farmers, e.g. to suggest suitable assisting policy instruments for technology uptake, the elicitation practices in the field are challenging.

While there is a wide range of instruments available – from self-stated attitudes over intuitive, domain specific experiments to complex lotteries – researchers tend to prefer the HL task as it yields detailed information on risk attitudes, if fully understood. However, when played with low-numeracy subjects, the information is typically relatively noisy, as seen by the high inconsistency levels. The reason for such high inconsistencies remains opaque, even though the literature hypothesizes that it is due to cognitive capacities. This essay tests this hypothesis by analyzing the inconsistency levels within the HL task, taking into account sociodemographic characteristics and cognitive capacities measured through the Raven's Progressive Matrix. We employ a probit regression to investigate the relationship. In synthesis, our field study reveals that cognitive skills can explain the inconsistencies in the HL task. Furthermore, our analysis suggests that cognitive skills are only a reliable indicator for inconsistent choice behavior of men.

From our findings, we draw that when aiming to measure risk attitudes in the field, researchers always face the trade-off between complex and simple methods. A complex task – such as the HL task – might reveal finer information, although the participants might not understand it and therefore the information is less meaningful. Our study suggests that the reason for inconsistencies is a lack of understanding, even though we can only confirm this for men. The specific reasons for why women show inconsistent choice patterns is yet to be investigated. Therefore, if applied in the field, researchers should consider incorporating the RPM test into their pre-test endeavors to understand potential suitability of the HL task for the respective sample.

Finally, the fifth essay (chapter VI) asks whether risk attitude is a relevant decision driver for the choice of a microcredit provider. Especially small farm managers need to be able to borrow to grow their business. However, money borrowed from informal money lenders is often attached to high interest rates and social pressure, while credits offered by microfinance institutions often entail lower interest rates but are further away and tend to be more difficult to approach. Nonetheless, it remains unclear why the risky and potentially harmful loan from an informal money lender is still able to compete with the apparently ubiquitous formal credit. In this essay, it is hypothesized that risk attitude might play an important role. The analysis relies on self-reported risk attitude, information provided on credit consumption and socio-economic characteristics. A binary logistic regression and a multinomial logistic regression are employed to assess the relationship between the choice of the credit source and risk attitude/other socio-demographics. The results reveal that respondents who consider themselves to be risk-seeking tend to turn to an

informal money lender when they need credit.

Our findings add the importance of risk attitude to the debate of choosing a microfinance provider. One possible assumption is that due to the *microfinance mission drift* MFIs shift their attention towards wealthier clients and potential poorer borrowers either have more difficulties accessing formal financial services or make ill-informed gut decisions when deciding on a credit source. It might also be rather complicated for a person to apply for a loan officially, which might cause riskier individuals to simply take up informal loans. Thus, we recommend that financial institutions in the Mekong Delta should make more efforts in terms of conveying information on rules and procedures, offering low-threshold services.

While the essays presented above reveal novel insights by themselves, interesting insights can be derived when looking at some combinations. The first essay presents evidence that cognitive capacity is an important aspect to consider when designing policy instruments for people living in poverty; for example, by providing inputs with default systems or unconditional cash transfers. While with unconditional cash transfers one worry might be that people start to spend it on temptation goods, i.e. alcohol and/or cigarettes, findings from essay II might ease things out. The farmers in Ratanakiri find a large variety of things tempting; for example, sweets, sweet drinks, fruits, clothes and money spent on communication. Thus, even though they were to spend some of the additional money on temptation goods, the second essay suggests that this would not necessarily mean that it is spent on alcohol.

Moreover, the insights at the level of cognitive capacity and its effect on economic performance from the first essay might also be interesting for the e-learning study presented in the second essay. E-learning holds strong potential beyond cutting transaction costs and reaching more farmers than traditional extension workers, given that farmers can store the information. With traditional extension sessions – for example, training in the village – the farmer might be cognitively taxed during the session and thus unable to absorb the information. Furthermore, the information might not be interesting to the farmer as she might not need it at the given moment, whereby back in her field she thus cannot make use of the potentially productivity increasing information provided in the training. However, in case the farmer has an IVR system that she can call or a voice message/pictures/videos that she can store on her mobile devise and access at the point of need, she can make use of that information even though she might be mentally taxed.

7.2 Limitations and future research

Naturally, the insights and policy implications of this dissertation presented are not free from methodological and conceptual limitations. In the following, the most important limitations will be touched upon, as well as insights from these.

All essays built on the same data set and thus discussing limitations in the sampling procedure and external validity is worthwhile. As Ratanakiri province is rather remote, visiting all areas of the province was unfortunately not possible due to the lack of infrastructure. Some villages in the north of the province are so remote that they can only be reached by boat and local experts found it impossible to go there during the rainy season, even if we planned for multiple days of travel. Thus, we were only able to visit the villages south of the capital Ban Lung. Nonetheless, we managed to include one extremely remote village, as the local experts helped us to invite the villagers to a less remote area. Therefore, while we managed to balance the sample with respect to many variables – for example, we capture a wide range of the ethnic groups residing in all of Ratanakiri – the geographical variance is limited. Future research might want to include phone interviews in the province of Ratanakiri to reach farmers living in the very north of the province. Furthermore, the work presented in this dissertation could be replicated in other countries to move from empirical evidence from rural Cambodia to broader evidence.

