Abstract

Health and Credit in Sub-Saharan Africa

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Abstract

This dissertation explores two important development policies, the introduction of microcredit, and access to free anti-retroviral medications, including the causal impact of providing access through a randomized control trial, and exploring expectations of policy outcomes through a new and innovative survey design. The first chapter conducts an impact evaluation of the introduction of microcredit in rural Ethiopia. Despite the prominence of micro-finance in development policy, only few rigorous impact evaluations have been conducted to date, a large majority in Asia. We describe the results of two parallel large-scale randomized controlled trials completed between 2003 and 2006 in rural Amhara and Oromiya (Ethiopia). We first document that borrowing increased substantially in communities where the programs started their operations. However, we find only mixed evidence of improvements in economic activities, including agriculture, animal husbandry and non-farm self-employment. We find instead that the introduction of micro-credit was overall associated with significant improvements in school attendance among 10-16 years old boys and (in Amhara only) among children of age 6-9 of either gender. Implications of the imperfect compliance with the experimental protocol are also discussed.

The second chapter explores the evidence that suggests that even in a setting where medications are free, HIV positive patients do not always follow doctors recommendations to take anti-retroviral therapy (ART). In Tanzania, a country disproportionately affected by the HIV/AIDS epidemic, 20% of HIV-positive persons in
our study sample do not fully adhere to their medication regimen. Individuals who take ART face a tradeoff between decreasing risk of death due to HIV and increasing risk of adverse side effects. The decision of whether or not to start and continue ART depends on the patient’s subjective expectations about the realization of health outcomes under different levels of adherence.

This paper combines new and innovative data on probabilistic expectations and elicited discount rates with self-reported measures of adherence to analyze individual beliefs about the effectiveness of available medication, and more specifically, how these beliefs influence individuals decisions to adhere to a medication regime. Medical literature suggests that in order for ART to be effective, 95% of doses must be taken on time, and we find that patients are aware of this threshold. They report a dramatic increase in the probability of mortality between fully adhering and taking less than 95% of doses.

Comparing elicited expectations with realized outcomes, we find that predictions of health outcomes were significantly different than realized outcomes in the following period. Respondents learned that perfectly adhering did not make them feel as good as they thought it would, and conversely, that imperfectly adhering did not make them feel as badly as they thought it would. In addition, respondents who were not on ART significantly overestimated being in worse health. As such, we would expect that individuals’ expectations would adjust over time to match more closely with realized outcomes. Examining how expectations change over time, we find that individuals update their expectations consistent with a Bayesian updating framework in which current expectations are determined by prior beliefs and new information.

Significant predictors of expectations include, overall health, completion of primary school, past choices, and patience as it related to health. Patience is measured by questions in the new survey allowing the estimation of a person-specific discount factor. This elicited discount factor (higher indicates more patience) does not vary v
significantly by gender, but HIV-positive respondents are significantly less patient than HIV-negative respondents.

Finally, incorporating elicited expectations we find that perceived effectiveness is an important predictor of taking ART, specifically respondents are less likely to take ART if they believe that taking it will worsen their health or increase their chances of mortality. Perceptions of the medications’ effectiveness at reducing viral loads are significant predictors of perfect adherence and there is also evidence that adherence decisions are consistent with respondents’ desire to avoid feeling nauseous, but that feeling fatigued may be associated with the effectiveness of ART.

Overall, this paper provides an analysis of individual subjective expectations data in an HIV/AIDS context and provides evidence that while individual subjective expectations do not accurately predict future health outcomes, they significantly influence adherence decisions. It is not sufficient to only use observable characteristics of HIV patients when analyzing adherence, as their expectations of the future comprise a large component of their decision to fully adhere to their medication regimen.
Dedication

To my dad, Jeff, for his constant love, support, advice, and encouragement.

To my grandfather, Arnold Johnson, for instilling in me the value of education by saving for his future family’s education early in his life, and who’s financial assistance has made college and graduate school a possibility for me.

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## Contents

Abstract iv  
List of Tables xii  
List of Figures xv  
List of Abbreviations and Symbols xvi  
Acknowledgements xvii  

1 Introduction 1  
  1.1 Framework 2  
  1.2 Microfinance 3  
  1.3 Anti-Retroviral Therapy 4  
  1.4 Conclusion 5  

2 On the Impact of Microcredit: Evidence from a Randomized Intervention in Rural Ethiopia 6  
  2.1 Introduction 6  
  2.2 Study Area, Experimental Design and Baseline Summary Statistics 10  
    2.2.1 Experimental Design 12  
    2.2.2 Baseline Summary Statistics 14  
    2.2.3 Migration 19  
  2.3 Estimation Methodology and Results 20  
    2.3.1 Impact on Borrowing Behavior 23
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.2 Impact on Households’ Economic Activities</td>
<td>25</td>
</tr>
<tr>
<td>2.3.3 Impacts on Child Schooling</td>
<td>29</td>
</tr>
<tr>
<td>2.3.4 Impacts on Other Outcomes</td>
<td>32</td>
</tr>
<tr>
<td>2.4 Conclusions</td>
<td>33</td>
</tr>
<tr>
<td>2.5 Tables and Figures</td>
<td>38</td>
</tr>
<tr>
<td>2.6 Appendix</td>
<td>50</td>
</tr>
<tr>
<td>2.6.1 Detailed Description of Outcomes</td>
<td>50</td>
</tr>
<tr>
<td>2.6.2 Alternative Model Specifications</td>
<td>52</td>
</tr>
<tr>
<td>3 Subjective Expectations and Adherence to Anti-Retroviral Medication:</td>
<td>61</td>
</tr>
<tr>
<td>Evidence from Tanzania</td>
<td></td>
</tr>
<tr>
<td>3.1 Introduction</td>
<td>61</td>
</tr>
<tr>
<td>3.2 Medical Background</td>
<td>66</td>
</tr>
<tr>
<td>3.3 Data</td>
<td>69</td>
</tr>
<tr>
<td>3.3.1 Description of CHAT Survey</td>
<td>69</td>
</tr>
<tr>
<td>3.3.2 Survey Construction</td>
<td>71</td>
</tr>
<tr>
<td>3.3.3 Summary Statistics</td>
<td>72</td>
</tr>
<tr>
<td>3.3.4 Sample Attrition</td>
<td>74</td>
</tr>
<tr>
<td>3.4 Description of Data</td>
<td>75</td>
</tr>
<tr>
<td>3.4.1 Adherence</td>
<td>75</td>
</tr>
<tr>
<td>3.4.2 Expectations Response Patterns</td>
<td>77</td>
</tr>
<tr>
<td>3.4.3 Health Time Discounting</td>
<td>82</td>
</tr>
<tr>
<td>3.4.4 Predictors of Beliefs</td>
<td>85</td>
</tr>
<tr>
<td>3.5 Analysis of Adherence Decision</td>
<td>90</td>
</tr>
<tr>
<td>3.5.1 Structural Estimation</td>
<td>90</td>
</tr>
<tr>
<td>3.5.2 Reduced Form</td>
<td>96</td>
</tr>
<tr>
<td>3.5.3 Perceived Benefits of Adherence</td>
<td>97</td>
</tr>
</tbody>
</table>
3.6 Conclusions ......................................................... 99
3.7 Tables and Figures ............................................. 101

4 Conclusion ......................................................... 125
  4.1 Incorporating Expectations .................................... 125
  4.2 Incorporating Randomized Design .............................. 126
  4.3 Time Preference and Summary ................................. 129

A CHAT: Appendix Tables ............................................ 130
  A.1 Summary ......................................................... 130
  A.2 Attrition ........................................................ 131
  A.3 Adherence ....................................................... 132
  A.4 Expectations Distributions ..................................... 135
  A.5 Accuracy of Beliefs ............................................ 139
  A.6 Discount Rates .................................................. 142
  A.7 Predictors of Expectations ..................................... 144
  A.8 Updating Expectations .......................................... 149
  A.9 Population Transition Probabilities ......................... 152

B CHAT: Survey Construction and Focus Group Discussions 153
  B.1 General Questions ............................................. 155
  B.2 Instructions for Probabilistic Expectations .................. 156
  B.3 Comprehension Questions ....................................... 157
  B.4 Expectations Questions ......................................... 158
  B.5 Health Discount Rate Questions .............................. 159
  B.6 Time Preferences Money ......................................... 163
  B.7 Risk Preferences - Health ...................................... 165
  B.8 Reasons for non-Adherence .................................... 167
C CHAT: Variable Construction 169

D CHAT: Focal Point and Anchoring Analysis 180
  D.1 Anchoring effects ........................................ 180
  D.2 Focal points ............................................. 181

Bibliography 187

Biography 194
List of Tables

2.1 Summary Statistics (Oromiya) ............................................. 39
2.2 Summary Statistics (Amhara) ............................................. 40
2.3 Predictors of Actual Treatment Status ................................. 41
2.4 Impacts on Borrowing .................................................... 42
2.5 Impacts on non-Farm Business Activities .............................. 43
2.6 Impacts on Animal Husbandry .......................................... 44
2.7 Impacts on Agricultural Activities ...................................... 45
2.8 Impacts on Income from Wages and Other Sources ................. 46
2.9 Impacts on Labor Supply, Adults .................................. 47
2.10 Impacts on School Enrollment ...................................... 48
2.11 Impacts on Other Outcomes ........................................... 49
2.12 Impacts on Borrowing w/ Family Planning Controls ............... 52
2.13 Alternative Model Specifications ..................................... 53
3.1 Enrollment Results .......................................................... 101
3.2 Summary Statistics (Round 1 Only) .................................. 101
3.3 Summary Statistics (Time Varying) .................................... 102
3.4 Completed Interviews ...................................................... 103
3.5 Missing Interviews .......................................................... 103
3.6 Attrition Analysis ............................................................ 104
3.7 Summary of Adherence ...................................................... 106
3.8 Testing Respondents’ Comprehension ........................................ 107
3.9 Accuracy of Beliefs (Worse Health) ........................................... 111
3.10 Discount Rate Bins ............................................................... 111
3.11 Difference in Elicited Discount Factors (Round 5) ....................... 113
3.12 Correlates of High Discount Factor ......................................... 114
3.13 Predictors of Mortality Expectations ....................................... 115
3.14 Predictors of Health Expectations .......................................... 116
3.15 Predictors of Viral Load Expectations ..................................... 117
3.16 Updating Mortality Expectations ........................................... 118
3.17 Updating Health Expectations (Nausea) ................................ 118
3.18 Updating Health Expectations (Fatigue) .................................. 119
3.19 Structural Estimation Results using Distance .......................... 120
3.20 Predictors of Adherence (All Rounds) .................................... 121
3.21 Predictors of Round 6 Adherence .......................................... 122
3.22 Learning Predictors of Round 6 Adherence ............................... 123
3.23 Benefits of Round 6 Adherence on Health .............................. 124
A.1 Tanzania Health Statistics ..................................................... 130
A.2 Causes of Deaths ................................................................. 131
A.3 Attrition Analysis (All Respondents) ...................................... 131
A.4 Attrition Analysis (HIV-positive only) .................................... 132
A.5 Summary of Adherence ......................................................... 133
A.6 Summary of Adherence ......................................................... 134
A.7 Reported Reasons for Non-adherence .................................... 134
A.8 Elicited Expectations (Football) ............................................ 135
A.9 Elicited Expectations (Market) .............................................. 135
List of Figures

2.1 Study Areas ........................................... 38
3.1 Elicited Expectations (Football) .......................... 105
3.2 Elicited Expectations (Market) ......................... 105
3.3 Elicited Expectations (Mortality) ....................... 108
3.4 Elicited Expectations (Health) ......................... 109
3.5 Elicited Expectations HIV-neg (Mortality) .............. 110
3.6 Elicited Expectations HIV-neg (Health) ................. 110
3.7 Discount Factor Tree .................................. 112
3.8 Elicited Discount Factors .............................. 112
3.9 Elicited Discount Factors by Sex, Age, and Serostatus (Round 5) .... 113
A.1 Discount Factor Tree .................................. 142
A.2 Elicited Discount Factors .............................. 142
A.3 Elicited Discount Factors by Sex, Age, and Serostatus (Round 6) .... 143
B.1 Laminated Scale ....................................... 168
List of Abbreviations and Symbols

Symbols

\[ r \] Health discount rate
\[ d \] Health discount factor

Abbreviations

AAUW American Association of University Women
AIDS Acquired Immunodeficiency Syndrome
ART Antiretroviral Therapy
CHAT Coping with HIV/AIDS in Tanzania
DHHS United States Department of Health and Human Services
FDA United States Food and Drug Administration
HIV Human Immunodeficiency Virus
NIH National Institutes of Health
RNA Ribonucleic Acid
UNAIDS Joint United Nations Programme on HIV/AIDS
VCT Voluntary Counselling and Testing
WHO World Health Organization
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Introduction

The study of development economics is largely driven by the desire to improve the welfare of impoverished populations using economic policies. In practice, many of these policies take the form of providing access to new goods, services, or technologies that were previously unavailable. The evaluation of these policies often compare outcomes before and after access is granted, largely ignoring the complex connection between access and outcomes. Specifically, a new policy providing access is dependent on the decision of each eligible individual to participate, which itself is a function of the individual’s expectations about how participating will affect her outcomes. In order to achieve desired outcomes, it is necessary to learn more about how access to new policies affects individuals’ beliefs and decisions, and ultimately the causal impact of the new access on outcomes of interest.

The pathway between implementation of a policy of access and outcomes of interest is often a repeated process by which people update their expectations based on previous outcomes and may change their decision to participate. The outcome is largely determined by an individuals’ decision to participate in the program, and this decision is based on their expectations of how the program will influence their future
outcomes. Therefore, in order to implement successful policies, we must consider the role of an individual’s expectations, decision to participate, and the causal effect of the participation on the desired outcome.

This thesis explores two such policies, access to microfinance in Ethiopia, and access to free HIV treatment in Tanzania, examining the intermediate behavioral responses linking the policy implementation to realized outcomes and providing new evidence of causal impact of such a policy on desired outcomes. First, I set forth a framework outlining these pathways and will then explore how each policy fits into this framework.

1.1 Framework

Policy makers in developing countries are faced with the challenge of providing assistance to impoverished populations in a cost-effective manner. They are often limited by small budgets allocated to promote large increases in welfare, implying that a policy maker is primarily concerned with the cost of a new program and achieving the desired outcomes. However, because policies providing access do not force participation, the targeted population first becomes aware of the new program, forms beliefs about its scope and effectiveness, chooses whether or not to participate, and only then is an outcome realized. Policy makers and researchers often need to make assumptions about how a policy will be perceived by the target population, forecast the percent of participation, and then predict the overall effect of the policy on outcomes. Suppose, however, that the researcher does not know how the program will be perceived. The researcher will then miscalculate anticipated participation rates, and final outcomes will not be comparable to predicted outcomes. Alternatively, suppose the researcher is able to accurately predict how the program will be received in the community, but cannot accurately predict how participants use the program; desired outcomes are still not met.
It is important for policy makers to be aware of the potential breakdowns in the link between providing a policy of access and creating a desired response. The two policy examples that follow explore this disconnect and further implications.

1.2 Microfinance

Microfinance, as an economic policy, has been implemented around the world under the assumption that given access to credit as a policy objective that people respond by borrowing, and that this borrowing improves the welfare of the borrower. Welfare can be measured by a number of different outcomes such as increases in business investment, financial security, increases in income, additional labor market opportunities, increases in school enrollment or gender parity.

The second chapter of this thesis explore the results of a randomized control trial in rural Ethiopia where new branches of microfinance banks were established in randomly selected peasant associations (PAs) previously unserviced by the formal financial market. Because of the randomized design, we are able to assess the causal impact of offering microcredit by comparing the outcomes of individuals in the “Credit” PAs with the outcomes of individuals in the “Control” PAs. In order to determine causal impact, ideally, we would want to compare the outcomes of individuals who received access to credit to the outcomes of the same individuals if they had not received access to credit. Because we cannot directly observe different outcomes of the same individuals, we identify a control group (individuals in the control PAs) and, because of the randomized design, are able to approximate that the outcomes of individuals in the Credit PAs would have been the same as the individuals in the Control PAs, had they not received microcredit.

This chapter takes a closer look at the later stages of the framework discussed above. While we do not observe the expectations and beliefs of individuals who were offered credit, we do observe whether they chose to participate (borrow), how they
used their borrowed funds, and how their outcomes were affected as a result. While access to microfinance significantly increased borrowing (an intermediate outcome) the resulting welfare outcomes such as income, business investment, and new business creation, are largely unaffected. This further suggests that there is a break in the link between borrowing and expected outcomes, and that individuals’ behavioral response (how they chose to spend their loan) may be an important determinant of the final outcomes.

1.3 Anti-Retroviral Therapy

The second policy I explore is the provision of free anti-retroviral therapy for HIV-positive patients in Tanzania. Free access was granted in 2004 as a governmental policy based on the scientific evidence of ART effectiveness at reducing viral load and increasing life expectancy. The large expansion of free access to ART medications is based on the premise that given access to ART, people will take the medication, and further, that taking the medications will improve their health (an assumption which, if the respondent does not believe, will significantly change behavior). The missing link here between providing free access and realizing health benefits is the behavioral response of the patients choosing whether to begin treatment, and upon beginning treatment, following the regimen as prescribed. Given free access to these drugs, individuals form expectations about how they believe the medications will affect their health outcomes, and based on these beliefs, make an adherence decision that will give them the highest utility.

This third chapter uses unique survey data from a questionnaire I developed that directly elicits the beliefs and expectations of HIV positive patients about ART. Because nearly 20% of respondents in my sample report imperfect adherence, even with access to free medications, there must be another factor entering into their decision-making process. I explore the influence of individual subjective beliefs on the
adherence decision. The first stage in the framework described above is individuals forming beliefs about the policy, and deciding whether to participate based on those beliefs. I collect an entire distribution of beliefs from each HIV-positive patient subject to different levels of adherence, and how those varying levels of adherence affect health, life expectancy, and overall welfare.

In summary, I find that individual beliefs are incredibly important in the adherence decision, and that expected outcomes conditional on present and past behavior are significantly different than realized outcomes. This suggests that given individuals cannot accurately predict their own outcomes based on beliefs and behavior, policy makers will have an even more difficult time predicting health outcomes based on providing access (to free ART). As demonstrated in the third chapter of this thesis, non-adherence is common, and as such, the full benefits of the medications, and thus, the policy of free access, are not realized.

1.4 Conclusion

Behavioral responses need to be incorporated into policy decisions in order to produce the largest impact. Recent economic literature has begun to address behavioral responses using incentives and restrictions. For instance, loans may only be granted under certain circumstances, where a potential borrower must meet certain requirements in order to secure a loan. In health, it may be the case that positive incentives provided for monitored adherence overcome an individuals subjective beliefs about how the medications will influence their health outcomes. The essays that follow illustrate the importance of subjective expectations and behavioral responses in the analysis of economic and health policies, and how these factors influence the resulting welfare outcomes. The conclusion chapter will tie together the lessons learned from these policies, and further work that may be done to improve the efficiencies and effectiveness of future policies.
On the Impact of Microcredit: Evidence from a Randomized Intervention in Rural Ethiopia

2.1 Introduction

Beginning in the 1970s, with the birth of the Grameen Bank in Bangladesh, microcredit has played a prominent role among development initiatives. Many proponents claim that micro-finance has had enormously positive effects among borrowers. However, the rigorous evaluation of such claims of success has been complicated by the endogeneity of program placement and client selection, both common obstacles in program evaluations. First, micro-finance institutions will typically choose to locate in areas they predict to be profitable, and/or where they expect to produce large impacts. In addition, individuals who seek out loans in areas served by micro-finance institutions are most likely systematically different from others who do not.

Until recently, the results of most studies could not be interpreted as conclusively causal because of the lack of an appropriate control group (see Brau and Woller (2004) and Armendariz de Aghion and Morduch (2005)) for comprehensive early surveys). In a seminal study, Pitt and Khandker (1998) used structural estimation to analyze
the impact of Grameen Bank’s operations in Bangladesh. They found substantial benefits of microcredit, including increases in expenditure and child schooling, especially when borrowers were female. Others, however, have criticized these estimates as biased upwards (Morduch 2005, Chemin 2008). Positive associations between women’s group lending and girl (but not boy) schooling were also documented in South India using matching methods (Holvoet 2004). Gertler et al. (2009) provide evidence from the Indonesian Family Life Survey that membership in microfinance programs is associated with households’ better ability to smooth consumption in response to adverse health shocks. Other studies have found increased contraceptive use associated to access to microcredit (Buttenheim 2006, Schuler et al. 1997), although others have found no impact (Pitt et al. 1999, Desai and Tarozzi 2011). Kaboski and Townsend (2009), using a structural approach, find large increases in consumptions associated with a nationwide microcredit program in Thailand, although they also find significant heterogeneity, and estimate that a simple transfer program would have been more effective.

Taken together, these studies have provided support to the hypothesis that microcredit can change lives for the better, although the estimated impacts were often small enough to cast doubts on the most optimistic claims about the promise of microfinance. Given the considerable identification difficulties due to endogenous program placement and client self-selection, randomized controlled trials (RCTs) provide an ideal research design to evaluate the impact of microcredit. However, at present only a handful of such studies exist.

Banerjee et al. (2010) describe the results of an RCT conducted in 2005-08 in 104 slums in Hyderabad, India, where half of the communities were selected for the introduction of microcredit operations by the micro-lender Spandana. After approximately 1.5 years they find, in treatment relative to control areas, a one-third increase in business creation and increases in durable consumption that are large relative to
baseline but very small in magnitude. Although they find no increases in average total expenditure per capita, their estimates show significant heterogeneity in the estimated impacts, depending on propensity to start new businesses. They also find no evidence of benefits on measures of self-reported health, child schooling, or women’s decision-making. In interpreting their results, it should be taken into account that entry of non-Spandana micro-lenders was significantly more likely in control areas, and also that Spandana did start operating in some of the control slums during the study. Crépon et al. (2011) study the results of a RCT conducted in 2006-07 in 81 villages in rural Morocco. They again find no impact on total expenditure, health and schooling, although they document increases in self-employment activities. They also find that expenditure responses vary depending on pre-program business activity. Karlan and Zinman (2009, 2010) use a randomized design to estimate the impact of access to credit for potential borrowers near a creditworthiness threshold in urban Philippines and South Africa. They find evidence of profit increases and overall improvements in several welfare-related outcomes.

In this paper, we present the results of two connected large-scale cluster RCTs conducted in rural Amhara and Oromiya (Ethiopia) between 2003 and 2006. The study areas were poor, with agriculture and animal husbandry representing the bulk of the local economic activities. Borrowing, from any source, was not common. At baseline, just above one household every ten had outstanding loans. The study area was identified in the context of the expansion of micro-credit and family planning programs supported locally by the David and Lucille Packard Foundation Population Program. The credit operations were implemented in the field respectively by the Oromiya Credit and Savings and Share Company (OCSSC) and the Amhara Credit and Savings Institute (ACSI). The project team identified areas where OCSSC and ACSI planned to expand their operations. In Amhara, the study was conducted in 162 villages from 54 kebeles (larger administrative units also called ‘peasant associ-
ations’, PAs for brevity). In Oromiya, study areas included 191 villages in 78 PAs. A baseline survey was completed in 2003 for about 3,000 households in each region, and subsequently all study villages in half of the PAs were randomly selected for introducing micro-lending operations. In 2006, a follow-up survey was completed among an independently drawn sample from the same villages.

Both micro-lenders operated on the basis of group lending, with small and self-formed groups of borrowers taking joint responsibility for loan repayment. Borrowers were supposed to be selected on the basis of several criteria, of which business plan and poverty status were the more salient ones, and women borrowing was supposed to be especially favored. However, these criteria were only loosely followed in practice. Although both programs were run using similar guidelines, they were implemented independently by different lenders in the two regions, and so we treat them separately throughout the paper. We will show that both programs led to a substantial increase in borrowing in the treated communities. The prevalence of borrowing in treatment areas increased by more than 20 percentage points in both regions.

The household surveys measured a broad range of outcomes, including income activities, asset ownership, schooling, and decision-making power of women. Although this allows us to evaluate the program impact on a large number of variables, expenditure data were not collected, so that we cannot estimate heterogeneous impacts on durables and total consumption as in Banerjee et al. (2010) and Crépon et al. (2011). Because we have a panel of villages, and not of households, we cannot estimate program impacts using difference-in-differences (DD) at the household level. However, the baseline data allow us to control for pre-intervention balance in a large number of observed characteristics, and also allow us to control for baseline differences in community-level means. An additional difficulty derives from the fact that the micro-lenders partly deviated from the experimental protocol and started operations
in some control areas, while doing the opposite in some treatment PAs.¹ We show that these deviations were largely uncorrelated with observed baseline characteristics in Oromiya, although a degree of endogenous program placement cannot be ruled out completely. In Amhara, where deviations from the experimental protocol were more common, there is also stronger evidence of potentially endogenous program placement.

The results presented in this paper should be a useful addition to the limited number of studies that estimate convincingly causal impacts of access to microcredit on welfare-related outcomes. In addition, the focus of most of the literature is on South and South-Eastern Asia. Few rigorous studies exist that evaluate the impacts of micro-credit in Africa, and to the best of our knowledge none exists from an East African country.

The rest of this paper is organized as follows. Section 2.2 describes the details of the intervention and the study design, and Section 2.3 discusses the results. Section 2.4 summarizes the results and concludes.

2.2 Study Area, Experimental Design and Baseline Summary Statistics

The study was implemented over a large geographical area in rural western Ethiopia, spread over eight woredas in two zones of the Oromiya region, and seven woredas in two zones in Amhara, respectively about 300-400 km west and north of the capital Addis Ababa (see the map in Figure 2.1).² All study areas were primarily reliant on agriculture and animal husbandry, which in some cases are supplemented

¹ A similar problem also arose in the field experiment studied in Banerjee et al. 2010, where the partner micro-lender also started operation in a fraction of the control areas.

² The eight woredas in Oromiya are Anfillo, Ayra Guliso, Haru, Mana Sibu, Nedjo and Seyo in West Wellega zone, and Metu and Chora in Illubabor zone. In Amhara, the PAs are from Bugna, Gidan and Meket Delanta woredas in the Semien (or ‘North’) Wollo zone, and from Metema, Chilga, Alefa Takusa, and Lay Armachiho woredas in North Gonder zone.
with small-scale retailing activities or day labor. Unlike the arid eastern regions, the study locations usually benefit from plentiful precipitation, with an average of 1,200-2,000mm of rainfall per year in 1971-2000 in both regions. Although there are local variations, the study areas are broadly characterized by three season. A dry season (Bega) lasts from October to January, and is followed by a ‘small rainy season’ (Belg), that lasts from February to March-May, although it remains relatively dry in Amhara. The main rainy season (Kiremt) lasts from approximately June to September, and this is when the majority of crops in the country are produced.

The study area was identified in the context of the expansion of micro-credit and family planning programs supported by the David and Lucille Packard Foundation Population Program, and implemented in the field respectively by the Oromiya Credit and Savings Share Company (OCSSC) and the Oromiya Development Association (ODA) in Oromiya and Amhara Credit and Savings Institute (ACSI) and the Amhara Development Association (ADA). Within this context, the research team identified 191 villages in 78 kebeles or “peasant associations” (PAs) where OCSSC and ODA planned to expand in the coming years in Oromiya and 162 villages in 54 kebeles or “peasant associations” (PAs) where ACSI and ADA planned to expand.³

In each of the 133 study PAs, interview teams obtained a complete list of all villages with an estimate of the total number of households in each village. If the PA had more than 400 households, three villages were randomly selected. If the PA had less than 400 households, two villages were selected at random. Within each village selected, interview teams conducted a complete enumeration of households, and a random sample of households were chosen to participate. In all, 3240 households were selected and 3216 interviews (99.3%) completed in Oromiya. In Amhara, 3200 households were selected and 3068 interviews (96%) completed. The sample is

³ Peasant associations or are the smallest local unit of government in Ethiopia. A single PA is comprised of multiple villages, while several PAs form a woreda, which are then grouped into zones, and zones into regions (Ofcansky and Berry 1991).
not self-weighted and therefore sampling weights are required to produce unbiased estimates of population statistics. We use sampling weights throughout the paper, although the un-weighted results are generally very similar.

2.2.1 Experimental Design

The data used in this paper are part of the records collected in 2003 and 2006 as part of the evaluation of a cluster randomized controlled trial (RCT) conducted by Family Health International. The main focus of the RCT was on fertility choices and contraception, and its primary purpose was to determine whether linking microcredit (offered by OCSSC in Oromiya and ACSI in Amhara) with family planning services (carried out by ODA in Oromiya and ADA in Amhara) would increase the use of contraceptives beyond what each program could accomplish separately. As part of this evaluation, after the completion of the baseline survey the 78 PAs in Oromiya were randomly scheduled to see the introduction of microcredit (20 PAs), family planning services (18), both (20) or neither (20). The 54 PAs in Amhara were assigned as follows: microcredit (14), family planning services (13), both (15), or neither (12). Randomization into the three treatment groups and one control group was completed at the PA level, meaning that all villages selected in each PA (and all selected households in each of these villages) were assigned to the same group. Randomization was done to produce roughly 800 to 810 households in each of the four original treatment groups.

The community-based family planning programs were based on women from local communities trained and remunerated to make house-to-house visits, provide fertility-related information and offer contraceptives at no cost. In areas where both services were introduced, credit officers also provided information on family control methods to women borrowers (but did not offer contraceptives). In principle, the family planning programs could have had an impact on economic activities via a
change in family planning. However, Desai and Tarozzi (2011) show that the programs (both in isolation and when jointly present) failed to modify contraceptive behavior, and were only weakly associated with changes in fertility. For this reason, in this paper we largely ignore the family planning programs and we focus instead on the provision of microcredit. In results available upon request we also show that the estimated impacts of the introduction of micro-lending change only marginally when we take the family planning operations into account.

Both ACSI and OCSSC, the two micro-finance institutions (MFIs) that partnered with Packard for this evaluation, are development-oriented institutions with strong links to the Government. Prior to independence in 1991, all banking and insurance activities were monopolized by the Ethiopian government. Proclamation No. 84/94 was later issued allowing private domestic investors to also participate in these activities, but the government maintained a strong involvement in the evolution of Ethiopian MFIs, which overall operate in a non-competitive environment (Wolday 2002). A government-supported micro-enterprise lending program includes now 23 MFIs registered, licensed, and regulated by the National Bank of Ethiopia. These institutions comprise the Association of Ethiopian Micro-finance institutions (AEMFI), and include ACSI and OCSSC. The Amhara Credit and Saving Institution began as a project of the NGO Organization for the Rehabilitation and Development in Amhara, and was officially established as a microfinance institution in 1997. Its stated mission is to “improve the economic situation of low income, productive poor people in the Amhara region through increased access to lending and saving services”. The Oromiya Credit and Saving Share Company (OCSSC) was

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4 The most likely reason for the failure to affect behavior is that the family planning program did not provide injectables, the main method in use in these regions, although referrals to clinics were provided. Desai and Tarozzi (2011) also document that areas where micro-credit was introduced saw a 0.1-0.2 decline in births relative to control and family planning-only PAs.


6 For more information see http://www.acsi.org.et.
also established in 1997, and was born out of the Oromiya Rural Credit and Savings Scheme Development Project, with the stated mission to “provide need-based micro financial services to strengthen the economic base of the low-income rural and urban people in Oromiya through increased access to sustainable and cost efficient financial services”.

Both ACSI and OCSSC operated on the basis of group lending. Small and self-formed groups of borrowers, who took on collective responsibility for repayment of loans, were selected on the basis of several criteria, of which business plan and poverty status were the more salient ones. Loans were made for one year at interest rates reflecting market conditions. Based on OCSSC and ACSI records, the interest rate in 2002-2003 was 12% per year on average. Credit officers helped fill out loan applications, and monitored the groups. Borrowers were expected to make regular deposits and repayments. Both OCSSC and ACSI reported repayment rates higher than 95% in the years before the intervention. In both regions, the credit program expansion was supposed to target poor women borrowers, but in reality no strict guidelines about the gender of the borrowers was issued. For this reason, as we will show, loans were often granted to individuals of both genders.

2.2.2 Baseline Summary Statistics

The randomization was overall successful at producing balance in a broad range of statistics among the four original treatment groups across (Desai and Tarozzi 2011, Table 2). However, the implementation agencies complied with the protocol in only 66 of the 78 PAs (85%) in Oromiya and only 37 of the 54 PAs (69%) in Amhara. Despite opposite instructions, micro-lending was introduced in nine (six in Amhara) “control” PAs and not introduced in three (five in Amhara) “treatment” PAs. Tables 2.1 (Oromiya) and Table 2.2 (Amhara) show a wide array of baseline summary statistics.

statistics by region, together with tests of equality of means between PAs in actual treatment and control groups. The results show that, despite the deviations from randomized assignment, a large majority of observed characteristics are balanced between experimental arms, although there are notable exceptions which we highlight below.