Furthermore, specifically with respect to the five essays, interesting avenues for future research exist. In the first essay, the main drawback recognized is that we lack a pre-post comparison of cognitive capacity in the field. To understand the entire link – i.e. the link between poverty and cognitive capacity and then the link between cognitive capacity and economic performance – one would need to capture cognitive capacity and production data in a time of financial abundance and financial scarcity in a within-subject design. We focus our stochastic frontier analysis solely on the latter link – i.e. the relationship between cognitive capacity and economic performance – but would extend it in case we had pre-post data. Future research might benefit from collecting data at two points in time.

Additionally, many other avenues for future research exist. While we added cognitive

capacity as a determinant of technical efficiency, many other psychological variables as well as personal traits might be interesting to investigate in this context. For example, we measured fluid intelligence to capture cognitive capacity, but there are many other variables where evidence on economic performance is scarce and that can be measured experimentally; for example, attention or memory (see Dean et al. (2019) for a comprehensive overview and practical measurement advice). Furthermore, other variables deviating from the typical socio-economic determinants employed could reveal interesting insights. For example, little is known about the effect of eyesight or hearing capacity on economic performance. While in western societies glasses and hearing aids are commonly seen, they are rather seldom seen in rural regions, especially not in Ratanakiri province. It might be a fair hypothesis to believe that the lack of hearing or visual aid impairs a small farm manager from getting the most out of her business.

Results from the second, third and fifth essay suggest that adjustments in the survey and the experimental design might be a fruitful exercise to investigate the robustness of our findings. For example, with respect to the second essay regarding the investigation of temptation goods, one important limitation of the study is the way in which the farmers understood and stated their perception of a temptation good. Despite our careful survey design, we have good reason to believe that the participants only thought about the goods/services that they consume themselves when considering temptation goods. Therefore, eliciting the perception of temptation in different ways might also reveal what society as a whole finds tempting. Furthermore, interesting supplementary questions could be added to a survey, e.g. on perceived attributes of microfinance institutions (essay V) preferences of e-learning feedback loops (essay III). Also, Regarding the third essay, it might be a worthwhile endeavor to change the incentivization stricture of the experiment, as a direct incentivization might lead to an even stronger motivation of the participants.

In the fourth essay, focusing on the relationship between errors in risk attitude measurement and cognitive capacities of low-numeracy subjects, we find that our results only hold for male but not female participants. Thus, further replicating and – if proven robust – investigating why cognitive capacities only explain inconsistencies in the HL task for men is an interesting future avenue to pursue.

Taken together, a general future avenue – especially following from the experiment presented in chapter III – is to design randomized control trials to come up with particularly

precise evidence-based policy recommendations. Furthermore, in light of the last mile problem and all of the associated challenges, Mullainathan (2010) has an interesting suggestion, namely to move away from the last mile problem and towards a last mile opportunity. The opportunity lays in the chance for researchers to work even more interdisciplinary, combine expertise from economics, psychology, anthropology, medicine, geography and other disciplines to understand the world of the people living in poverty in rural remote areas and come up with solutions that include the human dimension in an evidence-based manner. Approaching the last mile problem seems to mean approaching many very precise questions in interdisciplinary teams, reflecting an interesting quest with much room for innovative ideas.

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Declarations

Declaration of contribution

I herewith declare my specific contribution to each of the essays presented in this dissertation.

The first essay *The effect of cognitive function on the poor's economic performance: Evidence from Cambodian smallholder farmers* was composed by Selina Bruns (SB), Dr. Bernhard Dalheimer (BD), and Prof. Dr. Oliver Mußhoff (OM) and was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation). SB conceptualized the research idea and the approach to collect the data in the field, under the supervision of OM. SB managed and collected the data. BD developed the empirical strategy and implemented the econometric modelling. SB drafted the manuscript with support and from BD and OM. OM critically revisited the manuscript contributing important intellectual content. All authors edited the manuscript.

The second essay *An empirical identification of temptation goods: Perceptions of Cambodian smallholder farmers* was composed by Selina Bruns (SB) and Prof. Dr. Oliver Mußhoff (OM) and was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation). SB conceptualized the research idea and the approach to collect the data in the field, under the supervision of OM. SB managed and collected the data. SB identified and implemented the analytical modelling. SB drafted the manuscript with support from OM. OM critically revisited the the conceptual ideas and analytical approaches as well as the manuscript, contributing important intellectual content. All authors edited the manuscript.

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OM. SB identified and implemented the analytical modelling. SB drafted the manuscript with support from OM. OM critically revisited the the conceptual ideas and analytical approaches as well as the manuscript, contributing important intellectual content. All authors edited the manuscript.

The fourth essay *Investigating inconsistencies in complex lotteries: The role of cognitive skills of low-numeracy subjects* was composed by Selina Bruns (SB), Dr. Dr. Daniel Hermann (DH), and Prof. Dr. Oliver Mußhoff (OM) and was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation). SB conceptualized the research idea and developed and implemented the data collection, with guidance from OM and DH. DH guided and strongly supported SB in sharpening the focus of the study. DH and SB undertook the data analysis. SB drafted the manuscript with support from OM and DH. OM critically revisited the the conceptual ideas and analytical approaches as well as the manuscript at all stages, contributing important intellectual content. All authors edited the manuscript.

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Author declaration

1. I, hereby, declare that this Ph.D. dissertation has no not been presented to any other examining body either in its present or a similar form. Furthermore, I also affirm that I have not applied for a Ph.D. at any other higher school of education.

Göttingen, ...

Selina Bruns

2. I, hereby, solemnly declare that this dissertation was undertaken independently and without any unauthorised aid.

Göttingen, ...

Selina Bruns