The two regions are quite distinct in their ethnic, religious and linguistic identity. In contrast, sample households in both regions share clear indications of widespread poor socio-economic status. Households are large (over 5 members on average) and head of household education is very low. Most study communities are remote, on average about an hour away from the nearest market or health center in Oromiya, and about 50% farther in Amhara. In this latter region control areas are on average about 25% closer to markets than treatment PAs, and the null of equality is rejected at the 10% level. The fraction of households that use surface water (from rivers, lakes etc.) as their main source for drinking needs is close to one half in Oromiya, and one fifth in Amhara. Food scarcity is also common: respondents reported on average 2.6 months of insufficient food in Oromiya and 2.2 in Amhara. In the latter region the null of equality is rejected at the 10%, although in this case it is treatment areas that appear to be at an advantage, with 1.9 months of food scarcity versus 2.4 in control PAs.

In both regions, agriculture is the main economic activity for almost 90% of households, with average land holdings of about 1 hectare in Oromiya and 20-25% less in Amhara. The data allow the estimation of what we call ‘net cash revenues’, calculated as the difference between crop sales in the previous 12 months and expenses for inputs over the same period.\(^8\) In Oromiya, net cash revenues average to about 100 Birr/year (or 44 USD using the PPP exchange rates in World Bank 2008), with about

\(^8\) We do not call these “profits” because we do not have sufficient information to impute the value of family labor or self-consumption. For additional details on the construction of these and other variables see Appendix 2.6.1.
three quarters accounted for by coffee cultivation, which is locally very prominent. In Amhara coffee production is negligible, but net cash revenues from cultivation are on average 60% higher. Income from wages are also important, especially in Oromiya, where the average (220 Birr/year) is about twice as large as net crop sales. Raising livestock is also common, and households own on average 632 Birr in livestock in Oromiya and 1347 Birr in Amhara (mostly in the form of large animals such as cows and oxen). In both regions, the null of equality between treatments and controls is rejected for the number of chickens owned (in both cases larger in areas targeted by microcredit) but the means are small and unlikely to be of much relevance for the analysis. However, in Amhara the null of equality is also rejected for the number of large animals owned (3.4 vs. 2.8), their total value (1317 vs. 1048 Birr), and total value of livestock owned (1488 vs. 1195 Birr). In Oromiya, we also find a large difference in revenues from non-farm self-employment over the last 12 months (77 vs. 564 Birr), but the result is driven by very few outliers, given that in Oromiya only 92 of the 3216 households (< 3%) had any manufacturing or trading business revenues at baseline. In fact, the difference decreases considerably and becomes insignificant once we drop three observations for respondents who reported implausibly high revenues of more than 150,000 Birr in the last 12 months.

Overall, the results in panels A and B show a good degree of balance between treatment and control areas, although the few differences raise some concerns, and in the estimation it will be important to control for baseline differences in means, especially in Amhara. The joint null hypothesis that the means for the 24 variables in panels A and B are equal between experimental arms is not rejected at standard levels in Oromiya ($\chi_2^{24} = 27.02$, p-value= 0.3035), but is rejected in Amhara ($\chi_2^{24} = 62.53$, p-value= 0.0000).

Finally, we look at statistics related to borrowing behavior, where in both regions we find some cases of important and statistically significant differences between treat-
ment groups. In Oromiya, borrowing was more common in control areas, with 17% of households with at least one outstanding loan, while the proportion was only 9% in treatment PAs. The difference is significant at the 5% level. Similarly higher in control areas were women’s borrowing (3 vs. 0.5%) and the frequency of loans from informal sources such as relatives, moneylenders and such (8 vs. 2.5%). In this region, less than 2% of households borrowed from “revolving credit associations” (RCA, hereafter). This is important, because RCA was the label used to denote microcredit in the household survey. Borrowing from formal institutions such as banks and cooperatives was relatively uncommon (5% of households had any) and was again similar between arms. Most loans were used to pay for agricultural inputs for the production of food crops and to pay directly for consumption. Only in a handful of cases we find instead loans used to purchase livestock, to invest in cash crops such as coffee or to pay for schooling costs. When we look at reasons for borrowing, the individual null of equality between groups is rejected at the 5% level only for the fraction of households who borrowed for consumption, twice as large as in control areas (4 vs 2%). When we look at Amhara, we find again cases of substantively and statistically significant differences between treatment groups. Borrowing was more common in control areas, with 16% of households with at least one outstanding loan, versus 10% in treatment PAs (the difference is significant at the 10% level). Similarly, means are statistically significantly higher (at the 10% level) in control versus microcredit areas for borrowing from informal sources (11 vs. 6%) or from banks/cooperatives (1.5 vs. 0.5%), and borrowing for consumption (9 vs. 5%).

Overall, these cross-arm differences show that microfinance was more likely to be introduced in areas with less borrowing at baseline. The differences are also large enough that the null that all 40 variables have equal means between treatments is rejected both in Oromiya ($\chi^2_{40} = 124.57$, p-value= 0.0000) and Amhara ($\chi^2_{40} =$
764.92, p-value= 0.0000). On the other hand, if we compare means between randomly assigned treatment and control arms, we find that in Oromiya there is strong evidence that heterogeneity of communities by actual treatment status was largely due to the randomization itself, which just happened to produce lack of balance in some cases. The same cannot be said about Amhara, where we also know that deviations from the experimental protocol had been more common.

To probe this point further, in Table 2.3, we show the results of linear probability models where we regress actual treatment on randomly assigned treatment and a series of 24 baseline predictors. In both regions, assigned treatment is not surprisingly the strongest predictor, with a coefficient of 0.6-0.7 in both regions, significant at any standard level. In Oromiya, five of the 24 predictors are significant at the 10% level, but none is at the 5% level, and the joint null that all are zero cannot be rejected at standard levels (p-value= 0.465). In contrast, in Amhara seven predictors are significant at the 10% level, of which two are significant at the 5% (value of livestock owned and loans from banks and cooperatives), and one is significant at the 1% level (income from transfers and other sources). Some of the coefficients for Amhara are also relatively large. For instance, the conditional probability of micro-credit having been introduced in a given community is 41 pp higher for households who borrowed from banks/cooperatives. Such form of borrowing was, however, rare. The fraction of households that had loans from such sources at baseline was only 1.5% in communities where MC was introduced, and close to zero in the other ones. Still, the null that all the borrowing-related indicators are zero is rejected at the 5% level, and the same holds for the null that all socio-economic indicators do not predict actual treatment status. Finally, in Amhara the null that all the coefficients are zero

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9 See Desai and Tarozzi (2011, Table 2) for details. Recall that the primary objective of the field work was an evaluation of the impact of community-based family planning services and micro-lending on contraceptive use and fertility outcomes. Such key outcomes were overall balanced across experimental arms.
(except the one related to assigned treatment) is strongly rejected (p-value= 0.001).

Overall, these results show that the randomization generated some lack of balance in a number of covariates, but we also find that only in Amhara the deviations from the experimental protocol were strongly correlated with a number of observable characteristics. Whenever possible, our estimates will therefore rely on regression models that control for the presence of PA fixed effects. Given that the randomization was conducted at the PA level, this will control for any time-invariant differences in observed or unobserved characteristics between (actual) treatment and control areas. It should be kept in mind, however, that such an approach does not eliminate the possibility of bias due to unobserved differences in trends between experimental arms.

2.2.3 Migration

Before discussing the results, we briefly address the potential problem of population changes between the baseline and the follow-up, carried out three years later. Because both surveys were conducted by drawing independently from a separately generated village census, the estimated treatment effects could be biased if local populations had changed between baseline and follow-up. For instance, access to micro-credit could have changed the likelihood of migrating from a village, or it could have induced migration into the village from control areas.

The lack of a true panel of households does not allow us to examine out-migration conclusively. However, only 80 of 6,275 respondents included in the post-intervention survey (1.3%) reported having lived in their village for less than four years. Information on the reason for migration is available for only 46 of these households, but in no case the reported reason was directly related to the availability of family planning or microcredit, although 23 respondents reported migration was due to ‘work’. Of these 23, 18 moved into control areas, so most of these re-locations were not due to
earning opportunities opened up by the increased availability of credit.

When we look at the two regions separately, we find that only 24 of the 80 households having relocated were from Oromiya, and 14 of them moved to treatment areas. In this region, in-migration was then very limited and balanced between treatment groups (the p-value of the test is 0.910 so that null of equality cannot be rejected at standard levels). In Amhara, the fraction of households having resided in the post-intervention location for less than four years was instead tilted towards control areas, with 41 households versus 15 in treatment villages. The null of equal in-migration between treatment groups is rejected for Amhara at the 10% level (p-value = 0.058). Despite this, the very small extent of migration into the study villages indicates that this kind of re-location was very unlikely to affect the results in any significant way.

2.3 Estimation Methodology and Results

The absence of information from the same households before and after the intervention does not allow us to use a standard difference-in-difference (DD) approach. However, the post-intervention survey was conducted with a sample drawn from the same villages as the baseline, and this still allows to control for the presence of time-invariant village or PA-level fixed effects. This may be important, because we have shown that not all pre-intervention characteristics were balanced, and because of the partial compliance with the experimental protocol.

To clarify our choice of estimation model, let $y_{pi,t}$ denote an outcome for household (or individual) $i$ in PA $p$ and time $t$, where $t = 0$ denotes baseline and $t = 1$ follow-up. Let also $Post_t$ and $MF_p$ denote binary variables equal to one when, respectively, $t = 1$ and when microcredit is introduced in PA $p$. Assuming the presence of a PA
fixed effect we can therefore write:

\[ y_{pi,t} = \beta_p + \beta_{Post} Post_t + \beta_{MF} MF_p \times Post_t + u_{pi,t}. \tag{2.1} \]

This model implies that

\[
\begin{align*}
    y_{pi,0} &= \beta_p + u_{pi,0}, \\
    y_{pj,1} &= \beta_p + \beta_{Post} + \beta_{MF} MF_p + u_{pj,1},
\end{align*}
\tag{2.2}
\]

where we have used a different index for households at time \( t = 1 \) to highlight the fact that a new sample was drawn at follow-up. As long as the PA-specific fixed effect is time invariant, we can estimate it using baseline data from the same PA, by calculating the baseline sample mean \( \bar{y}_{p,0} \). We therefore estimate all impacts using Ordinary Least Squares (OLS), using as dependent variables the quasi-differenced outcomes \( \Delta y_{pi} = y_{pj,1} - \bar{y}_{p,0} \).\(^{10}\) Rather than presenting separate estimates for the two regions of Amhara and Oromiya, we pool data from both regions together but allow for region-specific coefficients. We then estimate OLS regressions using the following simple model:

\[ \Delta y_{pi} = \beta_{Post}^O + \beta_{Post}^A + \beta_{MF}^A MF_p + \beta_{MF}^O MF_p + u_{pi}, \tag{2.3} \]

where the superscripts \( A \) and \( O \) refer respectively to Amhara and Oromiya. Because the interventions were carried out at the PA-level, all standard errors and tests are robust to intra-PA correlation of residuals. As a reminder, all regressions are

\(^{10}\) We prefer this specification to one where \( \bar{y}_{p,0} \) is included as a generated regressor on the right-hand side of equation (2.1) because this latter model would lead to biased estimates for \( \beta_{MF} \) if deviations from the experimental protocol are correlated with PA-level time-invariant characteristics \( \beta_p \). To see why, rewrite equation (2.2) as \( y_{pj,1} = \delta \hat{\beta}_p + \beta_{Post} + \beta_{MF} MF_p + v_{pj,1} \), where the regression residual is now \( v_{pj,1} = u_{pj,1} + [\beta_p - \hat{\beta}_p] \), and where the true value of the parameter \( \delta \) is 1. When the number of observations within each PA grows large, the estimation error in \( \beta_p \) becomes negligible, but for finite and potentially small within-PA samples (as in our empirical context), the estimation error would lead to biased estimates for \( \delta \) (because \( \text{Corr}(\hat{\beta}_p, v_{pj,1}) \neq 0 \)), and this in turn would lead to biased estimates for \( \beta_{MF} \) if \( \text{Corr}(\hat{\beta}_p, MF_p) \neq 0 \). The latter correlation will not be \( = 0 \) if program placement is correlated with PA fixed effects.
estimated using sampling weights, although the un-weighted results are generally only marginally different.

Note that, as an alternative, we could have estimated model (2.3) using *assigned* rather than actual treatment on the right-hand side (as, for instance, in Banerjee et al. 2010). These alternative results (available upon request) are overall similar. The use of a differenced dependent variable allows to control for any potential program endogeneity issue caused by time-invariant factors (regardless of whether they are measured in the data). On the other hand, the estimated impacts will be biased in the presence of time-variant factors correlated with actual treatment status, although the results in Section 2.2.1 suggest that such factors are unlikely to be important. With these caveats, the estimates can be interpreted as intent-to-treat, that is, we estimate the impact of making microcredit available to households, regardless of actual take-up (which, within treated communities, remains endogenous).

In interpreting the results, it is also useful to consider that Amhara and Oromiya (like most of Ethiopia) were experiencing socio-economic changes for the better during the study period. Real gross domestic product per head in Ethiopia grew by 12.3% in 2003, 8.7% in 2004 and 5.6% in 2005. Oromiya also benefited from increases in coffee prices: data on average composite world prices of coffee from the International Coffee Organization indicate that average prices remained steady around 0.5 USD per pound in 2003, but grew to 0.75 USD/pound by the end of 2004 and fluctuated between 0.75 and 1 USD/pound in 2005-2006. Overall, we therefore expected to observe significant improvement in socio-economic outcomes in both treatment and control areas.

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11 We therefore estimate the ‘mean effect of the offer of treatment’, as described in Heckman et al. (1999, p. 1903). If we used assigned treatment in the right-hand side, we would be estimating the average treatment effect of living in communities assigned to receive the micro-credit program, regardless of whether the lending program was actually implemented.
2.3.1 Impact on Borrowing Behavior

In Table 2.4, we first demonstrate that the intervention has substantively and significantly large impacts on borrowing. The figures in column 1 show that the fraction of households with any outstanding loans decreased slightly in control areas of Oromiya, while it increased substantially (by 15 pp) in Amhara. The key result is that access to OCSSC and ACSI micro-credit networks increased borrowing prevalence by 20 pp in Amhara and 24 pp in Oromiya. Both DD estimates are significant at any standard significance level. We also see that, despite the lack of strict guidelines about targeting women for loans, female borrowing saw very substantial increases. At baseline, less than 2% of women had outstanding loans, but the programs increased the proportion by 6 pp in Amhara, and by 11 pp in Oromiya. In columns 3 to 5, we also show that the changes in borrowing were largely driven by loans from OCSSC and ACSI. In both regions, loans from banks and cooperatives were barely affected (and the DD estimates are not significant at standard levels), while the programs are associated with a four pp higher rates of borrowing from informal sources (such as moneylenders, relatives etc.).\textsuperscript{12} Loans from micro-lenders (labeled RCA in the survey), which were almost absent at baseline, increased by 20-23 pp, amounts that track closely the changes in the total fraction of households borrowing. Note also that there is close to no change in control areas in Oromiya, while in Amhara the prevalence of borrowing from micro-lenders increased by 4 pp. Overall, it is clear that access of micro-credit had large impacts on borrowing behavior. Also, we do not find evidence of crowding out of alternative sources of credit.

In columns 6 to 8 we also look at amounts borrowed. These, as well as all other outcomes expressed in monetary terms are in 2006 Birr.\textsuperscript{13} The estimates show

\textsuperscript{12} It is not obvious why loans from informal sources were higher in treatment areas, although it is possible that this was due to loans initiated to repay other loans granted by OCSSC/ACSI.

\textsuperscript{13} In Amhara, the CPI increased from 114.6 in January-May 2003 to 158.1 in March-July 2006 (a
that borrowing increased substantially in all study areas, especially in Amhara, but that OCSSC/ACSI operations led to significantly higher average loans. Most of the increase in loans was due to ‘productive loans’ from micro-lenders, defined as loans reportedly used for working capital or basic investment.

As we discussed earlier, the micro-lending operations were accompanied, in a subset of PAs, by the introduction of community-based family planning programs. We ignore this component, because Desai and Tarozzi (2011) show that it did not have an impact on the targeted outcomes (fertility and contraceptive use), which in turn could have mediated impacts related to the presence of borrowing opportunities, especially for women. In Appendix 2.12, we also show that including dummies for family planning programs leaves the estimated impacts almost unchanged. In the rest of the paper we will then ignore the presence of these other program, but results for all outcomes that include this information are available upon request.

When we look only at households who borrowed from OCSSC/ACSI (results not in table), we estimate that in both regions the median micro-loan at follow-up was 1,100-1,200 Birr (~489 USD), with only ~10% of loans smaller than 600 Birr and ~10% larger than 2,000 Birr. To put these figures in perspective, the official poverty line, expressed in total consumption per adult/year in 2006, was ~1,500 Birr, while the mean amount of total outstanding loans among households who borrowed (from any sources) at baseline was ~300 Birr (in 2006 units). In other words, the micro-loans were substantial in relative terms, and hence an impact on socio-economic outcomes could have been expected.

38% increase), while in Oromiya the increase was from 122.8 to 156.8 (a 28% increase). The CPIs are from the Central Statistical Agency of Ethiopia.
2.3.2 Impact on Households’ Economic Activities

Next, we turn to the analysis of impacts of OCSSC/ACSI operations on households’ economic activities. Both baseline and follow-up surveys included information on sales as well as input purchases for farm and livestock activities, and for non-farm self-employment businesses. Unfortunately, no information was collected on family employment in household enterprise, so we cannot estimate a measure of profit. We also do not have records for home consumption. We focus then on measures of ‘net sales’, calculated as differences between yearly revenues and input purchases. Recall also that we do not have information on expenditures more generally, so we cannot gauge the impacts on consumption as in Banerjee et al. (2010) and Crépon et al. (2011).

In Table 2.5, we show that impacts on business activities (that is, non-farm self-employment) were mixed. The key result is that we find no evidence that the micro-credit operations led to an increase in non-farm business creation (column 1). Similarly, there is no evidence of female-led business creation (column 2). In Oromiya, where this form of economic activity was almost absent at baseline, we observe a massive 25 pp increase in the fraction of households with non-farm business activities, but this increase is almost identical in treatment and control areas. In Amhara there was little change over time, and micro-credit areas even saw a 1 pp overall decline. In contrast, we find a large impact on business net and gross revenues in Oromiya. Both estimates are substantively large, at around 900 Birr, or 60% of the poverty line expressed in terms of total consumption per adult/year. However, the estimates are noisy and only significant at the 10% level. The result also appear to be driven by a small number of outliers. When we re-estimate the impact on gross revenues using quartic roots, the coefficients become close to zero and not
significant at standard levels (see Appendix 2.13). Estimates from Amhara do not indicate substantive or statistically significant changes in revenues. Impacts on business-related costs are mostly small and not significant, with the exception of an estimated decline in material costs in Oromiya (significant at the 10% level).

Overall, there is weak evidence that micro-loans led to business creation or even to an increase in the scale of non-farm activities. Given that in Table 2.5 we estimate eight different regressions, it is also possible that the significance of some of the coefficient is just the result of chance. Indeed, the joint cross-equation null that $\beta_{MF}^A = \beta_{MF}^O = 0$ in all eight equations is not rejected at standard levels (p-value= 0.6444). We also note that the estimates remain overall substantively similar if we replace actual with assigned treatment, or if we include in the regressions a number of baseline means of village-level characteristics (see Appendix 2.13).

Given the prominent role of agriculture and livestock raising in the study area, it is possible that loans went disproportionately to finance activities in these two sectors, which we analyze next. Between 2003 and 2006, all study areas saw large increases in the value of livestock owned (Table 2.6). Column 1 shows that the total value of livestock owned increased in control areas in Amhara by 80% relative to the overall baseline mean of 1,850 (in 2006 Birr). The increase was 21 pp higher in treatment areas, although the DD is not significant at standard levels. In Oromiya, the value of holdings increased by 1,477 Birr in control areas, and by 420 Birr more in areas where OCSSC operated. In this region, the DD is significant at the 10% level. These changes were almost completely driven by increases in the value of large animals such as cows and oxen (column 2), while the estimated impacts on smaller

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14 The quartic root has shape similar to the logarithm for positive values, while it has the advantage of being defined over zero (Thomas et al. 2006).

15 The joint tests are calculated using seemingly unrelated regression, estimating all regressions in the table jointly, and then testing the joint cross-equation null that $\beta_{MF}^A = \beta_{MF}^O = 0$ in all equations. As usual the tests allow for intra-PA correlation of arbitrary form.
livestock like sheep or goats are small in magnitude and not significant (column 3). Note also that the impacts on the value of livestock appear to be driven by increases in the value, rather than the number, of animals (columns 4 and 5). Our data do not allow us to determine if this was due, for instance, to a change in the size, age or quality of the stock. The introduction of micro-credit was also associated with a 61% larger increase in livestock sales relative to baseline in Amhara, and a 40% larger increase in Oromiya, both significant at the 10% level. The magnitude of the estimates, although not very large, is not negligible either. In Amhara, the estimated impact on sales is $\hat{\beta}_{MF}^A = 49$ Birr (or 22 USD), which corresponds to 9% of the value of livestock holdings at baseline. In Oromiya, we find $\hat{\beta}_{MF}^O = 159$, which corresponds to about 70 USD, or 6% of baseline holdings.

In sum, there is some evidence of increases in livestock ownership and sales associated to the introduction of microcredit, although the estimates are not precise, and the cross-equation joint null of no impact on all outcomes in the Table cannot be rejected (p-value = .3184). In addition, all but one of the coefficients become statistically not significant when we transform monetary values using quartic roots (the exception is the impact on livestock sales in Amhara), and none of the estimates is significant if we include baseline PA-level means as controls (see Appendix 2.14).

Next, we move to the analysis of impacts on agriculture, which at baseline was the main economic activity for almost 90% of households in both regions. In Table 2.7, we look at different indicators of costs and revenues for either all crops or coffee cultivation. Recall that coffee is an important crop only in Oromiya. The first column indicates that in control areas there was some movement away from agriculture as the main activity of the household head (especially in Oromiya). The estimates indicate that both $\hat{\beta}_{MF}^A$ and $\hat{\beta}_{MF}^O$ are positive, but neither is significant

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16 The top panel of the table in Appendix 2.14 also shows that the estimated impacts are overall small and always not significant when we use assigned rather than actual treatment status as a regressor.
at standard levels. In addition, the intervention had no significant effect on cash revenues (gross or net) from all crops or coffee, or on cultivated land (columns 2-5 and 8). In Amhara we find the only statistically significant treatment effect (at the 1% level), on total costs for all crop production. The coefficient is equal to 156 Birr (about 70 USD), and is large compared to the baseline mean of 68 Birr/year in the same region. This estimate is also remarkably robust, and remains similarly large and significant when we include baseline PA-level means as controls, or when we reduce the role of outliers by transforming costs using the quartic root (see Appendix 2.15). On the other hand, given that no other impact on agricultural activities is substantively or statistically significant, we do not have a compelling interpretation for this result. Overall, we conclude that income from agricultural activities did not appear to respond substantively to the introduction of micro-lending operations in the study areas.

Next, in Table 2.8 we show that the micro-lending operations did not have an impact on income from wages and on income from transfers and other sources.\(^{17}\)

Lastly, we look at information on labor supply and time allocation for adults. For each household member age 10 or above, enumerators recorded the ‘main activity’ of the individual in the 12 months before the interview. If such activity was a form of labor supply, the respondent also reported the number of weeks and the number of hours per day devoted on average to the activity during the previous 12 months. In this section we only examine labor supply among ‘adults’, defined as individuals aged 17 and above, while we look at labor supply among younger individuals in the next section, where we also estimate impacts on schooling. The results are shown in Table 2.9.

\(^{17}\) Even in this case, the results are overall qualitatively very close if we transform monetary values in quartic roots, or if we use assigned rather than actual treatment, or if include PA-level baseline means as additional controls, see Appendix 2.16. The only exception is \(\hat{\beta}_{MF}\) in the regression for income from transfers and other sources, which is significant in the model with quartic roots, although the null is only rejected at the 10% level.
The estimates in columns 1 and 2 show, not surprisingly, that at baseline work was the primary activity of the large majority of men, while this was true for about one woman every three in Oromiya, and one every six in Amhara. In control areas, we find that this raw index of labor supply declined for both genders at the time of the follow-up, especially in Oromiya. However, all the estimated micro-credit impacts are small and not significant at standard levels. Similar results emerge when we look at the number of hours worked (columns 3-4). Finally, when we examine changes in housework among women, all the estimates are small and not significant.\textsuperscript{18}

2.3.3 Impacts on Child Schooling

Next we turn to an analysis of child schooling. In Ethiopia, public primary and secondary schools are nominally free, although associated costs such as textbooks and uniforms must be born by the families. Primary school covers grades 1 to 8, and by the end of eighth grade pupils must pass a national examination before they are allowed to start secondary school (grades 9 and 10). Students that pass another national examination at the end of the 10th grade are allowed to enroll in two years of ‘preparatory’ school (grades 11 and 12) and those who also pass a 12th grade exam are eligible to enroll in public universities.\textsuperscript{19} In rural Ethiopia, it is common for children to start school late. At baseline, only 9\% of 7-year old children were attending school in Amhara, and 25\% of them were in Oromiya. Relative to these rates, attendance among 10-year old children were three times as high in Amhara and more than twice as large in Oromiya. Such staggered start of school leads to the lack of clear discontinuities in enrollment by age, and to a large age variation in

\textsuperscript{18}The estimated impacts remain overall similar if we replace actual with assigned treatment, or if we include baseline means as controls. The main difference is that in the former alternative model the magnitude of the point estimates for females become larger, to the extent that the decline in labor supply and the increase in housework become significant at the 5\% level (see Appendix 2.17).

children enrolled in the same grade. We focus then on attendance rates by gender and by age group, looking separately at 6-9 and 10-16 children.\textsuperscript{20}

For each individual in the household roster, enumerators recorded years of school completion as well as school attendance (\textit{not} enrollment) at the time of the interview. For individuals 10 or older, we also have information about time allocation, and this offers the possibility of cross-checking information on school attendance for household members in this age group. We show the results in Table 2.10.

At baseline, attendance rates were low in both regions, ranging from 13\% among 6-9 years old boys in Amhara to 67\% of 10-16 years old boys in Oromiya. In Amhara, school attendance increased considerably during the study period, especially among girls, for whom in control areas we observe a 27 pp increase among 6-9 years old, and a 30 pp increase among girls 10 to 16. Among boys, the corresponding increases are much lower but still large (19 and 16 pp respectively). Such overall large increases in school attendance in study areas are broadly consistent with nationwide trends. For instance, data from the Ethiopia DHS show that the percentage of Ethiopian 10-14 year old girls with some primary education increased from 37 to 55\% between 2000 and 2005, while the increase was from 47 to 58\% among boys in the same age group (CSA 2006). Attendance in control areas increased also in Oromiya, although to a much lesser extent. In this region, the only statistically significant increase was among girls 10-16, whose attendance rates increased by 13 pp. The other changes in control areas of Oromiya range between 2 and 5 pp. The results are also reflected in the time allocation data (columns 3 to 6), which show substantive increases in the proportion of children whose primary activity is schooling, and declines in the proportion who spend most of their time working or (especially among girls) in housework chores.

\textsuperscript{20} We also looked at the impacts by age in years. However, in this case the number of observations within each year cell is relatively small, and the estimates are very imprecisely estimated. These results are available upon request.
When we turn to the estimated impacts of the introduction of microcredit, we find that treatment communities saw overall substantively higher increases in school attendance, especially among boys. In Amhara, the presence of ACSI was not associated with improvements among girls, but among 10-16 years old boys the program increased attendance by 11 pp, that is, about two thirds more than in control areas (column 2, panel A). The estimate is significant at the 5% level, and is also reflected in time allocation indices in columns 3 to 6. The fraction of boys in this age group whose primary activity was schooling increases by 9 pp, while the fraction who was primarily involved in work declines by 8 pp. The average number of hours of work declined by 171 per year, although this latter estimate is not significant at standard levels.

Turning now to Oromiya, we estimate that the introduction of microcredit was followed by large (11 pp) and significant increases in attendance among 10-16 year old boys, while among girls the impact was smaller (5 pp) and not significant. In this region we also observe large and significant increases in attendance among younger children, regardless of gender (10 and 8 pp for boys and girls respectively). These results, however, are somewhat in conflict with the data on time allocation, which show little or no impacts for both genders.21

Overall, these estimates point to substantial increases in child schooling associated with micro-credit, but such changes were concentrated among boys. The analysis so far does not explain clearly the mechanisms that could have led to such changes. The mixed results on economic activities suggest that income effects were unlikely to have driven the increases in school attendance.

21 The estimates remain overall similar when we include baseline means as controls in the regressions. In contrast, the impacts are quite different if we replace actual with assigned treatment. In the latter case, none of the estimates for boys remains significant at standard levels. The impacts for girls show again a significant 8 pp impact on attendance among 6-9-year-olds in Oromiya, but also show a substantial increase in time spent working among 10-16-year-olds in Amhara. See Appendix 2.18 for details
2.3.4 Impacts on Other Outcomes

In Table 2.11, we examine impacts on additional health and socio-economics status indicators. First, in column 1 we look at the number of months of food insecurity. In control areas, we observe a marked decline in food insecurity, consistent with the overall sharp improvement in economic conditions during the study period. However, in Amhara we observe surprisingly that intervention PAs saw a significantly smaller improvement: the decline was only 0.2 months, versus 0.8 months in control areas. The impact is also estimated precisely, so that it is significant at the 5 percent level. Given the coarse way this variable was measured, it is hard to exclude that this result is driven by reporting errors. This finding is also at odds with the results on economic activities, which did not point to a relative worsening in these locations.\(^{22}\)

In columns 2 to 4 we look at health-related outcomes. Unfortunately, these were only collected at follow-up, so the dependent variable is the level of the outcome in 2006, rather than a quasi-difference as in all other results. We find very little evidence that micro-credit was associated with lower prevalence of ‘serious illness’ or with lower health expenditures. The point estimates for the impacts of the prevalence of serious illnesses are negative, but they are always close to zero and not significant at standard levels. These health impacts have to be interpreted with caution, of course, because the health outcomes are self-reported, very coarse, and likely to be measured with error likely correlated with socio-economic status. Finally, we also find the in treatment areas households were less likely to use surface water (very likely to be bacteriologically unsafe) as primary source for drinking, although the estimated impacts are small and not significant at standard levels.\(^{23}\)

\(^{22}\) The result is very similar if we replace actual with assigned treatment, or if we include baseline controls. See Appendix 2.20.

\(^{23}\) The results are overall similar if we include baseline controls or if we use assigned rather than actual treatment status as regressors, although some of the impacts in these alternative models become significant at standard levels.
Both the 2003 and the 2006 surveys also recorded information on decision-making within the household. Both the head and the head’s spouse were asked about which members were regularly involved in 20 different decisions, ranging from child schooling, health and clothing, to fertility, social and financial issues.\textsuperscript{24} Recall that microloans were only loosely targeted towards women, and we have seen that a significant fraction of borrowers were actually males (Table 2.4). Hence, we had no compelling reason to expect that OCSSC or ACSI operations led to an increase in women’s empowerment in the treatment communities. Indeed in Amhara the estimated impacts are small and not significant (Table 2.11). However, in Oromiya the null of no impact is rejected, both when we use the wife’s and when we use the husband’s reports. Based on women’s reports, the introduction of microcredit was associated to an increase of 1.1 (on a scale from 0 to 20) in the number of decisions in which the woman was involved. The estimate is moderately large (at baseline the average number was 14.1) and is significant at the 10% level. Husbands on average report less involvement in their wives’ decision-making (the baseline mean in this case was 10.9), but the impact is about twice as large (2.3) and is significant at the 1% level. The estimates also remain similar when we include a series of baseline PA-level means as controls, while they are smaller and not significant when we replace actual with assigned treatment (see Appendix 2.20).

### 2.4 Conclusions

In this paper we have presented the results of the impact evaluation of two similar micro-credit programs, using data from a randomized field study carried out in

\textsuperscript{24} Married women of fertility age and their spouses separately responded if the woman was involved in decisions about the following: food eaten at home, purchase of housing supplies, clothing and health (separately for the woman, the husband and the children), children’s education, large purchases for the household, transfers to parents/family (of self and spouse separately), gifts, savings, sale of cattle, time spent socializing, work outside the household, number of children, contraceptive use and daughters’ marriage.
hundreds of villages in rural areas of Amhara and Oromiya, Ethiopia. Overall, we found little evidence of significant impacts of micro-credit operations on households’ economic activities, although livestock ownership and sales appear to have somewhat benefited in both regions. Such unimpressive impacts are perhaps surprising, given that we have also shown that a large fraction of the study population was making use of the credit opportunities offered by OCSSC and ACSI, and that loans from these sources were relatively large. From this perspective, our framework was similar to that studied in Crépon et al. (2011), who find large increases in borrowing following the implementation of a RCT in rural Morocco. In contrast, Banerjee et al. (2010) found in Hyderabad (India) that the main impacts of microcredit were the result of a decrease in the cost, rather than the quantity of credit.

Although a fraction of communities were mistakenly assigned to the incorrect experimental group, there is little evidence of contamination between actual treatment and control areas (see columns 5 and 8 in Table 2.4), so we think that cross-arm contamination is not likely to be driving results. In addition, the three years of time between baseline and follow-up are a relatively long period of time, and so any significant impact of micro-finance would have likely appeared by the time of the post-intervention survey.

In both study regions, the micro-credit programs significantly increased household borrowing by 20-24 pp, and this increase was in large part due to increases in women’s borrowing (we estimate that the program increased women’s borrowing by 6 pp in Amhara and 11 pp in Oromiya). We find some evidence that the intervention increased livestock sales, ownership, and business revenues, but although some of the impacts are substantively large and significant at the 10% level, none is significant at the 5% significance level. We also find no significant effect on agricultural activities. Using the limited survey information about self-reported health, and other socio-economic status indicators such as whether the household uses surface water as the
primary source for drinking, we see again no systematic differences between treatment and control areas. Surprisingly, in Amhara we also find that treatment locations saw an increase in reported food shortages, although this outcome is likely measured with considerable error. Finally, our analysis provides strong evidence that the micro-credit intervention had a significantly positive effect on school attendance for young children, especially boys, and particularly in Oromiya. In locations where micro-loans became available, we find a 11 pp larger increase in attendance among 10-16 year old boys in both Amhara and Oromiya. In the latter region, school attendance by children of age 6 to 9 increased by 8 pp among girls, and 10 pp among boys, relative to control areas.

Given the mostly insignificant impact of the program on income, business and agricultural profits, and welfare outcomes, it is not entirely clear why we observe large benefits on school attendance. It is possible that the presence of microcredit provided additional positive benefits that the survey could not measure, such as an increased ability to smooth consumption over time, or changes in expectations about future income, or even changes in perceived returns to schooling. Increases in women’s decision-making power observed in Oromiya are also somewhat surprising, given that OCSSC operations were only loosely targeted towards women, and a large fraction of loans were actually granted to men.

Another caveat to be kept in mind is that mere chance may have been the cause of some of the statistical rejections of null hypothesis of no impacts. Note that this is not just the standard argument that a probability of a type-II error must always be accepted when carrying out statistical tests. Throughout the paper, we have estimated the impact of OCSSC and ACSI on a very large number of outcomes, and even in a situation where micro-loans cause no changes in outcomes, it is unavoidable that a fraction of the estimated impacts will be individually statistically significant at standard levels. Indeed we have shown that, in most cases, the joint null of no
impacts across all outcomes considered in a single table was not rejected at standard levels. Had we used more conservative, Bonferroni-type tests to evaluate significance in individual equations, the null of no impact would not have been rejected in a large majority of cases, with the major exception of the estimated impacts on borrowing behavior.\textsuperscript{25}

Unfortunately, we could not estimate heterogeneous impacts on consumption items as in Banerjee et al. (2010) or Crépon et al. (2011), because such data were not collected during the field work. Therefore, our findings will not help in adding external validity of the hypothesis analyzed in those papers. On the other hand, to the best of our knowledge our paper describes one of only three RCTs that evaluate directly the impact of introducing microloans in communities who had previously no access to it. The fact that our study areas, in western Ethiopia, were very distinct from those in Banerjee et al. (2010) or Crépon et al. (2011) should add value to our results. The time interval between pre and post-intervention surveys in our study is also different (longer). While in our context the post-intervention survey was carried out approximately three years after the micro-lending operation started, the time interval was closer to 1 and a half years in Banerjee et al. (2010), and two years in Crépon et al. (2011). This is a potentially important distinction, because the impacts of increased access to credit may differ in the shorter and longer term (see for instance Fulford 2011). In addition, OCSSC and ACSI, the two micro-finance institutions (MFI) who implemented the programs, were not ‘typical’ NGO-driven MFIs. Rather, both were strictly tied to the Ethiopian Government, and therefore their ability to operate and enforce repayment may have been relatively atypical. For instance, although the official reports of the field operations, in 2003, state that no collateral would be requested from borrowers, a large majority of survey respondents

\textsuperscript{25} McKenzie et al. (2009) use Bonferroni-type tests to evaluate the statistical significance of a large number of estimated impacts of migration from Tonga to New Zealand.
who borrowed from OCSSC or ACSI actually stated that a collateral did exist.

Despite all these qualifications, our conclusion is that, in our study areas, the substantial increase in access to loans allowed by ACSI in Amhara and by OCSSC in Oromiya did not lead to large and unambiguous gains in most socio-economic indicators. The only strong evidence of gains come from schooling attendance, which did appear to have increased substantially, although only for some gender and age groups. In sum, although we certainly do not find evidence that the increased borrowing associated to the introduction of micro-credit made treatment communities worse off, overall the ‘miracle of microfinance’ did not appear to have taken place either.
2.5 Tables and Figures

Figure 2.1: Study Areas

Source: UN Emergencies Unit for Ethiopia, March 2000.
Table 2.1: Baseline Summary Statistics and Tests of Balance - Oromiya

<table>
<thead>
<tr>
<th></th>
<th>Micro-credit (actual)</th>
<th>Control (actual)</th>
<th>Test of equality (p-value)</th>
<th>Overall Mean</th>
<th>Overall S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td><strong>(A) Basic household characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HH Size</td>
<td>5.555 (.0933)</td>
<td>5.52 (.0972)</td>
<td>.7944</td>
<td>5.541</td>
<td>2.181</td>
</tr>
<tr>
<td>HH Head ≥ Primary Education</td>
<td>.124 (.0125)</td>
<td>.1321 (.0168)</td>
<td>.6995</td>
<td>.1274</td>
<td>.3334</td>
</tr>
<tr>
<td># Children ≤ 6</td>
<td>1.082 (.0355)</td>
<td>1.09 (.029)</td>
<td>.8505</td>
<td>1.085</td>
<td>.9907</td>
</tr>
<tr>
<td>Head is Christian Orthodox</td>
<td>.373 (.0353)</td>
<td>.3232 (.0345)</td>
<td>.777</td>
<td>.3314</td>
<td>.4708</td>
</tr>
<tr>
<td>Head is Christian protestant</td>
<td>.4871 (.0476)</td>
<td>.5513 (.0444)</td>
<td>.3267</td>
<td>.5138</td>
<td>.9999</td>
</tr>
<tr>
<td>Main water source is surface</td>
<td>.463 (.0372)</td>
<td>.4511 (.0408)</td>
<td>.8298</td>
<td>.458</td>
<td>.4983</td>
</tr>
<tr>
<td># months insufficient food</td>
<td>2.524 (.0884)</td>
<td>2.728 (.1229)</td>
<td>.1819</td>
<td>2.609</td>
<td>2.006</td>
</tr>
<tr>
<td>Distance to nearest market (minutes)</td>
<td>72.63 (7.2)</td>
<td>57.05 (6.408)</td>
<td>.1101</td>
<td>66.16</td>
<td>52.22</td>
</tr>
<tr>
<td>Distance to nearest health (minutes)</td>
<td>77.88 (7.478)</td>
<td>62.91 (8.716)</td>
<td>.1963</td>
<td>71.65</td>
<td>52.99</td>
</tr>
<tr>
<td><strong>(B) Economic activity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultivable land owned Hectares</td>
<td>1.027 (.0463)</td>
<td>1.006 (.0497)</td>
<td>.7552</td>
<td>1.019</td>
<td>1.11</td>
</tr>
<tr>
<td>Net cash rev from crops</td>
<td>107.3 (16.03)</td>
<td>104.6 (17.35)</td>
<td>.9089</td>
<td>106.2</td>
<td>320.2</td>
</tr>
<tr>
<td>Net cash rev from coffee</td>
<td>81.83 (16.21)</td>
<td>78.22 (17.09)</td>
<td>.8784</td>
<td>80.33</td>
<td>287.9</td>
</tr>
<tr>
<td>Income (transfers &amp; other) last 12mnts</td>
<td>8.19 (2.62)</td>
<td>16.82 (6.651)</td>
<td>.231</td>
<td>11.78</td>
<td>104.7</td>
</tr>
<tr>
<td>Agriculture main act of hh. head</td>
<td>.863 (.0203)</td>
<td>.8512 (.0165)</td>
<td>.6527</td>
<td>.8581</td>
<td>.349</td>
</tr>
<tr>
<td>Income wages, last 12mnts</td>
<td>181.8 (55.6)</td>
<td>271.9 (77.76)</td>
<td>.3492</td>
<td>219.3</td>
<td>1252</td>
</tr>
<tr>
<td># large animals owned</td>
<td>2.124 (2.194)</td>
<td>1.802 (2.044)</td>
<td>.2854</td>
<td>1.99</td>
<td>3.563</td>
</tr>
<tr>
<td>Tot value large animals owned</td>
<td>643.3 (53.95)</td>
<td>552.8 (59.93)</td>
<td>.2654</td>
<td>605.7</td>
<td>976.9</td>
</tr>
<tr>
<td>Rev sales large animals 12mnts</td>
<td>27.85 (3.731)</td>
<td>31.4 (4.731)</td>
<td>.5576</td>
<td>29.33</td>
<td>129</td>
</tr>
<tr>
<td># chicken owned</td>
<td>1.05 (.1158)</td>
<td>.7424 (.0915)</td>
<td>.403**</td>
<td>.9223</td>
<td>3.863</td>
</tr>
<tr>
<td># sheep/goats/other owned</td>
<td>.3269 (.0458)</td>
<td>.3219 (.0348)</td>
<td>.9311</td>
<td>.3248</td>
<td>1.16</td>
</tr>
<tr>
<td>Total value sheep/goats/other owned</td>
<td>22.22 (3.325)</td>
<td>22.25 (2.543)</td>
<td>.9937</td>
<td>22.23</td>
<td>79.1</td>
</tr>
<tr>
<td>Total value of livestock owned</td>
<td>671.2 (55.64)</td>
<td>579.2 (60.62)</td>
<td>.267</td>
<td>632.9</td>
<td>1002</td>
</tr>
<tr>
<td>Total value of livestock sales</td>
<td>32.08 (4.081)</td>
<td>34.62 (5.04)</td>
<td>.6961</td>
<td>33.14</td>
<td>134.6</td>
</tr>
<tr>
<td>Total revenue from bsns last 12 mnts</td>
<td>76.58 (56.17)</td>
<td>563.9 (305.5)</td>
<td>.1208</td>
<td>279.2</td>
<td>6243</td>
</tr>
<tr>
<td><strong>(C) Borrowing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one outstanding loan in HH</td>
<td>.0904 (.0155)</td>
<td>.1664 (.0262)</td>
<td>.0146**</td>
<td>.122</td>
<td>.3273</td>
</tr>
<tr>
<td>At least one woman borrowed</td>
<td>.0565 (.0019)</td>
<td>.0304 (.0106)</td>
<td>.0239**</td>
<td>.0159</td>
<td>1.251</td>
</tr>
<tr>
<td>Borrowed from informal sources</td>
<td>.0257 (.005)</td>
<td>.0796 (.0145)</td>
<td>.0000***</td>
<td>.0481</td>
<td>214</td>
</tr>
<tr>
<td>Borrowed from banks/cooperatives</td>
<td>.0478 (.0689)</td>
<td>.0577 (.0136)</td>
<td>.541</td>
<td>.0519</td>
<td>2219</td>
</tr>
<tr>
<td>Borrowed from revolving credit assns</td>
<td>.0111 (.0044)</td>
<td>.0138 (.0045)</td>
<td>.6683</td>
<td>.0122</td>
<td>1098</td>
</tr>
<tr>
<td>Borrowed from NGOs</td>
<td>.0057 (.0033)</td>
<td>.0148 (.0096)</td>
<td>.375</td>
<td>.0065</td>
<td>0971</td>
</tr>
<tr>
<td>Borrowed for capital investment</td>
<td>.0363 (.01)</td>
<td>.0717 (.0217)</td>
<td>.0148</td>
<td>.051</td>
<td>.22</td>
</tr>
<tr>
<td>Borrowed to purchase variable inputs</td>
<td>.0238 (.0077)</td>
<td>.0193 (.0088)</td>
<td>.6999</td>
<td>.0219</td>
<td>1465</td>
</tr>
<tr>
<td>Borrowed for consumption</td>
<td>.017 (.0036)</td>
<td>.0427 (.0081)</td>
<td>.0047***</td>
<td>.0277</td>
<td>1641</td>
</tr>
<tr>
<td>Borrowed to pay for schooling costs</td>
<td>.0016 (.00)</td>
<td>.0047 (.0026)</td>
<td>.2554</td>
<td>.0029</td>
<td>0537</td>
</tr>
<tr>
<td>Borrowed to finance food crops</td>
<td>.0459 (.01)</td>
<td>.0741 (.0207)</td>
<td>.2249</td>
<td>.0576</td>
<td>2331</td>
</tr>
<tr>
<td>Borrowed to finance cash crops</td>
<td>.0023 (.0014)</td>
<td>.0012 (.00)</td>
<td>.4798</td>
<td>.0019</td>
<td>043</td>
</tr>
<tr>
<td>Borrowed to finance livestock</td>
<td>.0014 (.00)</td>
<td>.0018 (.0013)</td>
<td>.7963</td>
<td>.0015</td>
<td>0391</td>
</tr>
<tr>
<td>Total borrowing in 2003</td>
<td>23.64 (7.21)</td>
<td>40.59 (9.979)</td>
<td>.1725</td>
<td>30.68</td>
<td>164.6</td>
</tr>
<tr>
<td>Total loans for productivity</td>
<td>17.21 (6.36)</td>
<td>24.3 (6.467)</td>
<td>.4464</td>
<td>20.16</td>
<td>146.5</td>
</tr>
<tr>
<td>Total loans from MC</td>
<td>4.919 (2.994)</td>
<td>8.212 (3.44)</td>
<td>.4725</td>
<td>6.288</td>
<td>70.7</td>
</tr>
</tbody>
</table>

Notes: Data from baseline (2003) survey. All statistics are calculated using sampling weights. Standard errors (in parenthesis in columns 1 and 2) and tests are robust to intra-PA correlation. The figures in column 3 are p-values for individual tests of equality of means between treatment and control PAs. Asterisks denote statistical significance at the 10(*)& 5(**) or 1(***)% level. All figures expressing monetary values are in 2003 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The joint null hypothesis that the means for the 24 variables in panels A and B are equal between experimental arms is not rejected at standard levels ($\chi^2_{24} = 27.02$, p-value=.3035), while the null that all 40 variables have equal means is rejected ($\chi^2_{40} = 124.57$, p-value=.0000).
Table 2.2: Baseline Summary Statistics and Tests of Balance - Amhara

<table>
<thead>
<tr>
<th>(A) Basic household characteristics</th>
<th>Micro-credit (actual)</th>
<th>Control (actual)</th>
<th>Test of equality (p-value)</th>
<th>Overall Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH Size</td>
<td>5.006 (.1072)</td>
<td>4.928 (.228)</td>
<td>.7578</td>
<td>4.969</td>
<td>2.08</td>
</tr>
<tr>
<td>HH Head Primary Education</td>
<td>.0114 (.0042)</td>
<td>.0163 (.0041)</td>
<td>.4041</td>
<td>.0138</td>
<td>.1166</td>
</tr>
<tr>
<td># Children under 6</td>
<td>1.123 (.035)</td>
<td>1.093 (.0731)</td>
<td>.7230</td>
<td>1.109</td>
<td>.8732</td>
</tr>
<tr>
<td>Head is Christian Orthodox</td>
<td>.9683 (.0105)</td>
<td>.9642 (.0227)</td>
<td>.872</td>
<td>.9663</td>
<td>.1804</td>
</tr>
<tr>
<td>Head is Christian protestant</td>
<td>0.00 (0.00)</td>
<td>0.00 (0.00)</td>
<td>.8683</td>
<td>0.00</td>
<td>.0261</td>
</tr>
<tr>
<td>Main water source is surface</td>
<td>.2361 (.0521)</td>
<td>.183 (.0423)</td>
<td>.4325</td>
<td>.2107</td>
<td>.4078</td>
</tr>
<tr>
<td># months insufficient food</td>
<td>1.944 (.151)</td>
<td>2.38 (.1583)</td>
<td>.0512*</td>
<td>2.153</td>
<td>1.785</td>
</tr>
<tr>
<td>Distance to nearest market (minutes)</td>
<td>103.1 (11.12)</td>
<td>78.28 (9.658)</td>
<td>.0977*</td>
<td>91.2</td>
<td>73.48</td>
</tr>
<tr>
<td>Distance to nearest health (minutes)</td>
<td>118.6 (13.96)</td>
<td>102.7 (24.69)</td>
<td>.5777</td>
<td>111</td>
<td>106.7</td>
</tr>
</tbody>
</table>

| (B) Economic activity               |                       |                  |                            |              |      |
| Cultivable land owned Hectars       | .8272 (.0546)         | .7455 (.0486)    | .2686                      | .7878        | .626 |
| Net cash rev from crops             | 186.1 (53.34)         | 125.6 (34.83)    | .347                       | 157.1        | 521  |
| Net cash rev from coffee            | 2.373 (1.946)         | 3.449 (.2215)    | .3051                      | 1.401        | 40.6 |
| Income (transfers &and other) last 12mths | 145.7 (29.1)         | 149 (20.44)     | .9261                      | 147.3        | 435.2 |
| Agriculture main act of hh head     | .8066 (.0198)         | .8458 (.0222)    | .6129                      | .8379        | .626 |
| Income wages, last 12mths           | 74.55 (18.47)         | 75.41 (24.99)    | .9779                      | 74.96        | 305.9 |
| # large animals owned               | 3.354 (2223)          | 2.81 (1735)      | .0592*                     | 1.434        | 6.558 |
| Tot value large animals owned       | 1317 (9347)           | 1048 (75.36)     | .3033*                     | 3.993        | 4.78 |
| Rev sales large animals 12mths      | 145.3 (19.93)         | 114.7 (12.91)    | .2036                      | 130.6        | 305.9 |
| # chicken owned                     | 1.792 (.3792)         | 1.046 (1779)     | .0805*                     | 1.434        | 6.558 |
| # sheep/goats/other owned           | 2.093 (2621)          | 2.141 (4449)     | .9261                      | 2.116        | 5.967 |
| Total value sheep/goats/other owned | 163 (21.24)           | 142.9 (28.67)    | .5744                      | 153.4        | 422.1 |
| Total value of livestock owned      | 1488 (100.8)          | 1195 (85.78)     | .0313**                    | 1347         | 1559 |
| Total value of livestock sales      | 199 (28.02)           | 157.9 (16.00)    | .208                       | 179.3        | 384.9 |
| Total revenue from bsns last 12mths | 129.3 (39.41)         | 116 (27.48)      | .7825                      | 122.9        | 1087 |

| (C) Borrowing                       |                       |                  |                            |              |      |
| At least one outst loan in HH       | .0996 (.0145)         | .1571 (.0263)    | .6061*                     | .1272        | .3323 |
| At least one woman borrowed         | .0168 (.0038)         | .0212 (.0051)    | .4993                      | .0189        | .1363 |
| Borrowed from informal sources      | .0573 (.0137)         | .1132 (.0264)    | .0652*                     | .0841        | .2775 |
| Borrowed from banks/cooperatives    | .0146 (.0047)         | .0046 (.0022)    | .0554*                     | .0098        | .0986 |
| Borrowed from revolving credit assns| .0189 (.0047)         | .0232 (.0054)    | .5502                      | .021         | .1433 |
| Borrowed from NGOs                  | 0.00 (0.00)           | .0019 (.0014)    | .1779                      | .009         | .0306 |
| Borrowed for capital investment     | .0184 (.0041)         | .028 (.0054)     | .1622                      | .023         | .1499 |
| Borrowed to purchase variable inputs| .0177 (.0048)         | .0171 (.0055)    | .9417                      | .0174        | .1308 |
| Borrowed for consumption            | .0496 (.0097)         | .0934 (.0209)    | .0618*                     | .0706        | .2562 |
| Borrowed to pay for schooling costs | .00 (0.00)            | .0012 (.00)      | .1639                      | .005         | .0243 |
| Borrowed to finance food crops      | .0102 (.0035)         | .0103 (.0025)    | .9765                      | .0102        | .1007 |
| Borrowed to finance cash crops      | .0013 (.00)           | .0048 (.0023)    | .1601                      | .003         | .0544 |
| Borrowed to finance livestock       | .017 (.0043)          | .0175 (.0054)    | .9395                      | .0172        | .1302 |
| Total borrowing in 2003             | 22.59 (4.216)         | 27.51 (4.199)    | .412                       | 24.95        | 98.88 |
| Total outst loans for productivity  | 12.56 (3.051)         | 12.65 (3.344)    | .9831                      | 12.6         | 79.99 |
| Total outst loans from MC           | 7.364 (2.299)         | 7.647 (2.632)    | .9357                      | 7.5          | 62.29 |

Notes: Data from baseline (2003) survey. All statistics are calculated using sampling weights. Standard errors (in parenthesis in columns 1 and 2) and tests are robust to intra-PA correlation. The figures in column 3 are p-values for individual tests of equality of means between treatment and control PAs. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***% level. All figures expressing monetary values are in 2003 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The joint null hypothesis that the means for the 24 variables in panels A and B are equal between experimental arms is rejected at standard levels ($\chi^2_{24} = 62.53$, p-value = 0.0000), and the null that all 40 variables have equal means is rejected ($\chi^2_{40} = 764.92$, p-value = 0.0000).
Table 2.3: Predictors of Actual Treatment Status

<table>
<thead>
<tr>
<th>Dependent Variable: Actual Treatment Status</th>
<th>(1) Amhara</th>
<th>(2) Oromiya</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Assigned Treatment</td>
<td>0.619 (0.105)***</td>
<td>0.699 (0.092)***</td>
</tr>
<tr>
<td>(2) Household size</td>
<td>-0.005 (0.008)</td>
<td>-0.004 (0.007)</td>
</tr>
<tr>
<td>(3) Household head has primary education</td>
<td>-0.012 (0.052)</td>
<td>-0.043 (0.026)*</td>
</tr>
<tr>
<td>(4) # children under age 6</td>
<td>0.012 (0.012)</td>
<td>0.01 (0.015)</td>
</tr>
<tr>
<td>(5) Drink surface water</td>
<td>-0.082 (0.046)*</td>
<td>-0.028 (0.031)</td>
</tr>
<tr>
<td>(6) # months of insufficient food</td>
<td>-0.02 (0.013)</td>
<td>-0.003 (0.007)</td>
</tr>
<tr>
<td>(7) Distance to nearest market (minutes)</td>
<td>0.001 (0.001)</td>
<td>0 (0.001)</td>
</tr>
<tr>
<td>(8) Distance to nearest health facility (minutes)</td>
<td>0 (0.001)</td>
<td>0.001 (0.001)</td>
</tr>
<tr>
<td>(9) Cultivated land in last 12 months (hectares)</td>
<td>-0.006 (0.036)</td>
<td>0.006 (0.006)</td>
</tr>
<tr>
<td>(10) Cash revenues from crops</td>
<td>0.016 (0.013)</td>
<td>-0.002 (0.010)</td>
</tr>
<tr>
<td>(11) Cash revenues from coffee</td>
<td>0.008 (0.022)</td>
<td>-0.001 (0.015)</td>
</tr>
<tr>
<td>(12) Income from transfers &amp; other sources, last 12 months</td>
<td>-0.026 (0.009)***</td>
<td>-0.015 (0.009)*</td>
</tr>
<tr>
<td>(13) Agriculture is main activity of hh. head</td>
<td>-0.077 (0.044)*</td>
<td>-0.02 (0.029)</td>
</tr>
<tr>
<td>(14) Income from wages, last 12 months</td>
<td>-0.02 (0.013)</td>
<td>-0.005 (0.005)</td>
</tr>
<tr>
<td>(15) # large animals owned</td>
<td>0.003 (0.001)*</td>
<td>0.007 (0.004)*</td>
</tr>
<tr>
<td>(16) Total value of livestock owned</td>
<td>0.014 (0.007)**</td>
<td>0.007 (0.007)</td>
</tr>
<tr>
<td>(17) Total net revenues from business last 12 months</td>
<td>0.005 (0.010)</td>
<td>-0.013 (0.007)*</td>
</tr>
<tr>
<td>(18) Any outstanding loan in household</td>
<td>-0.227 (0.119)*</td>
<td>-0.062 (0.100)</td>
</tr>
<tr>
<td>(19) Any outstanding loan initiated by a woman</td>
<td>0.027 (0.052)</td>
<td>-0.091 (0.053)*</td>
</tr>
<tr>
<td>(20) Any outstanding loan from informal sources</td>
<td>0.113 (0.142)</td>
<td>-0.046 (0.080)</td>
</tr>
<tr>
<td>(21) Any outstanding loan from banks/cooperatives</td>
<td>0.407 (0.198)**</td>
<td>0.089 (0.083)</td>
</tr>
<tr>
<td>(22) Any outstanding loan from RC Associations</td>
<td>0.187 (0.212)</td>
<td>0.086 (0.186)</td>
</tr>
<tr>
<td>(23) Total outstanding loans</td>
<td>-0.016 (0.033)</td>
<td>0.001 (0.022)</td>
</tr>
<tr>
<td>(24) Total outstanding loans for productive purposes</td>
<td>-0.001 (0.012)</td>
<td>-0.021 (0.017)</td>
</tr>
<tr>
<td>(25) Total outstanding loans from RC Associations</td>
<td>0.017 (0.051)</td>
<td>0.01 (0.042)</td>
</tr>
</tbody>
</table>

Observations 3051 3159
R-squared 0.43 0.54
P-value: All (2)-(25) 0.001 0.465
P-value: Socio-economic status (10)-(17) 0.011 0.297
P-value: Borrowing (18)-(25) 0.045 0.366

Notes: Data from 2003 survey. The regressions show the partial correlations between actual treatment status, the randomly determined assigned treatment status, and a series of predictors. Treatment status is defined by a binary variable = 1 if micro-credit operations were introduced in a given PA (actual) or whether the operations had been assigned to the PA (assigned). Standard errors (in brackets) and tests are robust to intra-PA correlation. All statistics are calculated using sampling weights. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. All figures expressing monetary values are in 2003 Birr.
## Table 2.4: Impacts on Borrowing

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any Outstanding Loan</td>
<td>Outstanding Loan Woman</td>
<td>Information Sources</td>
<td>Loans from Banks</td>
<td>Loans from RCAs</td>
<td>Amount Loans</td>
<td>Amount Productive Loans</td>
<td>Amount RCA Loans</td>
</tr>
<tr>
<td>Credit x Amhara</td>
<td>0.204***</td>
<td>0.058**</td>
<td>0.044*</td>
<td>-0.021</td>
<td>0.232***</td>
<td>597*</td>
<td>434*</td>
<td>518***</td>
</tr>
<tr>
<td></td>
<td>[0.060]</td>
<td>[0.023]</td>
<td>[0.023]</td>
<td>[0.036]</td>
<td>[0.057]</td>
<td>[308]*</td>
<td>[192]**</td>
<td>[170]**</td>
</tr>
<tr>
<td>Credit x Oromiya</td>
<td>0.240***</td>
<td>0.108***</td>
<td>0.036**</td>
<td>0.015</td>
<td>0.202***</td>
<td>254*</td>
<td>203*</td>
<td>283***</td>
</tr>
<tr>
<td></td>
<td>[0.038]</td>
<td>[0.022]</td>
<td>[0.017]</td>
<td>[0.016]</td>
<td>[0.030]</td>
<td>[61]**</td>
<td>[55]**</td>
<td>[44]**</td>
</tr>
<tr>
<td>Amhara</td>
<td>0.150***</td>
<td>0.045***</td>
<td>-0.051**</td>
<td>0.125***</td>
<td>0.039**</td>
<td>216*</td>
<td>201*</td>
<td>48***</td>
</tr>
<tr>
<td></td>
<td>[0.042]</td>
<td>[0.012]</td>
<td>[0.020]</td>
<td>[0.028]</td>
<td>[0.018]</td>
<td>[42]**</td>
<td>[42]**</td>
<td>[17]**</td>
</tr>
<tr>
<td>Oromiya</td>
<td>-0.038</td>
<td>0.016</td>
<td>-0.026*</td>
<td>-0.050***</td>
<td>0.014</td>
<td>67*</td>
<td>65*</td>
<td>18***</td>
</tr>
<tr>
<td></td>
<td>[0.027]</td>
<td>[0.010]</td>
<td>[0.015]</td>
<td>[0.013]</td>
<td>[0.013]</td>
<td>[35]*</td>
<td>[31]**</td>
<td>[14]</td>
</tr>
<tr>
<td>Observations</td>
<td>6,272</td>
<td>6,272</td>
<td>6,272</td>
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<td>6,272</td>
<td>6,272</td>
<td>6,272</td>
<td>6,272</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.210</td>
<td>0.082</td>
<td>0.017</td>
<td>0.108</td>
<td>0.213</td>
<td>0.033</td>
<td>0.033</td>
<td>0.031</td>
</tr>
<tr>
<td>Baseline mean, Amhara</td>
<td>0.120</td>
<td>0.019</td>
<td>0.074</td>
<td>0.011</td>
<td>0.022</td>
<td>35</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Baseline mean, Oromiya</td>
<td>0.121</td>
<td>0.014</td>
<td>0.046</td>
<td>0.055</td>
<td>0.012</td>
<td>36</td>
<td>23</td>
<td>7</td>
</tr>
</tbody>
</table>

Notes: Data from 2003 and 2006 surveys. Standard errors (in brackets) and tests are robust to intra-PA correlation. Estimates of model 2.3 in the text. The dependent variables are defined as follows: a dummy for whether the household had an outstanding loan (column 1), whether a woman had an outstanding loan (2), whether the household had any outstanding loans from informal sources such as money lenders or other individuals (3), or from a bank (column 4), or from a revolving credit association (5), the total amount of outstanding loans by household (6), the total amount of loans from revolving credit association (7), and the total amount of productive loans defined as loans taken for working capital or basic investment (8). All statistics are calculated using sampling weights. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The p-value for the joint, cross-equation null that \( \beta_{MF} = \beta_{MF}^O = 0 \) in all equations is 0.000.
### Table 2.5: Impacts on non-Farm Business Activities

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH has Non-farm Business</td>
<td>HH has Female-led</td>
<td>Business costs and revenues, 12 months before interview</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female-led Business</td>
<td>Revenues</td>
<td>Costs</td>
<td>Hired Labor Costs</td>
<td>Material Costs</td>
<td>Equipment Costs</td>
<td>Business Net Revenues</td>
<td></td>
</tr>
<tr>
<td>Credit x Amhara</td>
<td>-0.041</td>
<td>-0.026</td>
<td>-77.7</td>
<td>-109.5</td>
<td>-8.9</td>
<td>-75.5</td>
<td>-3</td>
<td>31.8</td>
</tr>
<tr>
<td></td>
<td>[0.057]</td>
<td>[0.038]</td>
<td>[135.9]</td>
<td>[154.7]</td>
<td>[7.0]</td>
<td>[148.9]</td>
<td>[2.1]</td>
<td>[107.4]</td>
</tr>
<tr>
<td>Credit x Oromiya</td>
<td>0.016</td>
<td>-0.013</td>
<td>872.8</td>
<td>-36.2</td>
<td>8.6</td>
<td>-79.9</td>
<td>13.6</td>
<td>909</td>
</tr>
<tr>
<td></td>
<td>[0.024]</td>
<td>[0.026]</td>
<td>[478.9]*</td>
<td>[56.8]</td>
<td>[8.0]</td>
<td>[46.2]*</td>
<td>[9.2]</td>
<td>[470.8]*</td>
</tr>
<tr>
<td>Amhara</td>
<td>0.030</td>
<td>0.038</td>
<td>202.3</td>
<td>363.1</td>
<td>4</td>
<td>323.7</td>
<td>3.7</td>
<td>-160.8</td>
</tr>
<tr>
<td></td>
<td>[0.049]</td>
<td>[0.037]</td>
<td>[86.9]**</td>
<td>[135.1]***</td>
<td>[2.8]</td>
<td>[128.3]**</td>
<td>[1.8]**</td>
<td>[88.8]*</td>
</tr>
<tr>
<td>Oromiya</td>
<td>0.251***</td>
<td>0.159***</td>
<td>-225.7</td>
<td>197.5</td>
<td>9.7</td>
<td>169.2</td>
<td>7.3</td>
<td>-423.2</td>
</tr>
<tr>
<td></td>
<td>[0.017]</td>
<td>[0.020]</td>
<td>[312.2]</td>
<td>[43.0]***</td>
<td>[4.1]**</td>
<td>[40.4]***</td>
<td>[2.0]***</td>
<td>[298.3]</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.146</td>
<td>0.089</td>
<td>0.002</td>
<td>0.017</td>
<td>0.004</td>
<td>0.015</td>
<td>0.006</td>
<td>0.002</td>
</tr>
<tr>
<td>Baseline mean, Amhara</td>
<td>0.146</td>
<td>0.064</td>
<td>162.5</td>
<td>28.4</td>
<td>6.5</td>
<td>16.1</td>
<td>1.9</td>
<td>134.2</td>
</tr>
<tr>
<td>Baseline mean, Oromiya</td>
<td>0.051</td>
<td>0.016</td>
<td>280.6</td>
<td>8.3</td>
<td>1.1</td>
<td>6.3</td>
<td>0.5</td>
<td>272.3</td>
</tr>
</tbody>
</table>

Notes: Data from baseline (2003) and follow-up (2006) surveys. All statistics are calculated using sampling weights. Standard errors (in brackets) and tests are robust to intra-PA correlation. All regressions are as in model 2.3. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The p-value for the joint, cross-equation null that $\beta_{MF} = 0$ in all equations is 0.6444.
Table 2.6: Impacts on Animal Husbandry

<table>
<thead>
<tr>
<th></th>
<th>(1) Total owned</th>
<th>(2) Large animals owned</th>
<th>(3) Sheep/goats/etc. owned</th>
<th>(4) Large animals owned</th>
<th>(5) Sheep/goats/etc. owned</th>
<th>(6) Total sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(value)</td>
<td>(value)</td>
<td>(value)</td>
<td>(number)</td>
<td>(number)</td>
<td></td>
</tr>
<tr>
<td>Credit x Amhara</td>
<td>388</td>
<td>418</td>
<td>-29</td>
<td>0.458</td>
<td>-0.027</td>
<td>159</td>
</tr>
<tr>
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Notes: Data from baseline (2003) and follow-up (2006) surveys. All statistics are calculated using sampling weights. Standard errors (in brackets) and tests are robust to intra-PA correlation. All regressions are as in model 2.3. ‘Large’ animals include cows, oxen, calves, bulls, camels, horses, donkeys, and mules. Asterisks denote statistical significance at the 10(*), 5(**) or 1(*** percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The p-value for the joint, cross-equation null that \( \beta_{MF}^A = \beta_{MF}^O = 0 \) in all equations is 0.3184.
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<th>(1) Agriculture Main activity</th>
<th>(2) Cash revenues (All crops)</th>
<th>(3) Cash revenues (coffee)</th>
<th>(4) Net cash revenues (All crops)</th>
<th>(5) Net cash revenues (coffee)</th>
<th>(6) Total production costs (all crops)</th>
<th>(7) Total production costs (coffee)</th>
<th>(8) Land cultivated last 12 months (Hectares)</th>
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<td>155</td>
<td>2</td>
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<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
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<td>130</td>
<td>101</td>
<td>76</td>
<td>16</td>
<td>1.033</td>
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</tbody>
</table>

Notes: Data from baseline (2003) and follow-up (2006) surveys. All statistics are calculated using sampling weights. Standard errors (in brackets) and tests are robust to intra-PA correlation. All regressions are as in model 2.3. Asterisks denote statistical significance at the 10(***), 5(***), or 1(***%) percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The p-value for the joint, cross-equation null that $\beta_A = \beta_O = 0$ in all equations is 0.0006.
Table 2.8: Impacts on Income from Wages and Other Sources

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<th>(1) Income from wages (last 12 months)</th>
<th>(2) Income from Other Sources (last 12 months)</th>
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<td>Credit x Oromiya</td>
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<td></td>
<td>[73]</td>
<td>[18]</td>
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<tr>
<td>Amhara</td>
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<td>-63</td>
</tr>
<tr>
<td></td>
<td>[71]**</td>
<td>[39]</td>
</tr>
<tr>
<td>Oromiya</td>
<td>-36</td>
<td>2</td>
</tr>
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<td>0.01</td>
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<td>Baseline mean, Amhara</td>
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<td>198</td>
</tr>
<tr>
<td>Baseline mean, Oromiya</td>
<td>251</td>
<td>14</td>
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</table>

Notes: Data from baseline (2003) and follow-up (2006) surveys. Standard errors (in brackets) and tests are robust to intra-PA correlation. Estimates of model 2.3 in the text for income received in the past 12 months from wages (column 1) and income from transfers and other sources in the past 12 months (column 2). All statistics are calculated using sampling weights. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The p-value for the joint, cross-equation null that $\beta_{MF}^A = \beta_{MF}^O = 0$ in all equations is 0.5433.
Table 2.9: Impacts on Labor Supply, Adults

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<tbody>
<tr>
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<td>Work Primary Activity</td>
<td>Hours Worked / year</td>
<td>Housework Primary Activity</td>
<td>Females</td>
<td>Females</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
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<td>-46</td>
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<td>[114]</td>
<td>[55]</td>
<td>[0.048]</td>
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<td>-257***</td>
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<tr>
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<td>[0.039]</td>
<td>[90]</td>
<td>[48]</td>
<td>[0.039]</td>
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<tr>
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<td>-0.092***</td>
<td>-268***</td>
<td>-148***</td>
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<td>0.086</td>
<td>0.037</td>
<td>0.006</td>
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<td>0.16</td>
<td>1268</td>
<td>142</td>
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<td>0.363</td>
<td>1507</td>
<td>482</td>
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Notes: Data from baseline (2003) and follow-up (2006) surveys. Standard errors (in brackets) and tests are robust to intra-PA correlation. Individual-level estimates of model 2.3. All statistics are calculated using sampling weights. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. The number of hours worked per year is estimated as the product of the reported number of hours worked in a typical week of work and the number of weeks worked in the 12 months before the interview.
Table 2.10: Impacts on School Enrollment

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<td>Attends school</td>
<td>Primary Activity last 12 months</td>
<td>Hours Worked</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Age 6-9</td>
<td>Age 10-16</td>
<td>School Work</td>
<td>Age 10-16</td>
<td>Work</td>
<td>Age 10-16</td>
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<tr>
<td>(A) - Boys</td>
<td></td>
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<td></td>
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<tr>
<td>Credit x Amhara</td>
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<td>0.087**</td>
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<td>-0.009</td>
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<td>[0.046]</td>
<td>[0.037]</td>
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<td>0.100</td>
<td>0.035</td>
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Notes: Estimates of model 2.3 in the text. Data are from baseline (2003) and follow-up (2006) surveys. All statistics are calculated using sampling weights. Standard errors (in brackets) and tests are robust to intra-PA correlation. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level.
<table>
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<th>(6)</th>
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<td>Any HH member</td>
<td>Any child U6</td>
<td>Health expenditures</td>
<td>Drinking water</td>
<td># Decisions</td>
<td># Decisions</td>
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<td>seriously ill</td>
<td>last 3 years</td>
<td>last 3 years</td>
<td>from surface sources</td>
<td>woman involved (woman's report)</td>
<td>woman involved (man's report)</td>
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<td>-0.534</td>
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<td>[0.792]</td>
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<td>[0.027]***</td>
<td>[19]***</td>
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<td>R-squared</td>
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<td>0.1</td>
<td>0.127</td>
<td>0.12</td>
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<td>0.07</td>
<td>0.202</td>
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<td>Baseline mean, Oromiya</td>
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<td>1.14</td>
<td>10.9</td>
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Notes: Data from baseline (2003) and follow-up (2006) surveys. Standard errors (in brackets) and tests are robust to intra-PA correlation. Estimates of model 2.3 in the text for the number of months the household reported food insecurity with the past 12 months (column 1) and whether the household relies on surface water as their main source of drinking water (column 5). The data used in columns 2 through 5 were only collected during the follow-up survey, and therefore the dependent variables represents levels and not changes over time. The dependent variables in columns 2 and 3 are indicator variables for whether a member (or child under the age of 6) has been seriously ill in the past 3 years. Column 4 includes all health expenditures reported by the household over the last 3 years. Data are from baseline (2003) and follow-up (2006) surveys. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008). The p-value for the joint, cross-equation null that $\beta_{MF}^{A} = \beta_{MF}^{O} = 0$ in all equations is 0.2586.
2.6 Appendix

2.6.1 Detailed Description of Outcomes

**Outstanding Loans:** A household is labeled as having an outstanding loan if any household member owes money or goods to anyone at the time of the interview, or if such loans existed in the 12 months before the interview. At the time of the follow up, 440 of 4,164 households (10.6%) with no current outstanding loans had extinguished loans in the previous 12 months. Women’s borrowing is identified by specific questions about the individual who contracted the loan.

**Revenues and Costs from Non-farm Self-employment:** These activities include “non agricultural enterprise which produces goods or services (for example, artisan, metalworking, tailoring, repair work; also include processing and selling your outputs from your own crops if done regularly), shops or trading business. Respondents were asked to report for how many days/weeks/months the business operated in the previous 12 months, and the total revenues from sales per unit of time. Total monetary costs incurred during the previous 12 months were also recorded separately for hired labor, raw materials, equipment/machinery, transport/packing/storage and other items. As an example, suppose that a business operated for 3 months, with weekly earnings of 100 Birr/week, and with total costs of 500 Birr. Then we estimate ‘net revenues’ equal to 700 Birr (= 100 × 4 × 3 − 500). Separate information was collected for each existing business separately. The survey did not collect information on family labor or self-consumption of any goods produced by the business.

**Animal Husbandry:** The value of animals owned is derived from questions about the expected revenues from their sale at the time of the interview. The value of sales (in Birr) is the total revenue from actual sales of animals over the previous year. Separate information was collected for each animal type separately (types included cows, oxen, calves, bulls, camels, horses, donkeys, mules, sheep, goats, chicken and ‘others’). No information was collected about costs for hired labor, veterinarian services, feed, etc.
Revenues and Costs from Crop Cultivation: Information was collected separately for each crop type (the principal crops were wheat, barley, teff, maize, sorghum/millet, beans and (in Oromiya) coffee. For each crop, the questionnaire recorded the total revenues from sales (in Birr) over the last 12 months, the share of the total crop sold, and the total amount of expenses incurred for cultivation and sales. We calculate net revenues from sales as the difference between revenues and the corresponding imputed costs, estimated as total costs multiplied by the fraction of the crop sold.

Other Sources of Income: Income from wages is reported as total earnings (in Birr) in monetary or in-kind terms, for work conducted for someone else over the previous 12 months.
2.6.2 Alternative Model Specifications

Table 2.12: Impacts on Borrowing w/ Family Planning Controls

<table>
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<tr>
<th>VARIABLES</th>
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<th>(3)</th>
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<th>(10)</th>
<th>(11)</th>
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<tr>
<td></td>
<td>Any Outstanding Loan</td>
<td>Outstanding Loan</td>
<td>Woman</td>
<td>Sources</td>
<td>Loans from Banks</td>
<td>Loans from RCAs</td>
<td>Amount Loans adjusted</td>
<td>Productive Loans</td>
<td>RCA Loans</td>
<td>Amount Loans</td>
<td>Productive Loans</td>
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<td>0.055**</td>
<td>0.030</td>
<td>0.047</td>
<td>0.033***</td>
<td>0.213***</td>
<td>0.530***</td>
<td>0.720***</td>
<td>0.927***</td>
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<td>434.544***</td>
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<td>[0.025]</td>
<td>[0.027]</td>
<td>[0.049]</td>
<td>[0.200]</td>
<td>[0.162]</td>
<td>[0.195]</td>
<td>[260.039]</td>
<td>[162.714]</td>
<td>[143.974]</td>
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<td>Credit x Oromiya</td>
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<td>0.112***</td>
<td>0.001*</td>
<td>0.010</td>
<td>0.114***</td>
<td>0.945***</td>
<td>0.856***</td>
<td>0.927***</td>
<td>0.810***</td>
<td>280.672**</td>
<td>229.103**</td>
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<td>[0.018]</td>
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<td>[0.135]</td>
<td>[0.113]</td>
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<td>[59.302]</td>
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<td>0.041**</td>
<td>-0.059***</td>
<td>0.173***</td>
<td>0.036</td>
<td>0.068***</td>
<td>0.794***</td>
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<td>163.090</td>
<td>201.627*</td>
<td>-13.188</td>
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<td>[0.017]</td>
<td>[0.021]</td>
<td>[0.026]</td>
<td>[0.030]</td>
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<td>[109.748]</td>
<td>[77.612]</td>
<td>[59.229]</td>
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<td>Oromiya</td>
<td>-0.035*</td>
<td>0.022</td>
<td>-0.034**</td>
<td>-0.058***</td>
<td>0.031*</td>
<td>0.015</td>
<td>0.069</td>
<td>0.121*</td>
<td>106.178**</td>
<td>102.996**</td>
<td>46.440**</td>
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<td>[0.014]</td>
<td>[0.016]</td>
<td>[0.018]</td>
<td>[0.087]</td>
<td>[0.075]</td>
<td>[0.068]</td>
<td>[47.144]</td>
<td>[42.630]</td>
<td>[23.395]</td>
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<td>0.017</td>
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<td>-0.030</td>
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<td>[0.024]</td>
<td>[0.020]</td>
<td>[0.044]</td>
<td>[0.186]</td>
<td>[0.158]</td>
<td>[0.177]</td>
<td>[220.336]</td>
<td>[141.294]</td>
<td>[124.242]</td>
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<tr>
<td>FP x Oromiya</td>
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<td>-0.021</td>
<td>0.024</td>
<td>0.021</td>
<td>-0.054</td>
<td>-0.122</td>
<td>-0.211</td>
<td>-121.461*</td>
<td>-118.672**</td>
<td>-87.510*</td>
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<tr>
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<td>[0.025]</td>
<td>[0.015]</td>
<td>[0.016]</td>
<td>[0.035]</td>
<td>[0.142]</td>
<td>[0.119]</td>
<td>[0.130]</td>
<td>[65.163]</td>
<td>[58.814]</td>
<td>[52.353]</td>
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</table>

Observations: 6,272
R-squared: 0.212
Mean Dep. Var. Amhara: 0.120
Mean Dep. Var. Oromiya: 0.121
Joint P-Value (all eqns): 0.000

Notes: Data from 2003 and 2006 surveys. Standard errors (in brackets) and tests are robust to intra-PA correlation. Estimates of model 2.3 in the text for whether the household had an outstanding loan (column 1), whether a woman had an outstanding loan (2), whether the household had any outstanding loans from informal sources such as money lenders or individuals (3), or from a bank (column 4), or from a revolving credit association (5), the total amount of outstanding loans by household (9), the total amount of loans from revolving credit association (11), and the total amount of productive loans defined as loans taken for working capital or basic investment (10). Columns 6, 7, and 8 (labeled ‘adjusted’) transform the dependent variable using the quartic root. All statistics are calculated using sampling weights. Asterisks denote statistical significance at the 10(*), 5(**) or 1(***)) percent level. All figures expressing monetary values are in 2006 Birr. The PPP exchange rate according to the latest World Bank figures is 2.25 Birr/1USD (World Bank 2008).
Table 2.13: Alternative Model Specifications: non-Farm Business Activities

### Assigned Treatment

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<th>(4)</th>
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<td></td>
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<tr>
<td>Business Costs</td>
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<td>[135.923]</td>
<td>[7.045]</td>
<td>[148.917]</td>
<td>[2.105]</td>
<td>[0.038]</td>
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<td>Business Costs</td>
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<td>[9.237]</td>
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<td>[470.754]</td>
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<td>202.325**</td>
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<td>323.685**</td>
<td>3.087**</td>
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<td>-160.788***</td>
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<td>0.006</td>
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<tr>
<td>Mean Dep. Var. Amhara</td>
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<td>162.509</td>
<td>6.451</td>
<td>16.062</td>
<td>1.914</td>
<td>0.064</td>
<td>134.150</td>
<td>0.146</td>
</tr>
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<td>Mean Dep. Var. Oromiya</td>
<td>8.307</td>
<td>280.647</td>
<td>1.065</td>
<td>6.333</td>
<td>0.433</td>
<td>0.016</td>
<td>272.340</td>
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<tr>
<td>Joint P-Value (all eqns)</td>
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<td>0.252</td>
<td>0.252</td>
<td>0.252</td>
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### Including Baseline PA-level Means as Controls

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<td>887.615**</td>
<td>10.824</td>
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<td>[626.041]</td>
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<td>[1,202.052]</td>
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<tr>
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<td>0.015</td>
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<td>6.333</td>
<td>0.433</td>
<td>0.016</td>
<td>272.340</td>
<td>0.051</td>
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<td>0.248</td>
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### Monetary Values in Quartic Root

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<tr>
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53
Table 2.14: Alternative Model Specifications: Livestock Activities

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<th></th>
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<th>(2) Large animals owned (value)</th>
<th>(3) Sheep/goats/etc. owned (value)</th>
<th>(4) Large animals owned (number)</th>
<th>(5) Sheep/goats/etc. owned (number)</th>
<th>(6) Total sales</th>
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<td></td>
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<td>Credit x Amhara</td>
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<td>[408]</td>
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<td>[103]</td>
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<td>36</td>
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<td>[239]</td>
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Table 2.16: Alternative Model Specifications: Income from Wages and Other Sources
Table 2.17: Alternative Model Specifications: Labor Supply

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<td>[0.048]</td>
</tr>
<tr>
<td>Amhara</td>
<td>0.261</td>
<td>0.221</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>[0.263]</td>
<td>[0.263]</td>
<td>[0.231]</td>
</tr>
<tr>
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<td>0.246</td>
<td>-0.198</td>
</tr>
<tr>
<td></td>
<td>[0.293]</td>
<td>[0.293]</td>
<td>[0.261]</td>
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58
Table 2.19: Alternative Model Specifications: Girls’ Schooling

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<td>Attends school</td>
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<td>Hours Worked</td>
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<tr>
<td>Age 6-9</td>
<td>Age 10-16</td>
<td>Age 10-16</td>
<td>Age 10-16</td>
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<td>Assigned Treatment</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

| Credit x Amhara | -0.026 | -0.052 | -0.038 | 0.031 | -0.001 | 66.681 |
| [0.045] | [0.043] | [0.043] | [0.047] | [0.030] | [119.172] |
| Credit x Oromiya | 0.082* | 0.048 | -0.012 | 0.005 | 0.010 | -43.741 |
| [0.043] | [0.045] | [0.038] | [0.027] | [0.028] | [41.576] |

| Amhara |
| 0.295*** | 0.335*** | 0.324*** | -0.200*** | -0.113*** | -530.935*** |
| [0.029] | [0.044] | [0.041] | [0.026] | [0.026] | [79.468] |

| Oromiya |
| 0.032 | 0.131*** | 0.114*** | -0.047** | -0.100*** | -41.893 |
| [0.032] | [0.025] | [0.027] | [0.019] | [0.018] | [28.021] |

Adding Baseline PA-level Means as Controls

| Credit x Amhara | -0.005 | -0.052 | -0.038 | 0.031 | -0.001 | 66.681 |
| [0.043] | [0.043] | [0.043] | [0.037] | [0.030] | [119.172] |
| Credit x Oromiya | 0.050 | 0.005 | -0.032 | 0.030 | 0.010 | 35.243 |
| [0.048] | [0.042] | [0.041] | [0.026] | [0.026] | [57.701] |

| Amhara |
| 0.306 | 0.286 | 0.289 | -0.125 | -0.105 | -455.897 |
| [0.281] | [0.267] | [0.222] | [0.150] | [0.171] | [468.030] |

| Oromiya |
| 0.134 | 0.033 | 0.072 | 0.019 | -0.109 | 27.235 |
| [0.322] | [0.308] | [0.248] | [0.166] | [0.188] | [454.863] |

59
<table>
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<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<tr>
<td>Month of food insecurity</td>
<td>Any HH member seriously ill last 3 years</td>
<td>Any child U6 seriously ill last 3 years</td>
<td>Health expenditures from surface sources</td>
<td># Decisions woman involved (woman’s report)</td>
<td># Decisions woman involved (man’s report)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assigned Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit x Amhara</td>
<td>0.544**</td>
<td>-0.014</td>
<td>-0.033</td>
<td>-11.778</td>
<td>-0.115**</td>
<td>0.327</td>
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<td>[0.227]</td>
<td>[0.037]</td>
<td>[0.027]</td>
<td>[29.327]</td>
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<td>[0.811]</td>
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<td>0.136</td>
<td>-0.051*</td>
<td>-0.027</td>
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<td>0.138***</td>
<td>221.230***</td>
<td>-0.199***</td>
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<td>[18.636]</td>
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<td>Adding Baseline PA-mean as Controls</td>
<td></td>
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</tr>
<tr>
<td>Credit x Amhara</td>
<td>0.484**</td>
<td>-0.004</td>
<td>-0.028</td>
<td>-9.689</td>
<td>-0.024</td>
<td>-0.235</td>
<td>0.337</td>
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<tr>
<td>[0.195]</td>
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<td>[0.018]</td>
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<td>[0.589]</td>
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<tr>
<td>Credit x Oromiya</td>
<td>0.324*</td>
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<td>-0.017</td>
<td>-18.476</td>
<td>-0.019</td>
<td>1.360**</td>
<td>2.608***</td>
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<td>[0.025]</td>
<td>[18.090]</td>
<td>[0.028]</td>
<td>[0.530]</td>
<td>[0.765]</td>
<td></td>
</tr>
<tr>
<td>Amhara</td>
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<td>0.291*</td>
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<td>[3.688]</td>
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Subjective Expectations and Adherence to Anti-Retroviral Medication: Evidence from Tanzania

3.1 Introduction

The majority of people living with HIV/AIDS reside in Sub-Saharan Africa where access to antiretroviral therapy (ART) is expanding quickly. However, the medical literature (consistent with the data used in this paper) has established that HIV/AIDS patients do not fully adhere to commonly accepted treatments such as ART. In the medical, psychological and sociological literatures there are many theories attempting to explain why people who are infected with HIV/AIDS, and who have cheap or free access to ART treatments, choose either not to accept treatment or not to fully adhere to the recommended method of treatment, including inconsistent dosing and skipping doses. Using innovative subjective expectations data from Tanzania, this paper describes expectations of various health outcomes under different assumptions of adherence, utilizes unique data on elicitation of time preference parameters, and provides an analysis of how these parameters enter into an individual’s decision to
appropriately take their medication.

Perhaps the most prominent explanation of non-adherence is that HIV patients learn about their body’s ability to respond to their medication as time progresses, and that their expectations provide important information entering their decision to continue taking, or begin taking prescribed medication. While anti-retroviral therapy cannot fully eliminate the HIV virus, it reduces the levels of the virus in the bloodstream, reducing the likelihood of transmitting HIV and also the progression to AIDS (CDC, 2009). For most individuals, near perfect (greater than 95%) adherence is necessary to prevent virologic failure, commonly defined as HIV RNA level over 400 copies per mL (Stephenson, 1999). For a patient on a twice daily regimen, this implies that they cannot miss, or delay more than an hour, more than three doses of antiretroviral medications per month and still be in compliance.

As of 2007, the HIV prevalence rate in Tanzania was estimated to be 6.2% among adults ages 15-49 (UNAIDS/WHO, 2008). The government has implemented free ART through the public health system since 2004 (WHO, 2005). However, estimated perfect adherence in our baseline sample is only 80%.\(^1\)

Because citizens of Tanzania now have universal access to free ART the key question is why 20% of people report imperfect adherence.\(^2\) Intuitively, there are many reasons why a person might not fully adhere. The travel cost to the clinic may be prohibitively high, she may be afraid of the stigma attached to taking HIV medication in public, resulting in either missing doses or delaying doses until she can be in

\(^1\) Based on a number of studies using diverse measures of adherence in the U.S., the average level of perfect ART medication adherence is approximately 70% (Bangsberg and Deeks, 2002). However in some specific sub-Saharan African contexts, self-reported perfect adherence rates have been observed to be higher, 89% in Kenya (Unge et al., 2010) and 94.3% in Ethiopia (Amberbir et al., 2008).

\(^2\) HIV patients in developing countries are not unique in their non-adherence to prescribed medications. In fact, it has been documented that individuals prescribed medication all across the world experience less than perfect adherence (Osterberg and Blaschke, 2005). In a context of sub-Saharan Africa, this problem is arguably more important due to the epidemic nature of HIV in that setting, and its high probability of transmission.
private, or she may have differential expectations about the effect, efficacy, costs, and benefits of taking and adhering perfectly to the ART treatment. Respondents base their adherence decision on how they believe the medications will affect their future health outcomes such as their overall health status, existence of side effects, and the probability of survival. When choosing whether to adhere to medication, people likely base their decisions on their own subjective beliefs about the probabilities of health outcomes occurring.

To illustrate the importance of separating expectations and preferences, suppose a HIV-positive patient is faced with the decision to fully adhere to her treatment or not. Objectively, she has a lower probability of mortality in the next period if she fully adheres to the treatment; however, there are also adverse side effects associated with the treatment regime. If I observe that an individual does not fully adhere, there are two possible, observationally equivalent, explanations: she either cares more about not experiencing side effects than about dying, or she values life more, but believes that taking the medication will not result in a lower probability of death or extended life expectancy. In addition, it is possible that she believes that partial adherence is sufficiently effective to increase life expectancy but will minimize side effects. If I were to observe only whether an individual adheres or not, without the individual’s subjective beliefs, I would not be able to distinguish these two scenarios.

There have been many studies examining the correlation between factors believed to influence adherence levels, but few that delve deeper into the decision-making process. In South Africa Orrell et al. (2003) found a correlation between adherence and factors such as speaking English and age. Conversely, other studies have found that stigma (Nachega et al., 2004), depression (Yun et al., 2005), hazardous alcohol use (Chander et al., 2006), financial constraints and side effects (Weiser et al., 2003), lost

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3 Of course there is also the possibility that an individual simply forgets. While unable to specifically address this issue, I acknowledge that it complicates inference based on the intent of perfect adherence.
wages due to waiting times, and hunger (Hardon et al., 2007) are associated with non-adherence. Horne et al. (2007) surveyed 153 participants who were given a recommendation of HAART and found that uptake and adherence was associated with perceptions of personal necessity of treatment and concerns about potential side effects. Delavande and Kohler (2009) collected subjective mortality expectations from HIV-positive patients in Malawi and found that respondents substantially overestimated the mortality risks compared to life table mortality rates.

While there is little evidence linking subjective expectations to adherence, there is a growing body of literature in developing countries eliciting subjective expectations about future events. Most commonly these surveys ask questions based on a Likert scale (e.g. very likely, likely, not very likely) as opposed to eliciting subjective probabilities or higher moments of the subjective distributions (Delavande et al., 2011). Other studies have asked respondents about the percent chance of future employment (Dominitz and Manski, 1997), expectations of future income (McKenzie et al., 2007; Attanasio et al., 2005; Attanasio and Kaufmann, 2009), likelihood of rainfall (Luseno et al., 2003; Lybbert et al., 2007), likelihood of malaria infection (Tarozzi and Mahajan, 2011), and future coffee prices (Hill, 2007). Economists have recently been incorporating subjective expectations in other decision-making processes. For instance, Van der Klaauw (2000) uses expectations about future occupation to estimate a structural dynamic model of teacher career decisions under uncertainty. Recently, Arcidiacono et al. (2011) examine college major choices based on expectations of expected earnings in their chosen major as well as in other counterfactual majors. In this paper, I use a model similar to Delavande (2008), where data on subjective expectations about the efficacy, side effects, and costs of birth control were used to explore contraceptive choice among college-aged females. I provide new, direct evidence of the importance of expectations in the adherence decision by developing a new survey module that provides information about a comprehen-
sive set of factors that theory suggest might influence the adherence decision. This new survey module was added to an existing longitudinal survey in Moshi, Tanzania called Coping with HIV/AIDS in Tanzania (CHAT), conducted by the Center for Health Policy and Inequalities Research (CHPIR) and the Tanzanian Women’s Research Foundation (TAWREF). The primary problem with evaluating choice data in the context of beliefs and expectations is that identifying beliefs is difficult because a particular behavior may be consistent with multiple characterizations of preferences and expectations (Manski, 2004). Anti-retroviral medications, in particular, are associated with numerous negative side effects, thus it is useful to learn whether non-adherence is due to preference, expectations of the medications, or other factors altogether.

In addition to probabilistic expectations, I included a series of questions that provides a measure of an individual’s time preference discount factor as it relates to health decisions. While elicitation of time preference parameters for monetary outcomes through survey choice data is not new, it has only recently been considered in regard to health as an outcome variable. While there are a few studies which analyze time preference for health separately from money or assets, none of these studies are in the region of sub-Saharan Africa or related to HIV/AIDS and ART adherence (Khwaja et al., 2009).

Overall, this paper finds that by incorporating elicited expectations, perceived effectiveness is an important predictor of taking ART. Specifically, respondents are less likely to take ART if they believe that taking it will worsen their health or increase their chances of mortality. Perceptions of the medications’ effectiveness at reducing viral loads are significant predictors of perfect adherence and there is also evidence that adherence decisions are consistent with respondents’ desire to avoid feeling nauseous, but that feeling fatigued may be associated with the effectiveness of ART. Respondents learned that perfectly adhering did not make them feel as good as
they thought it would, and conversely, that imperfectly adhering did not make them feel as badly as they thought it would. And finally, patience (as it relates to health) does not vary significantly by gender, but HIV-positive respondents are significantly less patient than HIV-negative respondents.

The rest of this paper is organized as follows: Section 3.2 provides a medical overview of HIV/AIDS. Section 3.3.2 describes the creation process of the new expectations survey module I developed. Section 3.3 describes the data, including summary statistics. Sections 3.4.2 and 3.4.3 summarize responses to the new expectations and health-time discounting questions. Section 3.4.4 explores the predictors and updating of the elicited subjective expectations. Section 3.5 analyzes the role of these elicited subjective expectations on the adherence decision, and Section 3.6 concludes.

3.2 Medical Background

Human Immunodeficiency Virus (HIV) is a virus that attacks the body’s white blood cells (T-cells or CD4 cells). White blood cells comprise the body’s immune system, and are vital in fighting infections and other diseases. HIV uses the body’s white blood cells to replicate, destroying the immune system in the process (DHHS, 2009). HIV/AIDS can be transmitted through blood-to-blood or sexual contact. HIV-positive women can also pass the virus to their children through childbirth or breastfeeding (CDC, 2009). Acquired Immuno Deficiency Syndrome (AIDS) is the final stage of HIV infection, where the body’s immune system is so weakened that the body has a difficult time fighting infection. AIDS is usually diagnosed when someone has one or more specific infections, certain cancers, or a very low T-cell or CD4 count (CDC, 2009).

When an individual first becomes infected with HIV, the virus replicates rapidly, but may remain dormant and undetected by the immune system. Severe symptoms
are rare in the early stages of infection, with 70% of HIV-positive people suffering only mild flu-like symptoms (NIAID, 2009). After 2-4 weeks of infection, the immune system begins fighting the virus by producing killer T-cells (CD8 cells) which dramatically reduces the concentration of HIV in the body (viral load). At this time the white blood cells may rebound almost to pre-infection levels. This stage of relative dormancy may last several years. The virus will eventually overtake the white blood cells to the point where the viral load is so high, and the white blood cell count so low, that the body contracts an opportunistic infection, such as pneumonia or tuberculosis, and the patient is officially diagnosed with AIDS (NIAID, 2009).

There are currently 31 antiretroviral drugs (ART) approved by the U.S. Food and Drug Administration (FDA) to treat HIV infection. These drugs do not cure HIV or AIDS but they can reduce the viral load in the body to undetectable levels and an HIV-positive individual may be able to live a fully functional life (NIAID, 2009). At undetectable levels it may still be possible to transmit the virus to another individual (AVERT, 2009). A patient’s white blood cell (or CD4) count serves as the major clinic indicator of the body’s immune function and serves as the basis of whether to start an HIV-positive patient on ART. Currently the U.S. Department of Health and Human Services (DHHS) strongly recommends an HIV-positive individual start ART if her CD4 count is less than 500 cells/mm$^3$ or if she is pregnant, has HIV associated kidney disease or has Hepatitis B (AIDS Info, 2009). DHHS also recommends ART if a patient’s CD4 count is above 500 cells/mm$^3$, but in this case treatment is deemed as optional. However, in resource-poor parts of the world patients are not prescribed ART until much lower levels. In Tanzania, it is common for doctors to wait until a patient’s CD4 count is 200-300.

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4 The respondents in the CHAT survey have access to a subset of these drugs, including Stavudine (Stavir, Stadine, Stavex, Zerit), Lamivudine (Lamivir, Laminox, Lavir, Lamivirsol), Nevirapine (Nevimune, Viramune), Zidovudine (Zidovir, Zidine), Efavirenz (Efavir, Stocrin), Abacavir (Zia-gen), Didanosine (Videx), Nelfinavir (Viracept), Saquinavir (Viracept), and Lopinavir + Ritonavir (Kaletra).
HIV easily adapts within the body, and quickly can become resistant to any one particular antiretroviral drug. When the virus replicates, it often mutates to become immune to a particular antiretroviral drug, rendering the current drug useless in preventing the reproduction of the virus. Physicians often prescribe a combination of 2 or more drugs together in order to increase the chance that the virus does not become resistant to the treatment. When a combination of three or more ART drugs (belonging to at least two different ART classes) are taken, the drug mix is referred to as highly active antiretroviral therapy (AVERT, 2009), or HAART.

When HIV becomes resistant to treatment (called drug resistance), the level of HIV in the blood rises. If the virus reaches a high enough level (>400 copies /mL), called virologic failure, the virus’ progression to AIDS becomes more likely (Mayo Clinic, 2008). Symptoms include swollen lymph nodes, diarrhea, weight loss, fever, and coughing. One of the most common reasons for virologic failure is failure to adhere properly to the prescribed drugs. Missing doses, or not taking them on time, lowers the amount of antiretroviral chemicals in the body, which means the virus is not properly suppressed. The virus is then able to replicate faster, increasing the chance of it becoming resistant and of virologic failure (AVERT, 2009).

In order to prevent virologic failure, near perfect (>95%) adherence is necessary (Paterson et al., 2000). However, it is common for patients to either delay taking doses at prescribed times or to miss doses altogether. In the case where a patient is prescribed only one dose per day, she cannot miss any more than one dose per month to be fully adherent. The mortality consequences of non-compliance are well established. de Olalla et al. (2002) find, using multivariate hazard analysis over a 10-year period, that a non-adherence patient on triple drug therapy is approximately 4 times more likely to die than an adherent patient on the same therapy.

There are multiple reasons individuals may not comply with treatment. The medical literature often cites the cost of adherence, both the direct cost of the medication
and the opportunity cost of travel, and adverse side effects of the medication as two main reasons. In addition, non-adherence may be due to individual perceptions of disease severity, efficacy of the treatment, or even holding cultural beliefs about how God or alternative medicine can cure AIDS (AVERT, 2009).

3.3 Data

3.3.1 Description of CHAT Survey

The data in this paper come from a longitudinal survey in Moshi, Tanzania called Coping with HIV/AIDS in Tanzania (CHAT), conducted by the Center for Health Policy and Inequalities Research (CHPIR) and the Tanzanian Women’s Research Foundation (TAWREF) with funding from the National Institute of Health (NIH). The purpose of CHAT is to examine the link between adherence to antiretroviral medications and the experience of early childhood traumatic events. The survey contains detailed questions about adherence, health and wellbeing from the person and chart abstractions and viral load testing, history of traumatic events and ongoing potential traumatic and stressful life events, sociodemographic characteristics, mental health, stigma, sexual risk behaviors, feelings, fertility decisions and history, and alcohol consumption.

Study enrollment and the initial survey round ran from November 2008 through August 2009. A total of 1500 participants were targeted for enrollment in the study and included individuals from four cohorts: 500 newly diagnosed HIV-positive persons (VCT+), 250 recently diagnosed HIV-negative persons (VCT-), 500 previously diagnosed HIV-positive persons (Clinic), and 250 randomly selected community members with unknown serostatus (Community). Participants were restricted to be at least 18 years of age and reside in the vicinity of Moshi with no plans to move in the next 12 months. Individuals were also excluded if they had an obvious psychological or psychiatric disorder that would prevent them from providing sufficient
informed consent.

The newly diagnosed cohort was obtained in a Voluntary Counseling and Testing (VCT) site. Individuals visit these types of testing sites when they suspect they might be HIV-positive and want to be tested. CHAT survey enumerators approached individuals who were leaving the facility after they had received a diagnosis. For each newly diagnosed HIV-positive individual who agreed to participate, an HIV-negative person was also targeted. However, due to high expected refusal rates, the study targeted only 250 HIV-negative individuals (half the sample size of the VCT+ cohort).\(^5\)

The clinic cohort was drawn from existing patients at the Infectious Disease Clinic (KCMC and Mawenzi). On days that the survey team was recruiting for the study, every fifth HIV-positive person over the age of 18 who was scheduled to attend the clinic was pre-selected and approached about participation until the target was met.

Community participants were enrolled from a group of 25 randomly selected villages and wards (10 rural villages and 15 urban wards). Lists of households were obtained from each village elder and 10 households from each village/ward were randomly selected for participation. In each selected household an adult was chosen at random (using slips of marked paper) and was asked to participate. If she refused, another adult in the house was chosen.

Table 3.1 compares target and actual enrollment across all cohorts. The clinic and community cohorts achieved 99% of targeted enrollment, but not surprisingly, patients from the VCT clinics were much less likely to consent to the study (53%-73%). Coming directly out of the testing facility, these persons may not have emotionally

\(^5\) HIV-negative individuals were expected to have a high rate of refusal due to the negative stigma surrounding HIV and AIDS in this setting. While the individuals leaving the clinic with an HIV-positive diagnosis know that they will have to start facing the reality of the virus, the HIV-negative individuals are free to disassociate with the HIV stigma altogether, and therefore might be more likely to decline any association with the testing center. It was due to low HIV+ test result rates, however, that a lower number of HIV-negative respondents were chosen.
processed their newly discovered serostatus, and therefore, been unwilling to provide personal information to the study enumerators. Attrition among the VCT cohort will suffer from the same problem. After the initial enrollment, follow-up surveys were conducted every 6 months. Each wave of surveys is referred to as a “round”, with a total of 7 rounds. This paper utilizes data from the first 6 rounds.

3.3.2 Survey Construction

The existing CHAT survey did not include questions related to expectations of the future and how these expectations might influence the adherence decision. Specifically, respondents were not asked to think about future events and uncertain outcomes in the original survey. I developed a short survey module to be included in the survey instrument for two consecutive rounds of interviews which included questions that would elicit individual beliefs about mortality and the occurrence of side effects assuming different levels of adherence. I also included questions allowing me to calculate a time-preference discount rate for health (described in Section B in greater detail). I developed this module with the aid of previous studies by Delavande and Kohler (2009), Tarozzi et al. (2011) and Sloan and Platt (2011).

Household surveys in the past have avoided collecting complex information from developing countries for fear that “poor illiterate individuals do not understand probability concepts” (Delavande et al., 2011). However, Delavande et al. (2011) suggest that people in developing countries can, in fact, understand probabilistic questions and that Likert scales have often been used to collect these types of data with possible answers such as “Very Likely”, “Likely”, “Neither likely nor unlikely”, “Unlikely” and “Very Unlikely”. The primary critique of these questions is that respondents may interpret the scales differently, and that it is hard to translate responses into a probability. Delavande et al. (2011) suggest a method which elicits an entire distribution of several possible future states using 10 beans on a plate, and asking the
respondents to choose the number of beans that corresponds to the probability of an event occurring. Using this method as a guide, I constructed the expectations module now included in the CHAT survey. Details of the survey construction, focus groups, revisions based on focus group discussions, and the final module added to the CHAT survey can be found in the appendix, Section B.

3.3.3 Summary Statistics

Tables 3.2 and 3.3 show personal and household characteristics for the CHAT sample as well as for the overall Tanzanian population as measured in the 2010 DHS surveys. There were a number of demographic questions that were only asked in the first round of CHAT data collection. These variables are displayed in Table 3.2 whereas variables for which we have information in every round are presented in Table 3.3. The first panel of Table 3.2 tabulates the percentage of the total CHAT sample that falls into each of the five cohorts. From the second panel, we see that compared to the DHS sample, the population in Moshi and in the CHAT sample are older due to the fact that the CHAT data do not include any person under 18 and the DHS data do not include any person over 50. In addition, CHAT respondents are more likely to have any formal education (only 1.9% of males and 5.3% of females have had no formal education), but of those, CHAT respondents have completed fewer years of formal study with the majority (~75%) having completed some level of primary schooling. Also, only 3.2% of males and 1.7% of females attended university, whereas 22.9% and 16.2% of DHS respondents had.

The distribution of occupations is fairly balanced, with no particular occupation being chosen by more than 30% of the sample.\textsuperscript{6} Occupations indicated by approximately 30% of respondents include business, farming, and unskilled labor. Occupa-

\textsuperscript{6} Respondents were allowed to choose numerous responses and as such, the total percentages add up to more than 100%. They were not asked to indicate which choice was their primary occupation, thus all responses are reported in Table 3.2.
The distribution of occupations is consistent with what one would expect given the low levels of formal education of CHAT respondents, specifically the bias towards manual labor and unskilled work. Only 30% of CHAT respondents are farmers, whereas nearly 65% of DHS respondents reported farming as their primary source of income. In addition, approximately 30% of CHAT respondents and 5% of DHS respondents reported business as their occupation. The disparity between the CHAT and DHS samples may also be driven by the oversampling of HIV-positive respondents. If an individual runs a small business, she may have more flexibility in working hours and intensity, whereas farming potentially requires a more rigid schedule and undertaking more physically demanding tasks.

Table 3.3 displays demographic characteristics across survey rounds and by gender. The last 2 columns are the corresponding characteristics in the DHS 2010 survey. The distribution of marital status differs between the CHAT and DHS samples, especially among women. CHAT women are 30 percentage points (pp) less likely to be married, roughly 20pp more likely to be widowed, 11pp more likely to be divorced, and 7pp less likely to be single. This pattern is similar for men, although their rates of marriage are comparable to the DHS (50-60%). These differences are not surprising given the oversampling of HIV positive respondents in the CHAT sample, and the fact that HIV positive spouses are more likely to have deceased partners or marriages ending in divorce.

The third panel of Table 3.3 tabulates HIV status. Again, we would not expect for the CHAT statistics to be representative of the entire country, first because the region of Kilimanjaro has a higher prevalence rate than the rest of the country, and

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7 Skilled labor includes occupations such as carpenter and tailor. Salaried labor includes occupations such as office worker, nurse and teacher. Unskilled labor includes occupations such as cleaning and construction. Other includes all other sources of income, including if the respondent is a student or unemployed.
also because the survey specifically targeted HIV-positive respondents. We see a slight decrease in HIV prevalence between rounds 1, 2 and 3. Because the virus is incurable, the decrease in the percentage of HIV-positive respondents in these rounds is due to selective attrition by HIV-positive respondents. This is explored further in the following section.

3.3.4 Sample Attrition

As with any longitudinal panel survey, tracking respondents through all 5 rounds is not perfect. Table 3.4 summarizes completed interviews throughout the survey rounds. Beginning with all completed interviews in Round 1, we see a pattern of attrition by cohort. After the initial drop to 92% in Round 2, we see the clinic cohort was successfully followed through round 6 without any further attrition. The community cohort follows a similar pattern, dropping to 95% in Round 2 and steadily losing ~4% each round. The largest attrition occurs, as expected from the difficulty in recruiting participants, in the VCT cohorts, dropping to 78% (HIV-negative) and 82% (HIV-positive) by Round 5. The low percentages in Round 6 should not be interpreted as attrition at this time. At the time of this analysis (January 2012), not all data from Round 6 had been processed. Because the VCT cohort had been difficult to locate, the survey administrators complete these interviews after the other cohorts, and as such, would be the last interviews to be recorded. Table 3.5 explores further the attributes of respondents who missed interviews in each round, dividing them into four, mutually exclusive groups by serostatus and whether they were reported as dead at the time of this missed interview.\footnote{For additional details about deaths occurring during the sample period see the appendix, Section A.2.} Across rounds the majority of attrition (~75%) is not due to respondent deaths and respondents who missed interviews were more likely, in general, to be HIV-positive. This fact alone
does not imply selective attrition, as there were more HIV-positive respondents in the sample, and if attrition was random, we would expect to see the same pattern.

Table 3.6 presents probit results to determine which baseline personal characteristics predict whether a respondent is likely to be missing at least one interview. The first column includes the entire sample, the second excludes HIV-negative respondents, and the third excludes HIV-positive respondents who did not report being on any ART in Round 1. Notice that, with the exception of age, there are no significant predictors of interview completion among the HIV-negative cohort, and also, that being HIV-positive alone (row 1) does not predict completion. However, among HIV positive respondents, being in poor health is an important predictor of completion. Column 2 explores this cohort further, including whether the respondent was taking ART in Round 1. Taking ART in Round 1 is a positive predictor of interview completion, as well as poor health, being female, and being a member of the clinic cohort. Taking ART or being a part of the clinic cohort is expected to have much less attrition than other cohorts primarily because it is easier to recontact patients who have regular clinic appointments. When restricting the sample to HIV-positive respondents taking ART in Round 1, we also find that males are less likely to have completed all interviews as well as Muslims and respondents reporting perfect adherence. This implies that while being on ART generally decreases the likelihood of attrition but only if imperfectly adhering.

3.4 Description of Data

3.4.1 Adherence

First, recall from Table 3.2 that 64% of the initial CHAT sample is HIV-positive. The first panel of Table A.5 shows that the percent of HIV-positive respondents who

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9 Table 3.6 only includes data through Round 5 as Round 6 was not complete as of the writing of this paper. Attrition results including Round 6 and attrition due to death can be found in the appendix, Section A.2.
are taking some form of ART steadily increases from 57% in Round 1 to 85% in Round 6.

The respondents who report taking ART are then asked a number of questions to create a finer measure of adherence, including the percent of pills usually taken, the last time a dose was missed, the percent of pills missed in the past month, and the percent of pills taken early or late within the past month.  

From these questions there are five separate measures of perfect adherence, shown over time in the bottom panel of Table A.5. Responses to individual adherence questions separately are quite high across rounds, with averages between 91% and 99%, and dropping to only 82%- 92% when considering early or late dosing. However, for the purposes of analysis it is necessary to construct a single measure of adherence from these questions. Previous analysis assigned perfect adherence to any individual satisfying the first condition or the last four. This definition is summarized in the same table and results in nearly 99% perfect adherence for every round. It is important to note that the data used here are self-reported. Self-reports and pill counts tend to overestimate adherence, implying that the estimates of self-reported adherence are likely to be an upper-bound on actual perfect adherence (Chalker et al., 2010; Liu et al., 2001).

For this reason, I will assign “perfect adherence” to any respondent who satisfies perfect adherence according to all adherence questions (1 through 5). When perfect adherence is limited to the most strict definition, the percent of respondents who satisfy decreases to 71% in Round 1, and steadily increases through Round 6 to 85%. This table restricts the sample to respondents who completed all 6 interviews, to eliminate the confounding effect of attrition of poor adherers. Respondents present in all 6 rounds of surveys increase self-reported adherence throughout time. This is unexpected, as adherence rates usually decline over time.

\footnote{Details of the adherence questions in the survey can be found in the appendix, Section B.}
3.4.2 Expectations Response Patterns

Testing Respondents’ Comprehension

To introduce the concept of probabilistic expectations, the new survey module began with three questions about common events such as the outcome of a football match, or whether the respondent would go to the market. First, the respondents were asked the probability that the Tanzanian national football team would win a match against Brazil. Figure 3.1 graphically presents the mean and inner-quartile range of responses to this question by gender and survey round. The respondent was asked to choose a number between 0 and 10, that number was converted into a probability between 0 and 1. Because the Tanzanian national football team historically has had a losing record against the Brazil team, it is not surprising that the average response was \(~20\%\) both in Round 5 and 6. Women were more optimistic about Tanzania winning. The average implied probability of winning significantly differs (p-value=0.00) between men (\(~15\%\)) and women (\(~21\%\)).

To test whether the respondents understood the instructions and the concept of probability, they were then asked about two nested events: going to the market within (a) two days and (b) two weeks. If respondents understand the concept of probability, their probability of going to the market in two weeks should be greater than or equal to the probability of going to the market within two days. If the respondent violated the monotonicity property, the interviewer was instructed to explain the incoherency of the answers with the following statement: “Remember, as time goes by, you may find more time to go to the market. Therefore, you should have chosen a higher number.” The respondent was then asked to provide a new answer for the probability that they would go to the market in the next two weeks. Figure 3.2 graphically shows the mean and inner-quartile range of responses.

\(^{11}\) Refer to the appendix, Section A.4 for detailed summaries of numerical responses for all expectations questions.
by gender and survey round. Notice that in both rounds, men report a significantly lower probability of going to the market than women, both in the next 2 days (~20pp lower) and 2 weeks (~25pp lower). This is consistent with Tanzanian culture where the female of the house usually does the shopping for the entire household.

These nested questions provide valuable information about the respondents’ comprehension of probabilistic events. Respondents are categorized into three mutually exclusive groups based on their responses to the market questions: those who stated a higher probability of going to the market in 2 days than in 2 weeks (2 weeks < 2 days), those who stated an equal probability of these events occurring (2 weeks = 2 days), and those who stated a higher probability of going to the market in two weeks than in 2 days (2 weeks > 2 days). The middle group (2 weeks = 2 days) is not inconsistent, but questionable since it is unlikely that the probability would not increase when the time frame is extended by 12 days. The last group (2 weeks > 2 days) responded as expected, and as required by probability theory.

Table 3.8 presents the average characteristics of respondents in each of the three consistency groups in Round 5. Each of the last three columns displays the p-value of a test of equality between each pair of columns. Overall, there are only a few cases in which the characteristics of respondents who answered inconsistently (column 1) are significantly different than the respondents who provided the same, non-increasing response (column 2), or constant and increasing responses (column 3). The inconsistent group has a significantly larger proportion of HIV-positive individuals, specifically of the clinic cohort, than does the consistent group. The significant differences are found between the strictly consistent group (column 3) and the group who answered the same probability of going to the market in 2 days.

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12 Table A.9 provides greater numerical detail.

13 Results for Round 6 can be found in the appendix, Section A.4. Only 5 individuals answered inconsistently in Round 6, rendering the need for analysis moot.
as in 2 weeks (column 2). The group who repeated answers were significantly more likely to be male, HIV-positive, in poor health, and have completed primary school.

Exposition of Beliefs

This section describes the response patterns to the mortality and health expectations questions. The elicited mortality expectations are summarized in Figure 3.3. Figure 3.3 graphically presented the mean and inner-quartile range of elicited probabilities of mortality by time horizon (6 months, 1 year, and 5 years), gender, and level of adherence (100%, 95% or less, and No ART).

The first noteworthy pattern is that, on average, the elicited probabilities of mortality increase as the time frame is extended from 6 months to 1 year and to 5 years. While this is necessary in order to be consistent with probability theory, it cannot be interpreted as correct comprehension by the respondents, as the responses were restricted to be consistent by the survey software. For instance, if a respondent answered a 10% chance of mortality in the next 6 months under perfect adherence, and then attempted to answer a 0% probability of mortality within the next 12 months under perfect adherence, she was asked to reconsider her answer, making sure that it was greater than or equal to the previous response. There were no such monotonicity restrictions for any other questions. For instance, another trend not enforced by survey design, is that for both males and females, the probability of mortality increases dramatically as adherence decreases. In fact, as the time frame increases to 5 years, the difference between the perceived risk of mortality increases dramatically when the adherence assumption is changed from 100% to less than 95%. This pattern is consistent with the accepted medical literature on the effectiveness of ART. The response patterns persist in Round 6 and the changes in beliefs between

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14 Analysis of focal point responses and potential anchoring effects are explored in the appendix, Section D.

15 Table A.11 in the appendix, Section A.4 provides additional numerical details.
Round 5 and 6 are explored in Section 3.4.4.

Similarly, Figure 3.4 summarizes expectations of overall health, nausea, fatigue, headaches, and viral load across survey rounds. Health outcome probabilities follow a similar pattern to the mortality questions, with, on average, respondents putting a higher probability of experiencing each “bad” health outcome with lower levels of adherence. While this may be indicative of the fact that respondents think they will be healthier overall if they adhere to their medication, it is not consistent with the common knowledge that regularly taking ART often produces side effects. Specifically, nausea, fatigue, and headaches are common side effects for most combinations of ART, and thus, we might expect a reverse pattern indicating a tradeoff between mortality and side effects.\footnote{In retrospect, it would have been helpful to include a question asking the respondent what side effects they experience when they regularly take their medications. This would have allowed me to cross-check the hypothesis that respondents face a clear tradeoff between side effects and mortality.}

As a comparison group, HIV-negative respondents were asked the same questions above (except for the question concerning viral load), but without any instruction as to what level of adherence to assume. Responses are presented in Figures 3.5 and 3.6.\footnote{Table A.13 in the appendix, Section A.4 provides additional details of the distribution.} Surprisingly, these average mortality probabilities are extremely high (especially when compared to the responses by HIV-positive patients assuming perfect adherence). For instance, HIV-positive females in Round 5 reported, on average, a 4% chance of mortality within the next 6 months if they were to perfectly adhere to their medications. HIV-negative women in the same round reported a 32% chance of mortality. This suggests what while the HIV-negative respondents might be taking into account all potential causes of death, the HIV-positive respondents might be only considering death due to HIV/AIDS.\footnote{However, overall adult mortality rate in the region is only 5 in 1000, indicating that the difference is not only between HIV and overall causes of death, but a dramatic overestimation in general (National Bureau of Statistics, 2010).} Unfortunately, this means that
the results will not be comparable between the HIV-positive and -negative groups, but it should not bias the results within the HIV-positive group. In addition, the average does not increase significantly between 6 months, 1 year, and 5 years.

Accuracy of Beliefs

Table 3.9 presents the accuracy of health outcome beliefs between Rounds 5 and 6. The numbers in each table represent the difference between the realized value of the health outcome observed in Round 6 and the predicted value in Round 5, for each possible level of adherence in Round 5 and 6. Each cell represents a subsample of the respondents. A positive number indicates that the actual outcome was greater than the predicted outcome, so that, on average, the people in that cell underestimated the probability of that outcome occurring. The number in parentheses in each cell is the p-value testing equality between the actual and predicted outcome. The patterns of adherence described in Section 3.4.1 are highlighted in Table 3.9 by the large number of respondents that fall into the diagonal cells, indicating a higher likelihood of choosing the same level of adherence across rounds. There is also a non-trivial sample that switched in either direction between perfect and less than 95% adherence, although extremely few (between one and seven) respondents switched in either direction between taking ART at all.

Regardless of past adherence, respondents who perfectly adhered in Round 6 significantly underestimated the probability that they would experience worse health in Round 6. Conversely, respondents who imperfectly adhered in Round 6, regardless of prior adherence, significantly overestimated the probability of experiencing worse health. And lastly, respondents not taking ART in either round significantly overestimated experiencing worse health.\footnote{Results are consistent for other health outcomes (fatigue, nausea, and headaches) and can be found in the appendix, Section A.5.}
indicate that we cannot reject the null hypothesis that predictions from Round 5 are equal to Round 6 realizations, although there are no such cells for worse health.\footnote{It appears that respondents not on ART and those who adherence imperfectly are quite accurate at predicting fatigue in the following period. This pattern may speak more to the heterogeneity in side effects from the medications and that people who fully adhere may experience side effects differently than those who take it selectively. It also appears that perfect adherers in Round 6 are accurate in predicting headaches if they were not perfectly adhering in Round 5.} In general, respondents learned that perfectly adhering did not cause them to feel as good as they expected, and conversely, that imperfectly adhering did not cause them feel as bad as they expected. Therefore, we would expect individuals to update their expectations between Rounds 5 and 6.\footnote{Section 3.4.4 explores updating of expectations in greater detail. In addition, as Round 7 data become available, it will be possible to examine whether respondents improved the accuracy of their predictions.} Table 3.9 provides evidence that people had significantly different expectations than what occurred.

### 3.4.3 Health Time Discounting

Data on time preferences as they relate to health were taken from a series of questions contained in the new survey module I developed for the CHAT survey. In summary, each participant was asked to choose between 50 extra days of in perfect health 6 months from now and a smaller number of extra days days in perfect health now. The immediate reward began with 40 extra days, and decreased to 25, 5 and finally, 1 day.\footnote{Additional details of these survey questions can be found in the appendix, Section B.} Based on respondents’ choices to these questions, discount rates were calculated according to the following present-value formula:

\[
X(1 + r)^d = 50
\]  

(3.1)

where 50 is the magnitude of the delayed prize (number of extra healthy days to receive in 6 months), $X$ is the magnitude of the immediate prize (number of extra healthy days to receive now), and $d$ is the time period delay ($d=1$ will represent 6
months). Using this formula, upper and lower bounds of the discount are calculated for each respondent and shown in Table 3.10. Figure 3.7 shows the progression of discount factors as the respondents reveal themselves to be less and less “patient,” as well as the number and percent of respondents who fell into each bin. For the proportion of people who chose 50 extra healthy days in six months instead of 40 extra healthy days today, I assigned the lowest discount rate (highest discount factor) of 0.125 (d=0.88) which is the average between the upper bound and 0. I then assigned each subsequent group the lower bound of their bin. The current data show no time inconsistency. For instance, all respondents who would rather take the 50 healthy days in 6 months than 40 extra healthy days now, also chose 50 extra healthy days in 6 months regardless of the fewer number of other days offered now. From here on I will use the discount factor as the unit of analysis (as opposed to the discount rate). This implies that for all analyses, a higher value indicates more “patience” or willingness to delay health gratification.

**Discount Factor Results**

Figure 3.8 shows histograms of elicited discount factors in Round 5 by gender, with higher numbers indicating greater patience. The dashed vertical line indicates the average discount factor for each population. Notice that the distributions for each gender are polarized with a small mass around the mean. This implies that people are divided between two groups which tend to cluster around the extremes. The distribution is fairly evenly divided between these two extremes, while it appears that there is a larger proportion of males who have higher patience. Figure 3.9 presents the mean of elicited discount factors by sex, age, and HIV status in Round 5. Notice

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23 Round 6 discount rate data follow similar patterns to Round 5, and can be found in the appendix, Section A.6.

24 Following similar patterns and values as Round 5, corresponding figures and tables for Round 6 can be found in the appendix, Section A.6.
that, in general, HIV-positive respondents are less patient than the HIV-negative

group as it relates to health.

Table 3.11 summarizes the average discount factor by gender and serostatus. Differences are also presented, including stars which indicate that the difference is

significant at standard levels. In general, the difference, within serostatus, between

males and females is not significant. However, as seen in Figure 3.9, the differences

between HIV-positive and -negative respondents is significant for all but two age-
gender groups.\textsuperscript{25} The difference between patience for health between HIV-positive

and NIV-negative respondents is expected. HIV-positive patients have a reduced life

expectancy and thus would be expected to be more present minded as it pertains to

their own health.

Table 3.12 presents the results of ordinary least squares regressions where the
dependent variable is equal to one if the elicited discount factor was greater than

0.5 (i.e. high patience). The first column includes only Round 5. The second

column explores correlates of a high discount factor in Round 6, including whether the

individual had a high discount factor in Round 5. The final column explores changes

in the discount rate between the two rounds. Specifically, the dependent variable is

an indicator for whether the individual switched from a low discount factor to a high
discount factor between Rounds 5 and 6. As expected from the previous figure, the

first two columns confirm that HIV-positive respondents, in general, are less patient.

In addition, respondents in better current health are more patient; however, the

presence of headaches or fatigue seem to also be associated with higher patience. This

relationship might be driven by a belief that these health outcomes are side effects

indicating effectiveness of ART. The third column examines the characteristics of the

respondents who became more patient as it relates to health between Rounds 5 and 6.

Significant predictors of increasing patience are begin in good health, being a member

\textsuperscript{25} This pattern persists in Round 6 for all genders and age groups. See Section A.6.
of the clinic cohort, and having fewer household members under the age of 18. Also note the positive relationship between the financial planning horizon and the patience for health. The financial planning horizon variable is taken from a survey question which asks the respondent to choose the time period that is most important for their household; the next few months, the next year, the next 4 years, the next 5-10 years, and longer than 10 years. Based on the distribution of responses to this question, respondents were assigned a “Long Financial Time Horizon” if they selected answers two through five above. The significantly positive relationship (shown in Table 3.12) between a long financial planning horizon and the elicited health discount factor implies that there is consistency in responses and suggests that people are interpreting the health time discount questions as intended in both rounds. As discussed above, financial and health discount rates need not be related, although a positive relationship between patience in these distinct realms suggests coherency in preferences.

3.4.4 Predictors of Beliefs

Using the following equation, I estimate the predictive power of characteristics and behavior in Round 5 on expectations elicited in Round 5.

\[ r_{ijn} = \beta_{j0} + \sum_j \alpha_j H_{ij} + \sum_n \beta_{nj} (A_{in} \times H_{ij}) + \gamma X_i + \epsilon_i \] (3.2)

where \( H_{ij} \) is current health status of individual i for different health outcomes j (overall health, nausea, fatigue, and headaches). Health status is also interacted with levels of adherence (the omitted category is no ART). \( X_i \) are individual characteristics such as age, sex, marital status, number of household members, distance to the HIV clinic, years of education, and whether they were in the clinic cohort.

Specifying the baseline beliefs in this way allows me to examine beliefs based on
different types of individuals. In every case the individual has tested positive for HIV, but there is heterogeneity in whether they are currently taking medication, how consistently they are currently taking it, and their current health status. Tables 3.13 - 3.15 present the results for the probability that respondents would experience a variety of health outcomes if they were to perfectly adhere to their medication (column 1), take less than 95% of the prescribed doses (column 2), and if they were to not take any ART medications (column 3).

Table 3.13 shows the probability of mortality within 6 months under the scenarios listed above. A few patterns emerge. First, individuals with a high discount factor (high patience) report lower probability of death under less than perfect adherence or no ART. However, education has an opposite effect. Completing primary education is associated with nearly an 8pp increase in perceived mortality risk, but only when less than perfectly adhering. With the exception of fatigue, there are few variables that significantly explain variation in perceived mortality under perfect adherence. A plausible explanation for this is that patients might be given detailed information at the clinic about the benefits of perfectly adhering, such that HIV-positive respondents have more homogeneous expectations under the assumption of perfect adherence. A lack of universal, or common, information about the risks of not adhering, or not taking ART, could explain the variation between groups in these scenarios.

Respondents who reported perfect past adherence and no side effects (the first row in Table 3.13) consistently placed a higher probability of mortality if they were to stop taking any ART as compared to the sample not on medications. We do not see a significantly negative coefficient in the first column. While causality is unclear,

\[\text{Results for 12-month and 5-year mortality follow similar patterns and can be found in the appendix, Section A.7.}\]

\[\text{This finding is consistent with the theory that an individual with a high health time discount factor is also generally optimistic about their own life expectancy. If she would rather wait to take healthy days because she is confident that she will survive to collect them, she may also believe that her longevity will not be affected by non-adherence.}\]
it is possible that perfect adherers are more motivated by the perceived negative effects if they don’t take the medication, than by the positive effects if they do.

The coefficients on the health outcomes (without interactions) represent the individuals who did not take any medication and experienced adverse health effects. These results suggest that individuals who were not taking ART, but reported feeling fatigued, thought that if they were to perfectly adhere to medication, that it would have a detrimental impact on their chance of survival. People who already feel poorly believe that taking the medication would harm them further. However, this effect is completely cancelled out for people who reported fully adhering to their medication, where the net effect of fatigue is nearly zero. This finding is consistent with the implication that individuals who perfectly adhere associate fatigue with the effectiveness of their medication. The results in Table A.19 are consistent with this explanation. In the first column (assuming perfect adherence), note that perfect adherers report 7pp higher likelihood of mortality than those not on any ART, unless they also experience fatigue, in which case they reduce their chance of expected mortality by 13pp. This combination remains consistent with the explanation that people who perfectly adhere, associate fatigue with effectiveness.

Next, I turn to predictors of Round 5 expectations of the other health outcomes (being nauseous and increased viral load).\textsuperscript{28} Tables 3.14 and 3.15 refer to these expectations using the same specification in Equation 3.2. A pattern emerges similar to the mortality outcomes. First, for both health outcomes, we see that individuals who completed primary school report higher probability of bad health outcomes, and more patient respondents report a lower probability, but not under the assumption of perfect adherence. As above, this could be evidence that, in this population, there are homogeneous community beliefs about the effects of medications when they are

\textsuperscript{28} Results for being in worse health, feeling fatigued, and having headaches follow similar patterns and can be found in the appendix, Section A.7.
taken exactly as prescribed. In addition, respondents who report better health also report a lower probability of experiencing side effects if they were to perfectly adhere. Also similar to mortality expectations is the positive relationship between perfectly adhering with no side effects and the perceived probability of experiencing side effects if they were to stop taking any ART.

**Updating beliefs**

With two rounds of expectations data I am able to examine, first whether people update their expectations, and if so, whether changes in expectations are consistent with a Bayesian framework. In order to determine whether this is consistent with Bayesian updating, I first present a model of updating in which new beliefs \( \text{posterior}_{i6} \) are a function of previous beliefs \( \text{prior}_{i5} \) and new information (health status in round 5). This methodology is similar to that used in Stinebrickner and Stinebrickner (2009).

\[
\text{posterior}_{i6} = \sum_n \beta_n (\text{prior}_{i5} \times A_{in}) + \sum_j \alpha_j H_{ij} + \sum_n \beta_n A_{in} + \gamma X_i + \varepsilon_i
\]  

(3.3)

Again, adherence is represented by a set of indicator variables \( A_{in} \), where \( A_{i1} = 1 \) if the respondent perfectly adhered, and \( A_{i2} = 1 \) if the respondent was taking ART, but did not perfectly adhere. The omitted category is individuals who did not report taking any ART medications.

In this case, if people are consistent with Bayesian updating, then the coefficients on \( \text{prior}_{i5} \) will be significant, and in particular, we would expect the interactions with the decision that the individual took to be more significant. For instance, along the diagonal of each table, where someone who perfectly adhered in round 5, would learn more about health outcomes under the assumption of perfect adherence than under
the other outcomes. This would imply more significance along the diagonal of the top three rows in each of Tables 3.16 - 3.18. Note that demographic characteristics were included in this analysis, but have been omitted from the tables as they have already been discussed above.

The relationship between prior beliefs and current beliefs can be found in the first 3 rows of each table, divided by level of prior adherence. Table 3.16 presents 6-month mortality. Coefficients on health status variables can be interpreted as the portion of expectations formed from new information. High self-reported health is associated with a decrease in risk of mortality assuming perfect adherence or less than perfect, implying that if a respondent got a “good” health signal, she decreased her perceived chance of mortality, unless she were to not take any ART. However, when health is broken down into specific side effects, fatigue is associated with higher mortality under non-perfect adherence and no ART, and headaches are associated with lower mortality with no ART, but higher mortality under perfect adherence. This could imply that fatigue is associated with effectiveness, but only if medications are taken perfectly, otherwise it is a sign of ineffectiveness. In general, this could imply that people believe health outcomes associated with side effects do not influence mortality as long as they are perfectly adhering. However, headaches follow a reverse pattern. A respondent who has headaches is more likely to increase their perceived mortality under perfect adherence and decrease it under the assumption of ART. The relationship between prior beliefs and current beliefs is not as strong as expected. While prior beliefs significantly predict current beliefs assuming less than perfect adherence and no ART, there does not appear to be a significant relationship given perfect adherence. In addition, when significant, the coefficients are surprisingly low (~0.30).

29 Results for 12-month and 5-year mortality can be found in the appendix, Section A.8.
Tables 3.17 and 3.18 explore updating expectations of nausea and fatigue.\footnote{Results for worse health, headaches, and viral load can be found in the appendix, Section A.8.} There is a significant relationship between overall health status and current expectations. For both outcomes, being in good health reduces the risk of bad health outcomes under the assumption of perfect adherence, but increases the probability of experiencing bad or worse health outcomes under less than perfect adherence and no ART. It might be the case that individuals in better health have more to lose if they begin to feel sicker, whereas individuals already in poor health might not believe that any level of adherence would affect their health status.

In addition, because experiencing a health outcome provides information about an individuals’ likelihood of experiencing that outcome in the future, I expect a significant relationship between whether the respondent experienced a particular health outcome, and their beliefs about that outcome. This relationship is not significant for nausea, as seen in Table 3.17, however, respondents who experienced fatigue significantly increased their expectations of feeling fatigued in the future (Table 3.18. Prior beliefs only appear to significantly predict health expectations in a few select cases. It appears, in general, that individuals not on ART update more significantly from their prior beliefs, especially under the assumption of less than perfect adherence and no ART. There is not a significant impact of prior beliefs for the other groups.

3.5 Analysis of Adherence Decision

3.5.1 Structural Estimation

Theory

I will first sketch a 3-period model of adherence choice. Here I assume that an individual $i$’s instantaneous flow utility is a function of current period health outcomes, which depend on adherence in the previous period. Health outcomes may include
overall level of self-reported health (on a scale of 1-100), side effects such as diarrhea and nausea, viral load, level of contagiousness (transmission), and death. I define the utility of individual \( i \) in period \( t \) as \( u(h_{1,it}, \ldots, h_{J,it}) \), where \( (h_{1,it}, \ldots, h_{J,it}) \) is a vector of health outcomes \((j = 1, \ldots, J)\) at time period \( t \).

At time \( t=0 \) each patient chooses whether to fully adhere to her prescribed medications \( (m_0 \in \{m, \bar{m}\}) \). At time \( t=1 \) the patients are interviewed and report adherence over the past month \( (m_0) \) and current state of health \( (h_{1,i1}, \ldots, h_{J,i1}) \). Given these state variables, the patient forms expectations about future health outcomes as a function of her adherence choice at \( t=0 \). The patient \( (i) \) chooses whether to fully adhere to her medication in the next period \( (m_1) \) according to:

\[
\arg\max_{m \in M} u(h_{1,i1}, \ldots, h_{J,i1}) - \alpha c_{i,im} + \beta \mathbb{E} [u(h_{1,i2}, \ldots, h_{J,i2}) - \alpha c_{2,im}]
\]  

(3.4)

where \( c_{i,im} \) is a measure of the direct cost of choosing adherence level \( m \) at time \( t \) for individual \( i \), as measured by distance to the health care facility\(^{31}\) and \( \beta \) is the discount rate. This maximization problem is equivalent to maximization under a budget constraint of a quasilinear utility function depending on the health outcomes \((h_{1,it}, \ldots, h_{J,it})\) and a numeraire composite good.

Each person has a subjective belief about the probabilities of realizations of health outcomes \((h_{1,i2}, \ldots, h_{J,i2}, c_{2,im})\), denoted \( P_{im}(h_{1,i2}, \ldots, h_{J,i2}, c_{2,im}) \). Notice that these subjective probabilities are allowed to vary by \( m \), whether she chooses to adhere to her prescribed medication or not. Here, \( M \) is the entire choice set where an individual chooses \( m \in M \).

\(^{31}\) Distance to health care facility may be a problematic measure of cost to adherence. While migration and moving is uncommon within the survey sample, it is possible for patients to move closer to the facility as their health status deteriorates. I am working on a more accurate way to measure the cost of adherence. However, the assumption that cost, as measured by distance, is constant and non-stochastic is realistic within the CHAT context. The clinics available to patients are well-staffed and, unlike many other developing country contexts, are reliable in terms of service and availability of medication.
The adherence decision is then:

\[ \arg\max_{m \in M} u(h_{1,i1}, ..., h_{J,i1}) - \alpha c_{1,i} + \beta \left\{ \int u(h_{1,i2}, ..., h_{J,i2}) dP_{im}(h_{1,i2}, ..., h_{J,i2}) - \alpha c_{2,im} \right\} \]  

(3.5)

Letting the utility function be additively separable across health outcomes, \( u(\cdot) \) becomes:

\[ u(h_{1,it}, ..., h_{J,it}) = u_1(h_{1,it}) + \ldots + u_J(h_{J,it}) \]  

(3.6)

The advantage of making this assumption is that the quasi-indirect utility and, therefore, the probability of adhering, becomes computationally feasible.\(^{32}\) Employing distance to health facility as the measure of direct cost, I eliminate uncertainty surrounding cost to adherence, and I can assume that total cost is a multiple of the distance and enters the indirect utility function linearly. I will also allow utility to vary based on general characteristics \( (z_{it}) \) such as sex, age, marital status, education, religion, household size and composition. The problem simplifies to the following when I assume that utility is additively separable over outcomes, linear in direct costs, and identical for all individuals with individual characteristics \( z_{it} \):

\[ \max_{m \in M} \left\{ \sum_{j=1}^{J} u_j(h_{j,i1}, z_{i1}) - \alpha z_{i1} c_{1,i} + \beta \sum_{j=1}^{J} u_j(h_{j,i2}, z_{i2}) dP_{im}(h_{j}) - \alpha z_{i2} c_{2,im} + \xi_{im} \right\} \]  

(3.7)

Note that the first part of the utility is independent of the choice of adherence because all the variables that enter the current period utility function are determined by actions taken in the previous period. Under this simple model I abstract from other variables that may enter the utility function, such as income and consumption. In this case, I can use a standard one-period logit estimation technique.

\(^{32}\) This restrictive assumption will need to be revisited since I am aware that it is unrealistic. One key consequence of additively separable utility is that the marginal utility of any good (or health outcome in this case) is independent of the quantities of any of the other goods. In this case for instance, this would imply that the marginal utility of “not being nauseous” is independent of “overall health” or “survival”. This clearly is not true, and I will have to think more about how to simplify the computation without imposing such a strong assumption on the model.
Using this framework, and following the setup of Delavande (2008) the probability that an HIV-positive person with given characteristics \( z_{it} \), choice set \( M \), and subjective expectations \( \{P_{im}(h_j)\}_{j \in \{1, \ldots, m\}} \), chooses to adhere \((m = \overline{m})\) becomes:

\[
Pr\left(\overline{m}\,|\,z_{it}, \{P_{im}(h_j)\}_{j \in \{1, \ldots, n\}}\right) = Pr\left(\varepsilon_{im} - \varepsilon_{i\overline{m}} < V_{i\overline{m}} - V_{im}, \forall m \in M, m \neq \overline{m}\right) \tag{3.8}
\]

If I assume that the error terms \( \{\varepsilon_{i,m}\} \) are i.i.d and have a Type I extreme value distribution, then \( \varepsilon_{i,m} - \varepsilon_{i,\overline{m}} \) has a standard logistic distribution. Dropping the conditioning notation for convenience, when I make the simplifying assumption that people either adhere fully \((m = \overline{m})\) or not \((m = m)\), the probability becomes:

\[
Pr\left(\overline{m}\right) = \frac{\exp(V_{i\overline{m}})}{\exp(V_{im}) + \exp(V_{i\overline{m}})} \tag{3.9}
\]

For simplicity, I will assume that the health outcomes are binary, so that \( P_{im}(h_j) \) is \( P_{im}(h_j = 1) \). This may seems a restrictive assumption, but for the key health outcomes, such as survival, the binary assumption should not prove overly restrictive.\(^{33}\) I could allow for multiple points in the distribution, but this would increase the number of survey questions exponentially. I will drop the time subscripts from this point because all the outcomes in the utility function are assumed to be in the following period (time=2). The indirect utilities \((V_{im})\) become:

\[
V_{im} = \sum_{j=1}^{n} \left\{ u_j(h_j = 0, z_i)P_{im}(h_j = 0) + u_j(h_j = 1, z_i)P_{im}(h_j = 1) + \alpha_z, c_{i,m}\right\} \tag{3.10}
\]

\(^{33}\) Including survival in the utility function may seem strange since it implies a tradeoff between survival and bad health outcomes. In a developed context with low mortality rates, this may not be a reasonable assumption, but in the context of Moshi, with high HIV prevalence, it may not be so unrealistic. In fact, in my focus groups many respondents spoke about death in a much more casual way than I had expected. In response to a question that asked if they would be willing to take a risky medicine to cure a debilitating illness, but has a high probability of death, respondents would reply by saying things like “In the end, whether this scenario is true or not, everyone will die, so I would take the medicine regardless of the risk of dying.” “I would take the medicine because death is a must and being alive is lucky.” “It is up to god when I die, so nothing I do will influence my chances of dying.” “Yes, I would take the medicine because I know that I dies and if so then its bad luck but everyone dies and if I heal then that is very good luck.”
This can be simplified by noting that $P_{im}(h_j = 0) = 1 - P_{im}(h_j = 1)$, i.e. when choosing option $m$, the probability that you experience nausea is one minus the probability that you do not experience nausea.

\[
V_{im} = \sum_{j=1}^{J} (u_j(h_j = 0, z_{it}) - u_j(h_j = 0, z_{it}) P_{im}(h_j = 1) + u_j(h_j = 1, z_{it}) P_{im}(h_j = 1) + \alpha_{z_{it}} c_{i,m})
\]

\[
= \sum_{j=1}^{J} (u_j(h_j = 0, z_{it}) - \Delta u_j(z_i) P_{im}(h_j = 1) + \alpha_{z_{it}} c_{i,m})
\]

(3.11)

where $\Delta u_j(z_{it}) = u_j(h_j = 1, z_{it}) - u_j(h_j = 0, z_{it})$ or the difference in utility between experiencing and not experiencing the health condition $h_j$. $u_j(h_j = 0, z_{it})$ can be thought of as the utility associated with the health outcome $h_j$ not occurring. This is a constant because it does not depend on the choice of whether to adhere or not ($m$). Because I can identify only the difference in utilities between the 2 choices, and not the absolute value, any constant added to the indirect utility function will not affect the individual’s choice, and therefore our analysis. I will drop that term from here on. The probability that an individual chooses to adhere perfectly to his or her ART medication can then be written as:

\[
Pr(m) = \frac{\exp(\sum_{j=1}^{J} \Delta u_j(z_{it}) P_{im}(h_j = 1) + \alpha_{z_{it}} c_{i,m})}{\exp(\sum_{j=1}^{J} \Delta u_j(z_{it}) P_{im}(h_j = 1) + \alpha_{z_{it}} c_{i,m}) + \exp(\sum_{j=1}^{J} \Delta u_j(z_{it}) P_{im}(h_j = 1) + \alpha_{z_{it}} c_{i,m})}
\]

(3.13)

From this equation, I will estimate $\alpha_{z_{it}}$ and $\{\Delta u_j\}_{j=1,..,J}$. $\alpha_{z_{it}}$ is a measure of patient’s willingness to pay for treatment (in terms of transportation cost), and the $\Delta u_j$’s will rank each health outcome variable in terms of importance. The numerical value will not have any interpretation, but the relative ranking of the outcomes will allow me to analyze what factors people consider most when making the decision to adhere or not.

**Estimation**

Using the data outlined in the previous section, I will estimate the random utility model of adherence choice from equation 3.13 using maximum likelihood. As
described in Section 3.5.1 I will estimate \( \alpha_{z_{it}} \) (cost of adherence) and \( \{\Delta u_j\}_{j=1,...,J} \) (difference in utility between experiencing and not experiencing each health outcome, \( j \)). The overall goal is to estimate the relative value of each utility differential to see what factors people are considering the most when making the adherence decision. Variables include:

- \( h_{j,t} = \{ \text{“feel worse”}, \text{mortality, side effects (nausea, fatigue, headache), viral load} \} \)

- \( c_m = \begin{cases} 
\text{distance from health center} & \text{if } m = \overline{m} \\
0 & \text{if } m = \overline{m} 
\end{cases} \)

- \( z_{it} = \{ \text{Sex, Age, Marital Status, Education, Religion, Household Size, Number of Children, Number of Dependents} \} \)

Table 3.19 shows results for the static, one-period model where the cost of adherence is measured as the distance to the clinic.\(^{34}\) The first 2 columns present results using all HIV-positive respondents and the last 2 columns restrict the sample to the Clinic cohort. Arguably, the Clinic cohort is more cohesive, and homogeneous, and is analyzed separately. The results at this stage are consistent between the two samples. First, notice that the cost of adhering (in terms of distance in kilometers from the clinic) is negative and significant, as would be expected. The other coefficients are not as precisely estimated, and unfortunately at this stage, do not make much intuitive sense. There is a wide range of magnitude between the \( \Delta u \) estimates, but the coefficient on 6 month mortality, while negative, is significantly smaller than the coefficients on the other health outcomes. While I am hesitant to draw a strong conclusion at this point, these estimates indicate that people are much more concerned with side effects than with the impact of the drugs on survival. The negative coefficients on headaches and nausea signify that the respondents would prefer to avoid those health outcomes. Surprisingly, there are positive coefficients, while not significantly different from zero, on worse health and fatigue, implying that these are health outcomes that people would rather experience than not.

\(^{34}\) Table A.28 in the Tables Appendix uses travel time in hours as the cost of adherence.
3.5.2 Reduced Form

Now I turn directly to the impact of expectations on the adherence decision. Table 3.20 uses all 6 rounds of data to explore the predictors of being on ART and perfect adherence. A few familiar patterns emerge. First, the clinic cohort is 70% more likely to be taking ART, and once taking ART, is 17% more likely to fully adhere. Also note that the interview round is positive and significant, matching the summary statistics that show increasing adherence throughout the rounds. While respondents that are male, married, or have experienced a decrease in health are less likely to be taking ART, these characteristics do not influence adherence. Because expectations data were only collected in Rounds 5 and 6, they are excluded from this first table which includes all rounds.

Table 3.21 examines Round 6 adherence decisions using adherence behavior in Round 5 and expectations across all outcomes, time horizons, and assumed adherence behavior. The first two rows reconfirm the serial correlation between current actions and past actions. Respondents taking ART in Round 5 are 85% more likely to take ART in Round 6 and respondents who perfectly adhered in Round 5 are nearly 40% more likely to perfectly adhere in Round 6. The large difference between these percentages is likely driven by the fact that once taking ART, it is relatively easy to vary the level of adherence, whereas deciding to initially fill a prescription requires more effort to change. The decision to take ART in Round 6 appears to be driven largely by previous behavior, but it also appears that individuals who believe taking ART will worsen their health or increase their probability of mortality (within 12 months) are significantly less like to take it. Similarly, respondents who place a higher probability of headaches occurring when not taking ART are significantly more likely to take it. These results imply that expectations of health outcomes can significantly predict whether an individuals decides to take ART. From here on, I will refer to this as the extensive margin (deciding between taking ART and not).

Column 2 of Table 3.21 examines the difference in adherence among respondents who are taking ART. This will be referred to as the intensive margin (already taking ART and deciding whether to fully adhere or not). Notice that perfect adherence is
more likely the higher the probability an individual places on becoming nauseous if they imperfectly adhere. In addition, the higher probability of becoming nauseous while perfectly adhering, the less likely to report perfect adherence. This indicates that nausea, as compared to the other common side effects, is one that influences the adherence decision, and that respondents make choices in order to avoid feeling nauseous.

Table 3.22 also analyzes Round 6 adherence, but uses the difference in expectations between Rounds 5 and 6 as independent variables. This is a measure of learning, or how learning and updating beliefs influences decisions. Differences are in terms of probabilities elicited in Round 6 and the corresponding probabilities elicited in Round 5. A positive difference indicates a respondent believes her chances of bad health increased. She now believes she is at higher risk. As such, positive coefficients in Table 3.22 can be interpreted as the effect of increased perceived risk on adherence. From the first column, a respondent who believes she is at higher risk of fatigue if she takes medications, is less like to take them, whereas overall health and headaches have the opposite effect. The predictors of perfect adherence do not follow a logical pattern. It appears as if increased risk of 1 year mortality under no ART increases perfect adherence, but that increased risk of 5 year mortality under no ART decreases it.

3.5.3 Perceived Benefits of Adherence

In order to explore these effects further, I define the benefit of adherence, both for the extensive margin (the decision to take ART or not) and the intensive margin (the decision to perfectly adhere or not once taking ART). The extensive benefit \( \text{Ext}_{ih} \) is the perceived health benefit when transitioning from taking no medications to beginning ART.\(^{35}\) The intensive benefit \( \text{Int}_{ih} \) is the perceived health benefit when transitioning from less than perfect to perfect adherence. In general, the extensive and intensive benefits for health outcome \( h \) for individual \( i \) are:

\[ \text{Ext}_{ih} = \mathbb{E}(h | \text{some ART}) - \mathbb{E}(h | \text{no ART}) \]

\[ \text{Int}_{ih} = \mathbb{E}(h | \text{perfect adherence}) - \mathbb{E}(h | \text{less than perfect adherence}) \]

\(^{35}\) Respondents were only asked the probability of experiencing each outcome under perfect adherence and under less than 95% adherence. \( \mathbb{E}(h | \text{some ART}) \) is calculated as the average of these probabilities.
\[
\text{Ext}_{ih} = P_i(h \mid \text{no ART}) - P_i(h \mid \text{some ART})
\]

and

\[
\text{Int}_{ih} = P_i(h \mid <95\% \text{ adherence}) - P_i(h \mid \text{perfect adherence})
\]

where \( h \in \{6 \text{ mo mortality, 12 mo mortality, 5 yr mortality, nausea, headaches, fatigue, higher viral load, worse health}\} \) and \( P(h \mid \text{some ART}) \) is the average of probabilities between perfect adherence and \(<95\%\). For example, \( \text{Int}_{i,6\text{mo}} \) represents the reduction in perceived mortality by increasing adherence from \(<95\%\) to \(>95\%\). This is the intensive adherence margin because it examines only respondents who have already decided to take ART. Similarly, \( \text{Ext}_{i,6\text{mo}} \) represents the reduction in perceived mortality if one were to begin taking ART.

In addition, it may not only be the current period benefit influencing the adherence decision, but also how the perceived benefit of adherence changes from one period to the next. Table 3.23 presents the influence of perceived health benefits on the extensive and intensive adherence decision. The independent variables include the elicited benefit in Round 6 for all health and mortality outcomes, the amount these benefits changed between Rounds 5 and 6, prior adherence decisions, and other individual controls. It is important to note that for ease of presentation I have only listed “Benefit” and “Benefit Increased”, but these labels refer to the extensive benefits in the first column and the intensive benefits in the second.

For both the extensive and intensive margins it appears that the benefit a respondent assigns to any particular health outcome does not significantly influence her adherence decision. Prior behavior is an important predictor, indicating that respondents are not likely to change their behavior between rounds. However, notice that a larger increase in perceived benefit on fatigue significantly increases the likelihood that the individual took ART, implying that if she believed that taking ART would cause her to be less fatigued than in Round 5, she is more likely to take it. There is an opposite effect, though, for headaches, whereby an individual who believes taking ART will reduce headaches more than in Round 5 is actually less likely to take it. This could indicate that the respondent associates headaches with effectiveness, and that she is more likely to take ART if she thinks it will give her
headaches.

Finally, column 2 presents the effect of the perceived health benefits on the decision to perfectly adhere once taking ART. Similar to the extensive margin, we see no significant effect of the internal benefit of adherence, although there is an interesting relationship between perfect adherence, nausea, and viral load. Respondents who reported a larger perceived reduction in viral load by perfectly adhering were significantly more likely to perfectly adhere, implying that perceptions of viral load reduction are important components of the adherence decision. In addition, there is a significant negative coefficient on the change in nausea benefit, indicating as before, that nausea could be associated with the medications’ effectiveness.

3.6 Conclusions

Evidence suggests that even in a setting where medications are free, HIV positive patients do not always follow doctors recommendations to take anti-retroviral therapy (ART). In Tanzania, a country disproportionately affected by the HIV/AIDS epidemic, 20% of HIV-positive persons in our study sample do not fully adhere to their medication regimen. Individuals who take ART face a tradeoff between decreasing risk of death due to HIV and increasing risk of adverse side effects. The decision of whether or not to start and continue ART depends on the patient’s subjective expectations about the realization of health outcomes under different levels of adherence.

This paper combines new and innovative data on probabilistic expectations and elicited discount rates with self-reported measures of adherence to analyze individual beliefs about the effectiveness of available medication, and more specifically, how these beliefs influence individuals decisions to adhere to a medication regime. Medical literature suggests that in order for ART to be effective, 95% of doses must be taken on time, and we find that patients are aware of this threshold. They report a dramatic increase in the probability of mortality between fully adhering and taking less than 95% of doses.

Using elicited expectations and realized outcomes, predictions of health outcomes
are found to be significantly different than realized outcomes in the following period. Respondents learned that perfectly adhering did not make them feel as good as they thought it would, and conversely, that imperfectly adhering did not make them feel as badly as they thought it would. In addition, respondents who were not on ART significantly overestimated being in worse health. As such, we would expect that individuals’ expectations would adjust over time to match more closely with realized outcomes. Examining how expectations change over time, we find that individuals update their expectations consistent with a Bayesian updating framework in which current expectations are determined by prior beliefs and new information.

Significant predictors of expectations include, overall health, completion of primary school, past choices, and patience as it related to health. Patience is measured by questions in the new survey allowing the estimation of a person-specific discount factor. This elicited discount factor (higher indicates more patience) does not vary significantly by gender, but HIV-positive respondents are significantly less patient than HIV-negative respondents.

Finally, incorporating elicited expectations we find that perceived effectiveness is an important predictor of taking ART, specifically respondents are less likely to take ART if they believe that taking it will worsen their health or increase their chances of mortality. Perceptions of the medications’ effectiveness at reducing viral loads are significant predictors of perfect adherence. There is also evidence that adherence decisions are consistent with respondents’ desire to avoid feeling nauseous, but that feeling fatigued may be associated with the effectiveness of ART.

Overall, this paper provides an analysis of individual subjective expectations data in an HIV/AIDS context and provides evidence that while individual subjective expectations do not accurately predict future health outcomes, they significantly influence adherence decisions. It is not sufficient to only use observable characteristics of HIV patients when analyzing adherence, as their expectations of the future comprise a large component of their decision to fully adhere to their medication regimen.
### 3.7 Tables and Figures

#### Table 3.1: Enrollment Results

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Target</th>
<th>Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic (HIV-positive)</td>
<td>500</td>
<td>497 (99%)</td>
</tr>
<tr>
<td>Community (HIV-positive and -negative)</td>
<td>250</td>
<td>249 (99%)</td>
</tr>
<tr>
<td>VCT (HIV-positive)</td>
<td>500</td>
<td>267 (53%)</td>
</tr>
<tr>
<td>VCT (HIV-negative)</td>
<td>250</td>
<td>183 (73%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1500</strong></td>
<td><strong>1196 (80%)</strong></td>
</tr>
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</table>

#### Table 3.2: Summary Statistics (Round 1 Only)

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<thead>
<tr>
<th></th>
<th>Round 1</th>
<th>DHS 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td><strong>Cohort</strong></td>
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<td></td>
</tr>
<tr>
<td>VCT-negative</td>
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<td>11.9</td>
</tr>
<tr>
<td>VCT-positive</td>
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<td>24.1</td>
</tr>
<tr>
<td>KCMC (clinic)</td>
<td>18.0</td>
<td>19.6</td>
</tr>
<tr>
<td>Mawenzi (clinic)</td>
<td>18.7</td>
<td>24.9</td>
</tr>
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<td>19.5</td>
</tr>
<tr>
<td><strong>Age</strong></td>
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</tr>
<tr>
<td>Less than 20</td>
<td>1.8</td>
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</tr>
<tr>
<td>20-29</td>
<td>13.9</td>
<td>18.8</td>
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<td>33.5</td>
</tr>
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<td>40-49</td>
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<td>30.8</td>
</tr>
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<td>50 plus</td>
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<td><strong>Occupation</strong></td>
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<td>Business</td>
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<td>Farming</td>
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<td>Skilled Labor</td>
<td>17.2</td>
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</tr>
<tr>
<td>Other</td>
<td>8.8</td>
<td>10.9</td>
</tr>
<tr>
<td><strong>Sample Size</strong></td>
<td>431</td>
<td>755</td>
</tr>
</tbody>
</table>

Source: CHAT Survey and Tanzania DHS 2010. Skilled labor includes occupations such as carpenter and tailor. Salaried labor includes occupations such as office worker, nurse and teacher. Unskilled labor includes occupations such as cleaning and construction. Other includes all other sources of income, including if the respondent is a student or unemployed.
<table>
<thead>
<tr>
<th></th>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
<th>Round 4</th>
<th>Round 5</th>
<th>Round 6</th>
<th>DHS 2010</th>
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</thead>
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<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
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<td><strong>Marital Status</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Married (monogamous)</td>
<td>55.1</td>
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<td>59.3</td>
<td>34.0</td>
<td>59.0</td>
<td>32.6</td>
<td>59.4</td>
</tr>
<tr>
<td>Married (polygamous)</td>
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<td>4.0</td>
<td>2.4</td>
<td>2.5</td>
<td>2.6</td>
<td>4.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Widowed</td>
<td>7.4</td>
<td>22.3</td>
<td>10.5</td>
<td>24.9</td>
<td>8.3</td>
<td>25.7</td>
<td>9.7</td>
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<td>19.5</td>
<td>10.5</td>
<td>20.5</td>
<td>13.7</td>
<td>19.3</td>
<td>12.3</td>
</tr>
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<td>Co-habiting</td>
<td>1.4</td>
<td>2.6</td>
<td>0.9</td>
<td>1.9</td>
<td>0.9</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Single/never married</td>
<td>21.3</td>
<td>18.1</td>
<td>16.5</td>
<td>16.2</td>
<td>14.6</td>
<td>15.6</td>
<td>15.1</td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>24.3</td>
<td>25.2</td>
<td>23.3</td>
<td>24.8</td>
<td>23.1</td>
<td>24.7</td>
<td>24.5</td>
</tr>
<tr>
<td>Hindu</td>
<td>0.7</td>
<td>0.1</td>
<td>0.8</td>
<td>0.2</td>
<td>0.9</td>
<td>0.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Lutheran</td>
<td>26.9</td>
<td>25.2</td>
<td>26.8</td>
<td>25.4</td>
<td>27.1</td>
<td>25.8</td>
<td>26.5</td>
</tr>
<tr>
<td>Christian</td>
<td>46.1</td>
<td>49.1</td>
<td>46.7</td>
<td>49.3</td>
<td>46.7</td>
<td>49.0</td>
<td>46.1</td>
</tr>
<tr>
<td>Other</td>
<td>2.1</td>
<td>0.4</td>
<td>2.4</td>
<td>0.3</td>
<td>2.3</td>
<td>0.3</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>HIV Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>55.5</td>
<td>68.6</td>
<td>53.8</td>
<td>66.8</td>
<td>52.9</td>
<td>68.7</td>
<td>54.7</td>
</tr>
<tr>
<td>Sample size</td>
<td>434</td>
<td>755</td>
<td>381</td>
<td>650</td>
<td>350</td>
<td>642</td>
<td>351</td>
</tr>
</tbody>
</table>

*a* Tanzania DHS survey does not distinguish between monogamous and polygamous marriages.


*c* HIV data from the 2007-08 Tanzania HIV/AIDS and Malaria Indicator Survey ([http://www.nbs.go.tz](http://www.nbs.go.tz))
### Table 3.4: Completed Interviews (%)

<table>
<thead>
<tr>
<th>Cohort (HIV-pos)</th>
<th>Survey Round</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Clinic (HIV-pos)</td>
<td>100</td>
<td>92</td>
<td>92</td>
<td>93</td>
<td>94</td>
<td>93</td>
</tr>
<tr>
<td>VCT (HIV-neg)</td>
<td>100</td>
<td>86</td>
<td>78</td>
<td>85</td>
<td>78</td>
<td>44</td>
</tr>
<tr>
<td>VCT (HIV-pos)</td>
<td>100</td>
<td>74</td>
<td>74</td>
<td>84</td>
<td>84</td>
<td>45</td>
</tr>
<tr>
<td>Community (HIV-pos &amp; -neg)</td>
<td>100</td>
<td>95</td>
<td>91</td>
<td>84</td>
<td>89</td>
<td>84</td>
</tr>
<tr>
<td>Average</td>
<td>100</td>
<td>88</td>
<td>86</td>
<td>88</td>
<td>88</td>
<td>73</td>
</tr>
<tr>
<td>N</td>
<td>1197</td>
<td>1172</td>
<td>1154</td>
<td>1143</td>
<td>1133</td>
<td>1128</td>
</tr>
</tbody>
</table>

Missed interviews do not include attrition due to death.

### Table 3.5: Missing Interviews

<table>
<thead>
<tr>
<th>Survey Round</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing Interview</td>
<td>166 14%</td>
<td>180 15%</td>
<td>149 13%</td>
<td>143 13%</td>
<td>304 27%</td>
</tr>
<tr>
<td>Alive HIV+</td>
<td>100 60%</td>
<td>98 54%</td>
<td>3 2%</td>
<td>64 45%</td>
<td>159 52%</td>
</tr>
<tr>
<td>HIV-</td>
<td>41 25%</td>
<td>64 36%</td>
<td>135 91%</td>
<td>69 48%</td>
<td>140 46%</td>
</tr>
<tr>
<td>Dead HIV+</td>
<td>23 14%</td>
<td>16 9%</td>
<td>0 0%</td>
<td>8 6%</td>
<td>5 2%</td>
</tr>
<tr>
<td>HIV-</td>
<td>2 1%</td>
<td>2 1%</td>
<td>11 7%</td>
<td>2 1%</td>
<td>0 0%</td>
</tr>
<tr>
<td>N</td>
<td>166 100%</td>
<td>180 100%</td>
<td>149 100%</td>
<td>143 100%</td>
<td>304 100%</td>
</tr>
</tbody>
</table>

Individuals reported dead one one round are excluded from analysis in subsequent rounds.
Table 3.6: Attrition Analysis - Probit on Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Completed all Interviews</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>Entire Sample HIV+ only</td>
<td>On ART HIV+ only</td>
<td>only</td>
</tr>
<tr>
<td>HIV positive</td>
<td>0.561</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On ART</td>
<td></td>
<td>0.517***</td>
<td></td>
</tr>
<tr>
<td>Perfect Adherence</td>
<td></td>
<td></td>
<td>-0.726***</td>
</tr>
<tr>
<td>HIV+ x Health</td>
<td>-1.024*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV+ x Past Month Health</td>
<td>0.820</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV+ x Married</td>
<td>0.041</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV+ x Num. HH Members</td>
<td>-0.017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV+ x Male</td>
<td>-0.174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV+ x Muslim</td>
<td>-0.094</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV+ x Primary School</td>
<td>0.235</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health (0-1)</td>
<td>0.267</td>
<td>-0.966**</td>
<td>-1.066</td>
</tr>
<tr>
<td>Health Past Month (0-1)</td>
<td>-0.015</td>
<td>0.540</td>
<td>-0.482</td>
</tr>
<tr>
<td>Married</td>
<td>0.067</td>
<td>0.154</td>
<td>0.232</td>
</tr>
<tr>
<td>Num. HH Members</td>
<td>0.015</td>
<td>0.000</td>
<td>0.025</td>
</tr>
<tr>
<td>Male</td>
<td>-0.170</td>
<td>-0.360***</td>
<td>-0.327*</td>
</tr>
<tr>
<td>Muslim</td>
<td>-0.052</td>
<td>-0.160</td>
<td>-0.320*</td>
</tr>
<tr>
<td>Age</td>
<td>0.019***</td>
<td>0.017***</td>
<td>0.014</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.202</td>
<td>-0.053</td>
<td>-0.233</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.408***</td>
<td>-0.167</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.487</td>
<td>-0.121</td>
<td>2.030***</td>
</tr>
</tbody>
</table>

Observations: 1,182 755 431
Mean of Dep. Var.: 0.673 0.685 0.812

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Figure 3.1: Subjective Probability of Tanzania winning a football match against Brazil

Dots indicate the average elicited probability for each gender. The bars through each dot indicate the inner quartile range (25th through 75th percentile).

Figure 3.2: Subjective probability of going to the market

Dots indicate the average elicited probability for each gender. The bars through each dot indicate the inner quartile range (25th through 75th percentile).
Table 3.7: Adherence (by Round)

<table>
<thead>
<tr>
<th>Survey Round</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>sample size</td>
<td>445</td>
<td>447</td>
<td>446</td>
<td>452</td>
<td>453</td>
<td>452</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measures of Perfect Adherence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>taking any ART</td>
<td>328 (74%)</td>
<td>362 (81%)</td>
<td>369 (83%)</td>
<td>380 (84%)</td>
<td>386 (85%)</td>
<td>390 (86%)</td>
</tr>
<tr>
<td>sample size</td>
<td>445</td>
<td>447</td>
<td>446</td>
<td>452</td>
<td>453</td>
<td>452</td>
</tr>
<tr>
<td>% of time usually take each drug is 100</td>
<td>318 (97%)</td>
<td>345 (95%)</td>
<td>348 (94%)</td>
<td>356 (94%)</td>
<td>357 (92%)</td>
<td>359 (92%)</td>
</tr>
<tr>
<td>last time you missed any drug is never</td>
<td>301 (92%)</td>
<td>333 (92%)</td>
<td>342 (93%)</td>
<td>356 (94%)</td>
<td>386 (100%)</td>
<td>389 (100%)</td>
</tr>
<tr>
<td>% of drugs taken is 100</td>
<td>308 (94%)</td>
<td>348 (96%)</td>
<td>342 (93%)</td>
<td>361 (95%)</td>
<td>358 (93%)</td>
<td>360 (92%)</td>
</tr>
<tr>
<td>% of doses missed, forgotten, or skipped is 0</td>
<td>312 (95%)</td>
<td>346 (96%)</td>
<td>347 (94%)</td>
<td>361 (95%)</td>
<td>358 (93%)</td>
<td>360 (92%)</td>
</tr>
<tr>
<td>% of time drugs taken early or late is 0</td>
<td>256 (78%)</td>
<td>302 (83%)</td>
<td>312 (85%)</td>
<td>316 (83%)</td>
<td>358 (93%)</td>
<td>360 (92%)</td>
</tr>
<tr>
<td>Satisfies (1) OR (2)-(5)</td>
<td>325 (99%)</td>
<td>356 (98%)</td>
<td>365 (99%)</td>
<td>376 (99%)</td>
<td>386 (100%)</td>
<td>389 (100%)</td>
</tr>
<tr>
<td>Satisfies (1) - (5)</td>
<td>232 (71%)</td>
<td>278 (77%)</td>
<td>293 (79%)</td>
<td>299 (79%)</td>
<td>319 (83%)</td>
<td>332 (85%)</td>
</tr>
<tr>
<td>sample size</td>
<td>328</td>
<td>362</td>
<td>369</td>
<td>380</td>
<td>386</td>
<td>390</td>
</tr>
</tbody>
</table>

Note: Sample only includes respondents who completed all 6 interviews.
Table 3.8: Differences in Respondent Characteristics based on Consistency in Market Expectations Questions

<table>
<thead>
<tr>
<th></th>
<th>(1) 2 weeks &lt; 2 days</th>
<th>(2) 2 weeks = 2 days</th>
<th>(3) 2 weeks &gt; 2 days</th>
<th>Test of Equality between Columns:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.41</td>
<td>0.43</td>
<td>0.30</td>
<td>(***)(1)≠(2) (1)≠(3) (2)≠(3)</td>
</tr>
<tr>
<td>Age</td>
<td>42.4</td>
<td>42.6</td>
<td>41.2</td>
<td>(**)</td>
</tr>
<tr>
<td>HIV+</td>
<td>0.85</td>
<td>0.73</td>
<td>0.61</td>
<td>(<em><strong>)(</strong></em>)</td>
</tr>
<tr>
<td>Health (0-1)</td>
<td>0.79</td>
<td>0.79</td>
<td>0.81</td>
<td>(**)</td>
</tr>
<tr>
<td># HH Members</td>
<td>4.73</td>
<td>4.67</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Discount Factor</td>
<td>0.47</td>
<td>0.52</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>Primary School</td>
<td>0.15</td>
<td>0.23</td>
<td>0.16</td>
<td>(****)</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.78</td>
<td>0.57</td>
<td>0.37</td>
<td>(<em><strong>)(</strong></em>) (****)</td>
</tr>
<tr>
<td>Muslim</td>
<td>0.34</td>
<td>0.23</td>
<td>0.25</td>
<td></td>
</tr>
</tbody>
</table>

N: 41 315 639
**Figure 3.3: Subjective probability of Death**

Dots indicate the average elicited probability for each gender and level of adherence. The bars through each dot indicate the inner quartile range (25th through 75th percentile).
**Figure 3.4:** Subjective probability of experiencing each health outcome in 6 months

Dots indicate the average elicited probability for each gender and level of adherence. The bars through each dot indicate the inner quartile range (25th through 75th percentile).
Figure 3.5: Subjective probability of death (HIV-Negative only)

Figure 3.6: Subjective probability of experiencing each health outcome in 6 months (HIV-Negative only)
Table 3.9: Actual minus Predicted Outcomes
\( P(\text{Worse Health}) \) conditional of Round 5 and Round 6 choices

<table>
<thead>
<tr>
<th>Round 5 Adherence</th>
<th>Round 6 Adherence</th>
<th>Perfect</th>
<th>&lt; 95%</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td></td>
<td>0.25</td>
<td>-0.28</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td></td>
<td>(0.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N=338</td>
<td></td>
<td>N=36</td>
<td>N=1</td>
</tr>
<tr>
<td>&lt; 95%</td>
<td></td>
<td>0.24</td>
<td>-0.21</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td></td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N=40</td>
<td></td>
<td>N=37</td>
<td>N=3</td>
</tr>
<tr>
<td>No ART</td>
<td></td>
<td>0.49</td>
<td>-0.10</td>
<td>-0.26</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td></td>
<td></td>
<td>(0.00)</td>
</tr>
<tr>
<td></td>
<td>N=7</td>
<td></td>
<td>N=1</td>
<td>N=77</td>
</tr>
</tbody>
</table>

Null hypothesis that the difference between predicted and actual outcomes is zero is represented by the p-value in parentheses. Note that because the values are actual minus expected that positive numbers represent underestimates and negative numbers represent overestimates.

Table 3.10: Discount Rate Bins

<table>
<thead>
<tr>
<th>Question</th>
<th>Choice</th>
<th>Reward</th>
<th>Discount Rate Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>50 days in 6 months</td>
<td>&lt;25%</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>40 days today</td>
<td>&gt;25%</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>50 days in 6 months</td>
<td>&lt;100%</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>25 days today</td>
<td>&gt;100%</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>50 days in 6 months</td>
<td>&lt;900%</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>5 days today</td>
<td>&gt;900%</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>50 days in 6 months</td>
<td>&lt;4,900%</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1 day today</td>
<td>&gt;4,900%</td>
</tr>
</tbody>
</table>
Figure 3.7: Discount Factor Tree

Figure 3.8: Distribution of Elicited Discount Factors

Note: Higher discount factor (closer to 1) indicates greater patience.
Figure 3.9: Mean of Elicited Discount Factors by Sex, Age, and HIV status

Table 3.11: Average Discount Factors - Round 5

<table>
<thead>
<tr>
<th>Age</th>
<th>Female</th>
<th>Male</th>
<th>Diff</th>
<th>HIV-</th>
<th>HIV+</th>
<th>Diff</th>
<th>HIV-</th>
<th>HIV+</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>0.62</td>
<td>0.61</td>
<td>0.01</td>
<td>0.43</td>
<td>0.38</td>
<td>0.06</td>
<td>0.19**</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>0.59</td>
<td>0.58</td>
<td>0.01</td>
<td>0.41</td>
<td>0.51</td>
<td>-0.10</td>
<td>0.18***</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>0.63</td>
<td>0.64</td>
<td>-0.01</td>
<td>0.39</td>
<td>0.49</td>
<td>-0.11*</td>
<td>0.24***</td>
<td>0.14*</td>
<td></td>
</tr>
<tr>
<td>50+</td>
<td>0.68</td>
<td>0.69</td>
<td>-0.01</td>
<td>0.45</td>
<td>0.44</td>
<td>0.01</td>
<td>0.22***</td>
<td>0.24***</td>
<td></td>
</tr>
</tbody>
</table>

Asterisks denote significant differences between groups at the 10 (*), 5 (**), and 1 (***) percent level.
Table 3.12: Correlates of High Discount Factor

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Round 5</td>
<td>Round 6</td>
<td>Became</td>
</tr>
<tr>
<td>High Discount Factor (Round 5)</td>
<td>0.045</td>
<td>0.465***</td>
<td>More Patient</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>0.541***</td>
<td>1.030***</td>
<td>0.465***</td>
</tr>
<tr>
<td></td>
<td>[0.034]</td>
<td>[0.131]</td>
<td>[0.127]</td>
</tr>
<tr>
<td>HIV positive</td>
<td>-0.116**</td>
<td>-0.312***</td>
<td>-0.040</td>
</tr>
<tr>
<td></td>
<td>[0.045]</td>
<td>[0.058]</td>
<td>[0.048]</td>
</tr>
<tr>
<td>Nausea</td>
<td>-0.056</td>
<td>-0.111***</td>
<td>-0.066*</td>
</tr>
<tr>
<td></td>
<td>[0.041]</td>
<td>[0.041]</td>
<td>[0.039]</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.093***</td>
<td>-0.002</td>
<td>-0.014</td>
</tr>
<tr>
<td></td>
<td>[0.033]</td>
<td>[0.037]</td>
<td>[0.034]</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.022</td>
<td>0.143***</td>
<td>0.068**</td>
</tr>
<tr>
<td></td>
<td>[0.033]</td>
<td>[0.034]</td>
<td>[0.033]</td>
</tr>
<tr>
<td>Long Financial Time Horizon</td>
<td>0.165***</td>
<td>0.207**</td>
<td>-0.013</td>
</tr>
<tr>
<td></td>
<td>[0.052]</td>
<td>[0.082]</td>
<td>[0.071]</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>-0.099**</td>
<td>0.028</td>
<td>0.099**</td>
</tr>
<tr>
<td></td>
<td>[0.041]</td>
<td>[0.053]</td>
<td>[0.044]</td>
</tr>
<tr>
<td>Married</td>
<td>0.044</td>
<td>0.071*</td>
<td>0.067*</td>
</tr>
<tr>
<td></td>
<td>[0.034]</td>
<td>[0.036]</td>
<td>[0.035]</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.069*</td>
<td>0.010</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>[0.040]</td>
<td>[0.040]</td>
<td>[0.039]</td>
</tr>
<tr>
<td>Number HH members under 18</td>
<td>0.001</td>
<td>-0.023**</td>
<td>-0.015</td>
</tr>
<tr>
<td></td>
<td>[0.011]</td>
<td>[0.011]</td>
<td>[0.010]</td>
</tr>
<tr>
<td>Age</td>
<td>0.003*</td>
<td>0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>[0.002]</td>
<td>[0.002]</td>
<td>[0.002]</td>
</tr>
<tr>
<td>Male</td>
<td>0.028</td>
<td>-0.073**</td>
<td>-0.077**</td>
</tr>
<tr>
<td></td>
<td>[0.034]</td>
<td>[0.037]</td>
<td>[0.036]</td>
</tr>
<tr>
<td>Muslim</td>
<td>-0.045</td>
<td>-0.005</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>[0.037]</td>
<td>[0.037]</td>
<td>[0.037]</td>
</tr>
<tr>
<td>Constant</td>
<td>0.017</td>
<td>-0.219</td>
<td>-0.097</td>
</tr>
<tr>
<td></td>
<td>[0.147]</td>
<td>[0.144]</td>
<td>[0.130]</td>
</tr>
</tbody>
</table>

Observations: 975, 766, 766
R-squared: 0.101, 0.204, 0.045
Mean: 0.512, 0.551, 0.256

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table 3.13: Predictors of Round 5 Expectations

<table>
<thead>
<tr>
<th></th>
<th>(1) Assume Perfect Adherence</th>
<th>(2) Assume 95% Adherence</th>
<th>(3) Assume No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect Past Adherence</td>
<td>0.023</td>
<td>0.008</td>
<td>0.167**</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.017</td>
<td>-0.068</td>
<td>0.029</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.018</td>
<td>-0.007</td>
<td>0.070</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.061**</td>
<td>-0.017</td>
<td>-0.150*</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>-0.006</td>
<td>-0.137*</td>
<td>0.112</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Nausea</td>
<td>0.001</td>
<td>0.108</td>
<td>-0.007</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Headaches</td>
<td>0.027</td>
<td>-0.065</td>
<td>0.089</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.022</td>
<td>0.043</td>
<td>-0.033</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.009</td>
<td>0.026</td>
<td>-0.085</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0.042</td>
<td>-0.020</td>
<td>0.091</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>Male</td>
<td>0.008</td>
<td>0.062**</td>
<td>0.013</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.012</td>
<td>-0.041*</td>
<td>-0.079***</td>
</tr>
<tr>
<td>Married</td>
<td>0.003</td>
<td>0.018</td>
<td>0.007</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.001</td>
<td>0.002</td>
<td>-0.007</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.001</td>
<td>0.003**</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.069</td>
<td>0.010</td>
<td>0.137</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.004</td>
<td>0.088***</td>
<td>0.074**</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.007</td>
<td>0.118***</td>
<td>-0.008</td>
</tr>
<tr>
<td>Constant</td>
<td>0.095*</td>
<td>0.189</td>
<td>0.305**</td>
</tr>
<tr>
<td>Observations</td>
<td>576</td>
<td>568</td>
<td>567</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.031</td>
<td>0.107</td>
<td>0.085</td>
</tr>
<tr>
<td>Mean</td>
<td>0.040</td>
<td>0.350</td>
<td>0.590</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table 3.14: Predictors of Round 5 Expectations

Probability of Feeling **Nauseous** within 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume</td>
<td>Less than</td>
<td>Assume</td>
</tr>
<tr>
<td></td>
<td>Perfect</td>
<td>95%</td>
<td>No ART</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.048*</td>
<td>0.107</td>
<td>0.168**</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.040</td>
<td>0.017</td>
<td>-0.050</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.042</td>
<td>0.024</td>
<td>-0.005</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.024</td>
<td>-0.131</td>
<td>-0.074</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.024</td>
<td>0.007</td>
<td>0.137</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Nausea</td>
<td>-0.023</td>
<td>0.012</td>
<td>-0.043</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Headaches</td>
<td>0.074*</td>
<td>0.093</td>
<td>0.141</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Fatigue</td>
<td>0.013</td>
<td>0.025</td>
<td>0.015</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.026</td>
<td>-0.032</td>
<td>-0.025</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.044</td>
<td>-0.114</td>
<td>-0.091</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.033</td>
<td>0.142*</td>
<td>0.087</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001***</td>
<td>-0.001</td>
<td>-0.000</td>
</tr>
<tr>
<td>Male</td>
<td>0.008</td>
<td>0.017</td>
<td>0.002</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.003</td>
<td>-0.062**</td>
<td>-0.070***</td>
</tr>
<tr>
<td>Married</td>
<td>0.013</td>
<td>0.034</td>
<td>0.050*</td>
</tr>
<tr>
<td>Number of household members</td>
<td>0.001</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.002*</td>
<td>0.002**</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.115**</td>
<td>0.019</td>
<td>0.135</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>0.001</td>
<td>0.117***</td>
<td>0.125***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.010</td>
<td>0.147***</td>
<td>-0.021</td>
</tr>
<tr>
<td>Constant</td>
<td>0.141***</td>
<td>0.333**</td>
<td>0.417***</td>
</tr>
</tbody>
</table>

Observations | 568 | 568 | 565
R-squared    | 0.066 | 0.140 | 0.121
Mean         | 0.061 | 0.517 | 0.644

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table 3.15: Predictors of Round 5 Expectations

Probability of **Higher Viral Load** in 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume</td>
<td>Less than</td>
<td>Assume</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.034</td>
<td>0.109*</td>
<td>0.106**</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.033</td>
<td>-0.039</td>
<td>-0.053</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.064**</td>
<td>0.045</td>
<td>0.012</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.035</td>
<td>-0.062</td>
<td>-0.011</td>
</tr>
<tr>
<td>&lt;95% Past Adherence</td>
<td>0.011</td>
<td>0.047</td>
<td>0.087</td>
</tr>
<tr>
<td>&lt;95% Adherence x Nausea</td>
<td>-0.030</td>
<td>-0.076</td>
<td>-0.049</td>
</tr>
<tr>
<td>&lt;95% Adherence x Headaches</td>
<td>0.072**</td>
<td>0.122</td>
<td>0.045</td>
</tr>
<tr>
<td>&lt;95% Adherence x Fatigue</td>
<td>0.008</td>
<td>0.040</td>
<td>0.070</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.040</td>
<td>0.029</td>
<td>-0.006</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.046</td>
<td>-0.071</td>
<td>-0.026</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.024</td>
<td>0.074</td>
<td>0.014</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001***</td>
<td>-0.001</td>
<td>-0.000</td>
</tr>
<tr>
<td>Male</td>
<td>0.000</td>
<td>-0.010</td>
<td>0.003</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.023**</td>
<td>-0.069***</td>
<td>-0.067***</td>
</tr>
<tr>
<td>Married</td>
<td>0.023**</td>
<td>0.018</td>
<td>0.022</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.001</td>
<td>-0.001</td>
<td>-0.003</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.104**</td>
<td>0.053</td>
<td>0.202**</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.001</td>
<td>0.065**</td>
<td>0.063**</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>-0.023**</td>
<td>0.168***</td>
<td>-0.030</td>
</tr>
<tr>
<td>Constant</td>
<td>0.145***</td>
<td>0.510***</td>
<td>0.639***</td>
</tr>
</tbody>
</table>

Observations | 568       | 568       | 567       |
R-squared     | 0.086     | 0.148     | 0.089     |
Mean          | 0.035     | 0.732     | 0.832     |

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
### Table 3.16: Updating Expectations

**Probability of Death within 6 months**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume Perfect Adherence</td>
<td>Assume Less than 95% Adherence</td>
<td>Assume No ART</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>-0.006</td>
<td>-0.218</td>
<td>0.097</td>
</tr>
<tr>
<td>Prior x &lt;95% Adherence</td>
<td>-0.070</td>
<td>-0.109</td>
<td>0.111</td>
</tr>
<tr>
<td>Prior</td>
<td>0.001</td>
<td>0.321**</td>
<td>0.292**</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.007</td>
<td>0.062</td>
<td>-0.019</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.012</td>
<td>0.075</td>
<td>-0.048</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.052**</td>
<td>-0.229**</td>
<td>0.174</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.011</td>
<td>0.006</td>
<td>0.020</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.011*</td>
<td>-0.040</td>
<td>-0.070***</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.003</td>
<td>0.072***</td>
<td>0.076***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.026</td>
<td>0.283**</td>
<td>0.114</td>
</tr>
<tr>
<td>Observations</td>
<td>478</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.048</td>
<td>0.108</td>
<td>0.379</td>
</tr>
<tr>
<td>Mean</td>
<td>0.017</td>
<td>0.313</td>
<td>0.645</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

### Table 3.17: Updating Expectations

**Probability of Feeling Nauseous within 6 months**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume Perfect Adherence</td>
<td>Assume Less than 95% Adherence</td>
<td>Assume No ART</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>-0.128</td>
<td>0.039</td>
<td>-0.046</td>
</tr>
<tr>
<td>Prior x &lt;95% Adherence</td>
<td>0.122</td>
<td>0.029</td>
<td>-0.085</td>
</tr>
<tr>
<td>Prior</td>
<td>0.115</td>
<td>0.240**</td>
<td>0.315***</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.019</td>
<td>-0.032</td>
<td>0.004</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.004</td>
<td>-0.015</td>
<td>0.052</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.182***</td>
<td>0.179*</td>
<td>0.366***</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.001</td>
<td>0.006</td>
<td>0.039</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.002</td>
<td>-0.014</td>
<td>-0.025</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.011</td>
<td>0.081***</td>
<td>0.074***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.169***</td>
<td>0.118</td>
<td>0.070</td>
</tr>
<tr>
<td>Observations</td>
<td>473</td>
<td>473</td>
<td>470</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.068</td>
<td>0.388</td>
<td>0.393</td>
</tr>
<tr>
<td>Mean</td>
<td>0.031</td>
<td>0.609</td>
<td>0.737</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table 3.18: Updating Expectations

Probability of Feeling **Fatigued** within 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume</td>
<td>Assume</td>
<td>Assume</td>
</tr>
<tr>
<td></td>
<td>Perfect</td>
<td>Less than</td>
<td>No ART</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>-0.047</td>
<td>0.059</td>
<td>0.032</td>
</tr>
<tr>
<td>Prior x &lt;95% Adherence</td>
<td>0.065</td>
<td>0.067</td>
<td>-0.020</td>
</tr>
<tr>
<td>Prior</td>
<td>0.082</td>
<td>0.163*</td>
<td>0.172**</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.028</td>
<td>-0.040</td>
<td>-0.025</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.020</td>
<td>-0.050</td>
<td>0.025</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.241***</td>
<td>0.172**</td>
<td>0.323***</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.007</td>
<td>0.018</td>
<td>0.028</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.001</td>
<td>-0.005</td>
<td>-0.027</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.001</td>
<td>0.056***</td>
<td>0.063***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.177***</td>
<td>0.208**</td>
<td>0.263**</td>
</tr>
<tr>
<td>Observations</td>
<td>473</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.081</td>
<td>0.327</td>
<td>0.323</td>
</tr>
<tr>
<td>Mean</td>
<td>0.052</td>
<td>0.660</td>
<td>0.784</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
<table>
<thead>
<tr>
<th>Round 5</th>
<th>Full Sample</th>
<th>Clinic Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>SE</td>
</tr>
<tr>
<td><strong>∆u for 6 month mortality</strong></td>
<td>-0.61</td>
<td>0.39</td>
</tr>
<tr>
<td><strong>∆u for worse health</strong></td>
<td>1.37</td>
<td>0.72</td>
</tr>
<tr>
<td><strong>∆u for fatigue</strong></td>
<td>1.64</td>
<td>0.99</td>
</tr>
<tr>
<td><strong>∆u for headaches</strong></td>
<td>-1.14</td>
<td>0.72</td>
</tr>
<tr>
<td><strong>∆u for nausea</strong></td>
<td>-2.41</td>
<td>1.09</td>
</tr>
<tr>
<td>alpha - cost of adhering*</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>N</td>
<td>566</td>
<td>436</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round 6</th>
<th>Full Sample</th>
<th>Clinic Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>SE</td>
</tr>
<tr>
<td><strong>∆u for 6 month mortality</strong></td>
<td>-1.39</td>
<td>0.60</td>
</tr>
<tr>
<td><strong>∆u for worse health</strong></td>
<td>0.48</td>
<td>0.91</td>
</tr>
<tr>
<td><strong>∆u for fatigue</strong></td>
<td>1.71</td>
<td>1.49</td>
</tr>
<tr>
<td><strong>∆u for headaches</strong></td>
<td>-3.06</td>
<td>1.14</td>
</tr>
<tr>
<td><strong>∆u for nausea</strong></td>
<td>0.97</td>
<td>1.29</td>
</tr>
<tr>
<td>alpha - cost of adhering*</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>N</td>
<td>482</td>
<td>431</td>
</tr>
</tbody>
</table>
### Table 3.20: Predictors of Perfect Adherence Across Rounds

<table>
<thead>
<tr>
<th></th>
<th>(1) Any ART</th>
<th>(2) Perfect Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease in Health</td>
<td>-0.026***</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.016]</td>
</tr>
<tr>
<td>Married</td>
<td>-0.058***</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.017]</td>
</tr>
<tr>
<td>Muslim</td>
<td>-0.004</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>[0.010]</td>
<td>[0.019]</td>
</tr>
<tr>
<td>Male</td>
<td>-0.031***</td>
<td>-0.009</td>
</tr>
<tr>
<td></td>
<td>[0.010]</td>
<td>[0.018]</td>
</tr>
<tr>
<td>Age</td>
<td>0.004***</td>
<td>0.002**</td>
</tr>
<tr>
<td></td>
<td>[0.000]</td>
<td>[0.001]</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.025**</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>[0.011]</td>
<td>[0.020]</td>
</tr>
<tr>
<td>Number HH members under 18</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>[0.004]</td>
<td>[0.008]</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.002</td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>[0.003]</td>
<td>[0.005]</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.705***</td>
<td>0.175***</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.021]</td>
</tr>
<tr>
<td>Interview round</td>
<td>0.018***</td>
<td>0.016***</td>
</tr>
<tr>
<td></td>
<td>[0.003]</td>
<td>[0.005]</td>
</tr>
<tr>
<td>HH Expenses</td>
<td>-0.012</td>
<td>-0.153</td>
</tr>
<tr>
<td></td>
<td>[0.074]</td>
<td>[0.133]</td>
</tr>
<tr>
<td>Constant</td>
<td>0.035</td>
<td>0.847***</td>
</tr>
<tr>
<td></td>
<td>[0.172]</td>
<td>[0.311]</td>
</tr>
<tr>
<td>Observations</td>
<td>5,717</td>
<td>2,778</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.559</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***)
percent level. Self reported health is measured on a scale from 0 (worse
possible health) to 1 (perfect health).
### Table 3.21: Predictors of ART Take-up and Perfect Adherence

<table>
<thead>
<tr>
<th></th>
<th>(1) ART Perfect Adherence</th>
<th>(2) Perfect Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ART (t-1)</strong></td>
<td>0.853***</td>
<td>0.394***</td>
</tr>
<tr>
<td><strong>Perf. Adherence (t-1)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-0.007</td>
<td>-0.000</td>
</tr>
<tr>
<td>Age</td>
<td>0.000</td>
<td>0.005**</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.044**</td>
<td>0.068</td>
</tr>
<tr>
<td>Health (t-1)</td>
<td>0.056</td>
<td>0.168</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.004</td>
<td>0.036</td>
</tr>
<tr>
<td><strong>Round 5 Expectations:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P(die w/i 6mo) Perfect Adherence</td>
<td>-0.100</td>
<td>0.531*</td>
</tr>
<tr>
<td>P(die w/i 12mo) Perfect Adherence</td>
<td>0.036</td>
<td>0.026</td>
</tr>
<tr>
<td>P(die w/i 5yrs) Perfect Adherence</td>
<td>0.000</td>
<td>-0.272</td>
</tr>
<tr>
<td>P(worse health in 6mo) Perfect Adherence</td>
<td>0.076</td>
<td>0.192</td>
</tr>
<tr>
<td>P(nauseous w/i 6mo) Perfect Adherence</td>
<td>-0.139</td>
<td>-0.503*</td>
</tr>
<tr>
<td>P(fatigued w/i 6mo) Perfect Adherence</td>
<td>0.034</td>
<td>0.172</td>
</tr>
<tr>
<td>P(headaches w/i 6mo) Perfect Adherence</td>
<td>-0.010</td>
<td>-0.200</td>
</tr>
<tr>
<td>P(higher viral load in 6mo) Perfect Adherence</td>
<td>0.095</td>
<td>0.216</td>
</tr>
<tr>
<td>P(die w/i 6mo) &lt;95% Adherence</td>
<td>0.026</td>
<td>-0.039</td>
</tr>
<tr>
<td>P(die w/i 12mo) &lt;95% Adherence</td>
<td>-0.066</td>
<td>-0.084</td>
</tr>
<tr>
<td>P(die w/i 5yrs) &lt;95% Adherence</td>
<td>0.052</td>
<td>0.167</td>
</tr>
<tr>
<td>P(worse health in 6mo) &lt;95% Adherence</td>
<td>-0.131**</td>
<td>0.049</td>
</tr>
<tr>
<td>P(nauseous w/i 6mo) &lt;95% Adherence</td>
<td>0.119*</td>
<td>0.358**</td>
</tr>
<tr>
<td>P(fatigued w/i 6mo) &lt;95% Adherence</td>
<td>0.043</td>
<td>-0.024</td>
</tr>
<tr>
<td>P(headaches w/i 6mo) &lt;95% Adherence</td>
<td>0.057</td>
<td>-0.151</td>
</tr>
<tr>
<td>P(higher viral load in 6mo) &lt;95% Adherence</td>
<td>-0.050</td>
<td>-0.256*</td>
</tr>
<tr>
<td>P(die w/i 6mo) No ART</td>
<td>0.046</td>
<td>0.046</td>
</tr>
<tr>
<td>P(die w/i 12mo) No ART</td>
<td>-0.137*</td>
<td>-0.063</td>
</tr>
<tr>
<td>P(die w/i 5yrs) No ART</td>
<td>-0.011</td>
<td>-0.017</td>
</tr>
<tr>
<td>P(worse health in 6mo) No ART</td>
<td>0.009</td>
<td>0.007</td>
</tr>
<tr>
<td>P(nauseous w/i 6mo) No ART</td>
<td>0.046</td>
<td>-0.160</td>
</tr>
<tr>
<td>P(fatigued w/i 6mo) No ART</td>
<td>-0.127</td>
<td>0.068</td>
</tr>
<tr>
<td>P(headaches w/i 6mo) No ART</td>
<td>0.153**</td>
<td>0.118</td>
</tr>
<tr>
<td>P(higher viral load in 6mo) No ART</td>
<td>-0.002</td>
<td>0.021</td>
</tr>
<tr>
<td>Constant</td>
<td>0.051</td>
<td>0.107</td>
</tr>
<tr>
<td>Observations</td>
<td>510</td>
<td>443</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.812</td>
<td>0.221</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(*** percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table 3.22: Predictors of ART Take-up and Perfect Adherence (Learning)

<table>
<thead>
<tr>
<th></th>
<th>(1) ART Round 6</th>
<th>(2) Perfect Adherence Round 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART (t-1)</td>
<td>0.850***</td>
<td>0.409***</td>
</tr>
<tr>
<td>Perf. Adherence (t-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-0.004</td>
<td>-0.002</td>
</tr>
<tr>
<td>Age</td>
<td>-0.000</td>
<td>0.005**</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.044**</td>
<td>0.024</td>
</tr>
<tr>
<td>D - Health</td>
<td>-0.026</td>
<td>-0.044</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.010</td>
<td>0.065*</td>
</tr>
<tr>
<td>D - P(die w/i 6mo) Perfect Adherence</td>
<td>0.118</td>
<td>-0.273</td>
</tr>
<tr>
<td>D - P(die w/i 12mo) No ART</td>
<td>0.024</td>
<td>0.312***</td>
</tr>
<tr>
<td>D - P(die w/i 12mo) &lt;95% Adherence</td>
<td>-0.021</td>
<td>-0.068</td>
</tr>
<tr>
<td>D - P(die w/i 12mo) Perfect Adherence</td>
<td>-0.002</td>
<td>0.196</td>
</tr>
<tr>
<td>D - P(die w/i 5yrs) No ART</td>
<td>0.017</td>
<td>-0.249**</td>
</tr>
<tr>
<td>D - P(die w/i 5yrs) &lt;95% Adherence</td>
<td>-0.012</td>
<td>0.029</td>
</tr>
<tr>
<td>D - P(worse health in 6mo) No ART</td>
<td>0.004</td>
<td>-0.039</td>
</tr>
<tr>
<td>D - P(worse health in 6mo) &lt;95% Adherence</td>
<td>0.102**</td>
<td>-0.042</td>
</tr>
<tr>
<td>D - P(worse health in 6mo) Perfect Adherence</td>
<td>-0.059</td>
<td>-0.226</td>
</tr>
<tr>
<td>D - P(nauseous w/i 6mo) No ART</td>
<td>-0.041</td>
<td>-0.211</td>
</tr>
<tr>
<td>D - P(nauseous w/i 6mo) &lt;95% Adherence</td>
<td>-0.083</td>
<td>-0.169</td>
</tr>
<tr>
<td>D - P(nauseous w/i 6mo) Perfect Adherence</td>
<td>0.001</td>
<td>0.297</td>
</tr>
<tr>
<td>D - P(fatigued w/i 6mo) No ART</td>
<td>0.073</td>
<td>0.277</td>
</tr>
<tr>
<td>D - P(fatigued w/i 6mo) &lt;95% Adherence</td>
<td>-0.134**</td>
<td>0.194</td>
</tr>
<tr>
<td>D - P(fatigued w/i 6mo) Perfect Adherence</td>
<td>0.047</td>
<td>-0.014</td>
</tr>
<tr>
<td>D - P(headaches w/i 6mo) No ART</td>
<td>-0.034</td>
<td>-0.057</td>
</tr>
<tr>
<td>D - P(headaches w/i 6mo) &lt;95% Adherence</td>
<td>0.099*</td>
<td>0.015</td>
</tr>
<tr>
<td>D - P(headaches w/i 6mo) Perfect Adherence</td>
<td>-0.046</td>
<td>0.072</td>
</tr>
<tr>
<td>D - P(higher viral load in 6mo) No ART</td>
<td>-0.024</td>
<td>0.013</td>
</tr>
<tr>
<td>Constant</td>
<td>0.112***</td>
<td>0.244**</td>
</tr>
</tbody>
</table>

Observations | 506 | 443
R-squared    | 0.809 | 0.212

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***)) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
<table>
<thead>
<tr>
<th>Benefit (R6)</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6mo Mort.</td>
<td>-0.035</td>
<td>0.009</td>
</tr>
<tr>
<td>12mo Mort.</td>
<td>-0.062</td>
<td>-0.230</td>
</tr>
<tr>
<td>5yr Mort.</td>
<td>-0.028</td>
<td>0.201</td>
</tr>
<tr>
<td>Worse Health</td>
<td>0.126</td>
<td>-0.129</td>
</tr>
<tr>
<td>Fatigue</td>
<td>-0.081</td>
<td>0.275</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.126</td>
<td>-0.240</td>
</tr>
<tr>
<td>Nausea</td>
<td>-0.084</td>
<td>0.131</td>
</tr>
<tr>
<td>Viral Load</td>
<td>-0.021</td>
<td>-0.093</td>
</tr>
<tr>
<td><strong>Benefit Increased (Amt)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6mo Mort.</td>
<td>-0.003</td>
<td>-0.027</td>
</tr>
<tr>
<td>12mo Mort.</td>
<td>0.079</td>
<td>0.114</td>
</tr>
<tr>
<td>5yr Mort.</td>
<td>-0.005</td>
<td>-0.109</td>
</tr>
<tr>
<td>Worse Health</td>
<td>-0.083</td>
<td>0.042</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0.156**</td>
<td>0.046</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.130**</td>
<td>-0.004</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.003</td>
<td>-0.289*</td>
</tr>
<tr>
<td>Viral Load</td>
<td>0.016</td>
<td>0.249**</td>
</tr>
<tr>
<td>Taking ART (R5)</td>
<td>0.853***</td>
<td></td>
</tr>
<tr>
<td>Perfect Adherence (R5)</td>
<td></td>
<td>0.393***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.060</td>
<td>0.329*</td>
</tr>
</tbody>
</table>

| Observations | 477     | 425     |
| R-squared    | 0.805   | 0.226   |
| Mean         | 0.700   | 0.835   |

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

Also included in the analysis above, but not shown, are the following individual characteristics: sex, age, current self-reported health, past month self-reported health, whether the respondent completed primary school, if the respondent is muslim, if the respondent is married, if the respondent reported a higher discount rate in Round 6, the number of household members less than 18 years old, and if the respondent knows anyone who has died from HIV.
Development policies aimed at enhancing the health and welfare of impoverished populations through programs of increased access to goods and services thought to be helpful often overlook the complex decision-making process of a member of the targeted population. This thesis has provided evidence that targeted individuals often do not hold realistic expectations of the costs and benefits of the program (as in the case of adherence to anti-retroviral medications) and that the choices of participating individuals do not necessarily coincide with the outcomes desired of the policy makers (as in the case of the utilization of microcredit services).

4.1 Incorporating Expectations

Microfinance organizations have appeared in all corners of the developing world under the pretense that access to credit will improve welfare. The results from the second chapter of this dissertation suggest that merely providing access to credit may not improve all outcome measures, and that the causal impact of access to credit on financial outcomes is weaker than often assumed. Because of survey design, we cannot measure the influence of individual beliefs on observed financial decisions
and outcomes. Surveys studying microfinance interventions do not include questions about beliefs and expectations of the formal financial sector, however these data might provide important evidence as to why access to credit has a weaker effect on welfare outcomes as expected.

As researchers, we cannot observe the reasons behind which participants make decisions. In the second chapter of this dissertation we find that business creation and investment did not increase significantly in areas where credit was offered, despite a significant increase in borrowing. With the exception of an increase in schooling for some boys in Oromiya, there are few significant impacts of the increase in borrowing on welfare measures. While the study was not designed to elicit participant expectations, had expectations data been collected, we may have been able to draw a stronger conclusion as to why the households borrowed, and the benefits they expected to experience upon borrowing. The lack of impact may be driven by a disconnection between the goals of the microfinance institution and the welfare goals of the community members. While this first chapter can address the causal impact of the introduction of microcredit due to a randomized controlled trial design, it cannot address the decision making process of a participant once they become a borrower. In contrast, the third chapter of this thesis explores in great detail the beliefs and expectations of the target population, but cannot address the effectiveness of the policy of free medications directly on adherence rates.

4.2 Incorporating Randomized Design

Expectations are important predictors of adherence, both on the external margin (deciding whether to take ART) and on the internal margin (whether to perfectly adhere once taking ART). Expectations of mortality do not seem to play as large a role as potential side effects, a finding which may appear, but might be consistent
with the community-based culture in Tanzania. In addition, the perceived effectiveness of reducing viral load significantly increases the likelihood of taking ART, implying that respondents do prefer a more effective medication regimen, but that survival, alone, may not be the most important benefit.

These results come from a set of survey questions that asked the respondents to provide the likelihood of experiencing different side effects assuming differing levels of adherence to a medication regime. While the responses to these questions have provided a rich set of data and significant results, these results could easily be verified from direct questions asking respondents directly to describe the perceived costs and benefits of adhering. These direct questions were not included in the expectations module due to lack of space in the survey and because the results were unknown prior to constructing the questionnaire. Individuals make adherence choices consistent with wanting to avoid nausea and headaches, but that fatigue may be associated with effectiveness of the medication. Alternatively, it would be straightforward to design a set of survey questions that addressed these issues directly, such as “How do you know your medications are working?”, “Are you more likely to miss a dose if you think it will make you nauseous?”, “If you feel tired/nauseous/have headaches, are you less likely to take your medication?”, and “Do your medications make you feel tired/nauseous/give you headaches?”

In cases when a reason for imperfect adherence was given, forgetfulness was the most common response. There is a growing literature on helping patients remember their medications including regular reminders from the clinic. If it is the case that patients most commonly miss their doses because they forget, then there is scope for improving a system of reminders, in addition to collecting more information about commitment. Do patients view forgetfulness as a problem? If they do not, then they are essentially making a conscious choice not to take the medications. If patients are

1 Additional anecdotal evidence that this may be the case can be found in the appendix, Section B.
concerned with forgetfulness, then measures can be taken to overcome this barrier to adherence. Prior to beginning a randomized intervention, focus groups would need to identify what systems patients currently use to remember their medications, and what systems they can imagine that might be more effective. Hypothetical questions may be posed which elicit patients’ willingness to pay for treatment with different characteristics, such as method of dosing (pills vs. injections), timing of dosing (daily, weekly, monthly), and ease of procurement (number of times a clinic visit is necessary). Eliciting willingness to pay may be an extremely useful and interesting way to measure the usefulness of future health interventions.

Recent randomized control trials have evaluated the effectiveness of various programs to increase adherence to anti-retroviral medications with varying results (Rueda et al., 2009). Past interventions have targeted individuals vs. groups, included information sessions, supportive therapy sessions, motivational meetings, electronic reminders, and computerized medication planners. Results from these interventions are varied, and in need of future research to determine the most effective plan of action for a specific group of patients. Overall, the third chapter of this thesis provides evidence that patients may have significantly different expectations than researchers, and that aligning beliefs may be an important step in improving adherence.

In addition, the data used in the third chapter utilizes self-reports to measure adherence, a measure that is likely over-estimated, especially when respondents are asked to recall an average percent of adherence over the past month. Recent literature aims to tracks adherence more precisely, and analyzing data using more objective measures of adherence may produce significantly different results. Adherence is usually measured through self-reports (as in this study), pill count, electronic pill bottle caps (MEMS caps) and laboratory tests. Using a more object measure of adherence (not relying on patients’ recall) may produce dramatically different results that may be more applicable to the attitudes and behaviors of the study population.
4.3 Time Preference and Summary

In the short expectations section I was able to include four questions about time preference as it relates to health. This allowed me to construct a health discount rate to measure the patience of the respondents. As discussed in more detail in the appendix, Section B, preference for one’s own health may not be the outcome of concern for a respondent. A recurring theme from the focus group discussions was the concern for community and family over self. During a discussion of risk preference a woman explained to me that she would rather take any chance of death over the chance of disease or disability that would cause her to be a burden on her family and community. In the context of HIV in Moshi, Tanzania, death is not a fearful concept, and as such, conventional information campaigns which aim to educate patients on the mortality risks of not adhering, may not be successful. It may appear that individuals are impatient as it relates to their own health, but they may carry a distinctly different preference for the health and welfare of their families and communities. While unable to include additional questions in the expectations module, future work may focus on the dynastic preferences of an individual and how those preferences may coincide or conflict with individual well-being.

Dynamic risk taking and prospect theory play an important role in health and financial household decisions. Uncertainty in outcomes and unknown distributions of risk confound individual and household decisions, and further exploration of these factors will help to illuminate the complex motivating factors behind health and financial decision making both in Ethiopia and Tanzania, and sub-Saharan Africa as a whole.
A.1 Summary

Table A.1: Tanzania Health Statistics - 2010

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Expectancy at Birth</td>
<td>53</td>
</tr>
<tr>
<td>Healthy Life Expectancy at Birth</td>
<td>45</td>
</tr>
<tr>
<td>Neonatal Mortality</td>
<td>33</td>
</tr>
<tr>
<td>Infant Mortality</td>
<td>67</td>
</tr>
<tr>
<td>Under 5 Mortality</td>
<td>103</td>
</tr>
<tr>
<td>Adult Mortality</td>
<td>458</td>
</tr>
<tr>
<td>Cause Specific Mortality</td>
<td></td>
</tr>
<tr>
<td>HIV</td>
<td>237</td>
</tr>
<tr>
<td>Malaria</td>
<td>98</td>
</tr>
<tr>
<td>TB (HIV-)</td>
<td>13</td>
</tr>
<tr>
<td>HIV Prevalence (15-49)</td>
<td>6.2</td>
</tr>
<tr>
<td>ART Coverage (%)</td>
<td>31</td>
</tr>
<tr>
<td>Population (000)</td>
<td>42,484</td>
</tr>
<tr>
<td>% Living in urban areas</td>
<td>25</td>
</tr>
<tr>
<td>% Living on &lt;$1/day</td>
<td>88.5</td>
</tr>
</tbody>
</table>

Data from this table are taken from the World Health Organization, World Health Statistics 2010. Mortality statistics are per 1,000 population. Adult mortality displays the number of adults at age 15 that are not expected to live until age 60. Healthy life expectancy takes into account years lived in less than full health due to disease and/or injury.
## A.2 Attrition

### Table A.2: Cause of Death by Survey Round

<table>
<thead>
<tr>
<th>Survey Round</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>45 65%</td>
</tr>
<tr>
<td>3</td>
<td>10 14%</td>
</tr>
<tr>
<td>4</td>
<td>6 9%</td>
</tr>
<tr>
<td>5</td>
<td>1 1%</td>
</tr>
<tr>
<td>6</td>
<td>2 3%</td>
</tr>
<tr>
<td>Total</td>
<td>69 100%</td>
</tr>
</tbody>
</table>

### Table A.3: Attrition Analysis - Probit on Baseline Characteristics

**P(Completing all Interviews - All Respondents)**

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Through R6</th>
<th>Through R5</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV positive</td>
<td>0.518 0.638</td>
<td>0.561 0.636</td>
</tr>
<tr>
<td>HIV+ x Health</td>
<td>-0.341 -0.382</td>
<td>-1.024* -1.011*</td>
</tr>
<tr>
<td>HIV+ x Past Month Health</td>
<td>0.380 0.223</td>
<td>0.820 0.695</td>
</tr>
<tr>
<td>HIV+ x Married</td>
<td>-0.247 -0.220</td>
<td>0.041 0.122</td>
</tr>
<tr>
<td>HIV+ x Num. HH Members</td>
<td>-0.005 -0.004</td>
<td>-0.017 -0.022</td>
</tr>
<tr>
<td>HIV+ x Male</td>
<td>-0.207 -0.076</td>
<td>-0.174 -0.030</td>
</tr>
<tr>
<td>HIV+ x Muslim</td>
<td>-0.128 -0.136</td>
<td>-0.094 -0.107</td>
</tr>
<tr>
<td>HIV+ x Primary School</td>
<td>0.189 0.318</td>
<td>0.235 0.421**</td>
</tr>
<tr>
<td>Health (0-1)</td>
<td>-0.680 -0.760*</td>
<td>0.267 0.168</td>
</tr>
<tr>
<td>Health Past Month (0-1)</td>
<td>0.197 0.225</td>
<td>-0.015 0.016</td>
</tr>
<tr>
<td>Married</td>
<td>0.318** 0.299**</td>
<td>0.067 0.027</td>
</tr>
<tr>
<td>Num. HH Members</td>
<td>0.011 0.016</td>
<td>0.015 0.022</td>
</tr>
<tr>
<td>Male</td>
<td>-0.067 -0.072</td>
<td>-0.170 -0.182</td>
</tr>
<tr>
<td>Muslim</td>
<td>-0.024 -0.020</td>
<td>-0.052 -0.046</td>
</tr>
<tr>
<td>Age</td>
<td>0.015*** 0.016***</td>
<td>0.019*** 0.023***</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.032 -0.022</td>
<td>-0.202 -0.197</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.327 -0.311</td>
<td>-0.487 -0.495</td>
</tr>
</tbody>
</table>

Observations: 1,182 1,114 1,182 1,119
Mean of Dep. Var.: 0.553 0.587 0.673 0.711

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***)) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table A.4: Attrition Analysis - Probit on Baseline Characteristics
P(Completing all Interviews - HIV-positive only)

<table>
<thead>
<tr>
<th></th>
<th>Through R6</th>
<th>Through R5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Excluding Deaths</td>
</tr>
<tr>
<td>Perfect Adherence</td>
<td>-0.586*** -0.685***</td>
<td>-0.681*** -0.720***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>1.124*** 1.122***</td>
<td></td>
</tr>
<tr>
<td>Health (0-1)</td>
<td>-0.906 -0.733</td>
<td>-1.024 -0.763</td>
</tr>
<tr>
<td>Health Past Month (0-1)</td>
<td>-0.452 -0.668</td>
<td>-0.440 -0.643</td>
</tr>
<tr>
<td>Married</td>
<td>0.192 0.201</td>
<td>0.248 0.244</td>
</tr>
<tr>
<td>Num. HH Members</td>
<td>0.046 0.033</td>
<td>0.033 0.045</td>
</tr>
<tr>
<td>Male</td>
<td>-0.487*** -0.462***</td>
<td>-0.356** -0.327*</td>
</tr>
<tr>
<td>Muslim</td>
<td>-0.264 -0.157</td>
<td>-0.321* -0.239</td>
</tr>
<tr>
<td>Age</td>
<td>0.014 0.023**</td>
<td>0.014 0.022**</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.169 0.250</td>
<td>-0.268 0.199</td>
</tr>
<tr>
<td>Constant</td>
<td>0.330 0.090</td>
<td>1.792*** 1.748**</td>
</tr>
<tr>
<td>Observations</td>
<td>433 411</td>
<td>433 413</td>
</tr>
<tr>
<td>Mean of Dep. Var.</td>
<td>0.587 0.640</td>
<td>0.685 0.742</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***), percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

A.3 Adherence
<table>
<thead>
<tr>
<th>Survey Round</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>755</td>
<td>639</td>
<td>626</td>
<td>652</td>
<td>652</td>
<td>551</td>
</tr>
<tr>
<td>Taking any ART</td>
<td>431 (57%)</td>
<td>484 (76%)</td>
<td>489 (78%)</td>
<td>511 (78%)</td>
<td>525 (81%)</td>
<td>466 (85%)</td>
</tr>
<tr>
<td>Measures of Perfect Adherence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) % of time usually take each drug is 100</td>
<td>420 (97%)</td>
<td>451 (93%)</td>
<td>455 (93%)</td>
<td>475 (93%)</td>
<td>480 (91%)</td>
<td>422 (91%)</td>
</tr>
<tr>
<td>(2) Last time you missed any drug is never</td>
<td>397 (92%)</td>
<td>442 (91%)</td>
<td>456 (93%)</td>
<td>477 (93%)</td>
<td>520 (99%)</td>
<td>463 (99%)</td>
</tr>
<tr>
<td>(3) % of drugs taken is 100</td>
<td>409 (95%)</td>
<td>459 (95%)</td>
<td>452 (92%)</td>
<td>480 (94%)</td>
<td>482 (92%)</td>
<td>424 (91%)</td>
</tr>
<tr>
<td>(4) % of doses missed, forgotten, or skipped is 0</td>
<td>413 (96%)</td>
<td>459 (95%)</td>
<td>456 (93%)</td>
<td>475 (93%)</td>
<td>482 (92%)</td>
<td>424 (91%)</td>
</tr>
<tr>
<td>(5) % of time drugs taken early or late is 0</td>
<td>352 (82%)</td>
<td>405 (84%)</td>
<td>400 (82%)</td>
<td>408 (80%)</td>
<td>482 (92%)</td>
<td>424 (91%)</td>
</tr>
<tr>
<td>Satisfies (1) OR (2)-(5)</td>
<td>428 (99%)</td>
<td>469 (97%)</td>
<td>477 (98%)</td>
<td>501 (98%)</td>
<td>520 (99%)</td>
<td>463 (99%)</td>
</tr>
<tr>
<td>Satisfies (1) - (5)</td>
<td>322 (75%)</td>
<td>371 (77%)</td>
<td>374 (76%)</td>
<td>379 (74%)</td>
<td>427 (81%)</td>
<td>389 (83%)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>431</td>
<td>484</td>
<td>489</td>
<td>511</td>
<td>525</td>
<td>466</td>
</tr>
</tbody>
</table>
Table A.6: Adherence (by Round)

<table>
<thead>
<tr>
<th></th>
<th>Round 5</th>
<th>Round 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Taking ART</td>
<td>127 (19%)</td>
<td>85 (15%)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>652</td>
<td>551</td>
</tr>
<tr>
<td>Prescribed ART</td>
<td>14 (11%)</td>
<td>22 (26%)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>127</td>
<td>85</td>
</tr>
</tbody>
</table>

Table A.7: Reported Reasons for Non-adherence

<table>
<thead>
<tr>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conscious Choice</td>
</tr>
<tr>
<td>Improper Planning</td>
</tr>
<tr>
<td>Forgot</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Avoid side effects</td>
</tr>
<tr>
<td>Felt like drug was toxic</td>
</tr>
<tr>
<td>Felt sick from side effects</td>
</tr>
<tr>
<td>Felt good</td>
</tr>
<tr>
<td>Felt like the drug was unhelpful</td>
</tr>
<tr>
<td>Avoid stigma</td>
</tr>
<tr>
<td>Couldn’t deal with it that day</td>
</tr>
<tr>
<td>Felt depressed/overwhelmed</td>
</tr>
<tr>
<td>Had too many pills to take</td>
</tr>
<tr>
<td>Away from home</td>
</tr>
<tr>
<td>Busy with other things</td>
</tr>
<tr>
<td>Change in daily routine</td>
</tr>
<tr>
<td>Lost track of time</td>
</tr>
<tr>
<td>Ran out of pills</td>
</tr>
<tr>
<td>Couldn’t get to the pills</td>
</tr>
<tr>
<td>Simply forgot</td>
</tr>
<tr>
<td>Forgot if already taken</td>
</tr>
<tr>
<td>Slept through dose time</td>
</tr>
<tr>
<td>High on drugs or alcohol</td>
</tr>
<tr>
<td>Couldn’t afford pills</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Any other reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felt sick from side effects</td>
</tr>
<tr>
<td>Change in daily routine</td>
</tr>
<tr>
<td>Ran out of pills</td>
</tr>
<tr>
<td>Couldn’t get to the pills</td>
</tr>
<tr>
<td>Felt like drug was toxic</td>
</tr>
<tr>
<td>Busy with other things</td>
</tr>
<tr>
<td>Change in daily routine</td>
</tr>
<tr>
<td>Ran out of pills</td>
</tr>
<tr>
<td>Couldn’t get to the pills</td>
</tr>
<tr>
<td>Felt like drug was toxic</td>
</tr>
<tr>
<td>Busy with other things</td>
</tr>
<tr>
<td>Change in daily routine</td>
</tr>
<tr>
<td>Ran out of pills</td>
</tr>
<tr>
<td>Couldn’t get to the pills</td>
</tr>
</tbody>
</table>
### A.4 Expectations Distributions

#### Table A.8: Subjective Probability Distribution (Football)

<table>
<thead>
<tr>
<th>Round</th>
<th>Mean</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.20</td>
<td>0.00</td>
<td>0.10</td>
<td>0.30</td>
<td>636</td>
</tr>
<tr>
<td>Male</td>
<td>0.15</td>
<td>0.00</td>
<td>0.10</td>
<td>0.20</td>
<td>342</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.18</td>
<td>0.00</td>
<td>0.10</td>
<td>0.30</td>
<td>978</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round</th>
<th>Mean</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.22</td>
<td>0.00</td>
<td>0.20</td>
<td>0.40</td>
<td>514</td>
</tr>
<tr>
<td>Male</td>
<td>0.16</td>
<td>0.00</td>
<td>0.10</td>
<td>0.30</td>
<td>295</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.20</td>
<td>0.00</td>
<td>0.10</td>
<td>0.40</td>
<td>809</td>
</tr>
</tbody>
</table>

#### Table A.9: Subjective Probability Distribution (Going to market within the next)

<table>
<thead>
<tr>
<th>Round</th>
<th>2 days</th>
<th>2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>P25</td>
</tr>
<tr>
<td>Female</td>
<td>0.58</td>
<td>0.40</td>
</tr>
<tr>
<td>Male</td>
<td>0.38</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.51</td>
<td>0.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round</th>
<th>2 days</th>
<th>2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>P25</td>
</tr>
<tr>
<td>Female</td>
<td>0.52</td>
<td>0.40</td>
</tr>
<tr>
<td>Male</td>
<td>0.34</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.45</td>
<td>0.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round</th>
<th>2 days</th>
<th>2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>P25</td>
</tr>
<tr>
<td>Female</td>
<td>0.79</td>
<td>0.70</td>
</tr>
<tr>
<td>Male</td>
<td>0.53</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.70</td>
<td>0.60</td>
</tr>
</tbody>
</table>
Table A.10: Consistency in Comprehension Questions - Round 6

<table>
<thead>
<tr>
<th></th>
<th>(1) 2 weeks</th>
<th>(2) 2 weeks</th>
<th>(3) 2 weeks</th>
<th>Test of Equality between Columns:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 2 days</td>
<td>= 2 days</td>
<td>&gt; 2 days</td>
<td>(1) ≠ (2) (1) ≠ (3) (2) ≠ (3)</td>
</tr>
<tr>
<td>Male</td>
<td>0.20</td>
<td>0.55</td>
<td>0.31</td>
<td>(*** )</td>
</tr>
<tr>
<td>Age</td>
<td>40.7</td>
<td>41.7</td>
<td>42.7</td>
<td></td>
</tr>
<tr>
<td>HIV+</td>
<td>0.60</td>
<td>0.68</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Health (0-1)</td>
<td>0.86</td>
<td>0.81</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td># HH Members</td>
<td>6.2</td>
<td>4.46</td>
<td>4.56</td>
<td></td>
</tr>
<tr>
<td>Discount Factor</td>
<td>0.54</td>
<td>0.61</td>
<td>0.54</td>
<td>(**)</td>
</tr>
<tr>
<td>Primary School</td>
<td>0.20</td>
<td>0.23</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.60</td>
<td>0.47</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>0.00</td>
<td>0.18</td>
<td>0.25</td>
<td>(**)</td>
</tr>
<tr>
<td>N</td>
<td>5</td>
<td>173</td>
<td>649</td>
<td></td>
</tr>
</tbody>
</table>
Table A.11: Subjective Probability Distribution (Mortality within the next:)

<table>
<thead>
<tr>
<th></th>
<th>Perfect Adherence</th>
<th>&lt;95% Adherence</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
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<td></td>
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</tr>
<tr>
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<td>0.04</td>
<td>0.13</td>
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<td>0.05</td>
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<tr>
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<td>0.12</td>
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<td>0.01</td>
<td>0.09</td>
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<tr>
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<td>0.15</td>
<td>643</td>
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<tr>
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<td>0.12</td>
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</tr>
<tr>
<td>Male</td>
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<td>165</td>
</tr>
<tr>
<td>Total</td>
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<td>0.19</td>
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<td>191</td>
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<tr>
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<td>0.19</td>
<td>644</td>
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<td></td>
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</table>
Table A.12: Subjective Probability Distribution (Health Outcomes in 6 months)

### WORSE HEALTH

<table>
<thead>
<tr>
<th></th>
<th>Perfect Adherence</th>
<th>&lt;95% Adherence</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td><strong>Round 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.04</td>
<td>0.10</td>
<td>436</td>
</tr>
<tr>
<td>Male</td>
<td>0.05</td>
<td>0.12</td>
<td>185</td>
</tr>
<tr>
<td>Total</td>
<td>0.04</td>
<td>0.11</td>
<td>621</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.02</td>
<td>0.11</td>
<td>372</td>
</tr>
<tr>
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<td>0.02</td>
<td>0.11</td>
<td>161</td>
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<tr>
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<td>0.11</td>
<td>533</td>
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</table>

### NAUSEA

<table>
<thead>
<tr>
<th></th>
<th>Perfect Adherence</th>
<th>&lt;95% Adherence</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>SD</td>
<td>N</td>
</tr>
<tr>
<td><strong>Round 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td>Total</td>
<td>0.06</td>
<td>0.11</td>
<td>621</td>
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<tr>
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<td>0.03</td>
<td>0.11</td>
<td>372</td>
</tr>
<tr>
<td>Male</td>
<td>0.03</td>
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<td>161</td>
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<tr>
<td>Total</td>
<td>0.03</td>
<td>0.11</td>
<td>533</td>
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</table>

### FATIGUE

<table>
<thead>
<tr>
<th></th>
<th>Perfect Adherence</th>
<th>&lt;95% Adherence</th>
<th>No ART</th>
</tr>
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<tbody>
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<td></td>
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<td>SD</td>
<td>N</td>
</tr>
<tr>
<td><strong>Round 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.09</td>
<td>0.16</td>
<td>436</td>
</tr>
<tr>
<td>Male</td>
<td>0.12</td>
<td>0.17</td>
<td>185</td>
</tr>
<tr>
<td>Total</td>
<td>0.10</td>
<td>0.16</td>
<td>621</td>
</tr>
<tr>
<td><strong>Round 6</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.05</td>
<td>0.14</td>
<td>372</td>
</tr>
<tr>
<td>Male</td>
<td>0.06</td>
<td>0.15</td>
<td>161</td>
</tr>
<tr>
<td>Total</td>
<td>0.05</td>
<td>0.14</td>
<td>533</td>
</tr>
</tbody>
</table>

### HEADACHES

<table>
<thead>
<tr>
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<th>Perfect Adherence</th>
<th>&lt;95% Adherence</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
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<td>SD</td>
<td>N</td>
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<tr>
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<td></td>
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<tr>
<td>Female</td>
<td>0.10</td>
<td>0.17</td>
<td>436</td>
</tr>
<tr>
<td>Male</td>
<td>0.12</td>
<td>0.17</td>
<td>185</td>
</tr>
<tr>
<td>Total</td>
<td>0.11</td>
<td>0.17</td>
<td>621</td>
</tr>
<tr>
<td><strong>Round 6</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Female</td>
<td>0.05</td>
<td>0.13</td>
<td>372</td>
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<tr>
<td>Male</td>
<td>0.06</td>
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</tr>
<tr>
<td>Total</td>
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<td>0.14</td>
<td>533</td>
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### HIGHER VIRAL LOAD

<table>
<thead>
<tr>
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<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>SD</td>
<td>N</td>
</tr>
<tr>
<td><strong>Round 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.03</td>
<td>0.11</td>
<td>436</td>
</tr>
<tr>
<td>Male</td>
<td>0.04</td>
<td>0.12</td>
<td>185</td>
</tr>
<tr>
<td>Total</td>
<td>0.03</td>
<td>0.11</td>
<td>621</td>
</tr>
<tr>
<td><strong>Round 6</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.03</td>
<td>0.13</td>
<td>372</td>
</tr>
<tr>
<td>Male</td>
<td>0.03</td>
<td>0.14</td>
<td>161</td>
</tr>
<tr>
<td>Total</td>
<td>0.03</td>
<td>0.13</td>
<td>533</td>
</tr>
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</table>
Table A.13: Subjective Expectations of HIV-negative Cohort

<table>
<thead>
<tr>
<th></th>
<th>Round 5</th>
<th></th>
<th>Round 6</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>P(die 6 mo)</td>
<td>0.28</td>
<td>0.32</td>
<td>0.33</td>
<td>0.39</td>
</tr>
<tr>
<td>P(die 12 mo)</td>
<td>0.29</td>
<td>0.33</td>
<td>0.34</td>
<td>0.40</td>
</tr>
<tr>
<td>P(die 5 yrs)</td>
<td>0.32</td>
<td>0.34</td>
<td>0.35</td>
<td>0.41</td>
</tr>
<tr>
<td>P(worse health)</td>
<td>0.30</td>
<td>0.33</td>
<td>0.33</td>
<td>0.38</td>
</tr>
<tr>
<td>P(nauseous)</td>
<td>0.25</td>
<td>0.29</td>
<td>0.26</td>
<td>0.32</td>
</tr>
<tr>
<td>P(fatigued)</td>
<td>0.42</td>
<td>0.46</td>
<td>0.48</td>
<td>0.53</td>
</tr>
<tr>
<td>P(headache)</td>
<td>0.40</td>
<td>0.42</td>
<td>0.39</td>
<td>0.50</td>
</tr>
<tr>
<td>N</td>
<td>155</td>
<td>193</td>
<td>132</td>
<td>145</td>
</tr>
</tbody>
</table>

A.5 Accuracy of Beliefs

Table A.14: Actual minus Predicted Outcomes  
P(Nausea) conditional of Round 5 and Round 6 choices

<table>
<thead>
<tr>
<th>Round 6 Adherence</th>
<th>Perfect</th>
<th>&lt; 95%</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>0.11</td>
<td>-0.27</td>
<td>-0.60</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>338</td>
<td>36</td>
<td>1</td>
</tr>
<tr>
<td>&lt; 95%</td>
<td>0.14</td>
<td>-0.32</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.00)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>40</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>No ART</td>
<td>0.49</td>
<td>0.80</td>
<td>-0.27</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>-</td>
<td>(0.00)</td>
</tr>
<tr>
<td>N</td>
<td>7</td>
<td>1</td>
<td>77</td>
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</tbody>
</table>
Table A.15: Actual minus Predicted Outcomes
\( P(\text{Fatigue}) \) conditional of Round 5 and Round 6 choices

<table>
<thead>
<tr>
<th>Round 5 Adherence</th>
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<th>&lt; 95%</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>0.52</td>
<td>0.08</td>
<td>-0.60</td>
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<tr>
<td></td>
<td>(0.00)</td>
<td>(0.33)</td>
<td></td>
</tr>
<tr>
<td>N</td>
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<td>1</td>
</tr>
<tr>
<td>&lt; 95%</td>
<td>0.67</td>
<td>0.03</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.77)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>40</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>No ART</td>
<td>0.47</td>
<td>-0.30</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td></td>
<td>(0.49)</td>
</tr>
<tr>
<td>N</td>
<td>7</td>
<td>1</td>
<td>77</td>
</tr>
</tbody>
</table>

Null hypothesis that the difference between predicted and actual outcomes is zero is represented by the p-value in parentheses. Note that because the values are actual minus expected that positive numbers represent underestimates and negative numbers represent overestimates.
Table A.16: Actual minus Predicted Outcomes

\( P(\text{Headaches}) \) conditional of Round 5 and Round 6 choices

<table>
<thead>
<tr>
<th>Round 6 Adherence</th>
<th>Perfect</th>
<th>&lt; 95%</th>
<th>No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>0.19</td>
<td>-0.25</td>
<td>-0.70</td>
</tr>
<tr>
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<td>(0.00)</td>
<td>(0.01)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>N=338</td>
<td>N=36</td>
<td>N=1</td>
</tr>
<tr>
<td>&lt; 95%</td>
<td>0.06</td>
<td>-0.34</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(0.00)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>N=40</td>
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<td>N=3</td>
</tr>
<tr>
<td>No ART</td>
<td>0.17</td>
<td>-0.40</td>
<td>-0.15</td>
</tr>
<tr>
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<td>(0.30)</td>
<td></td>
<td>(0.07)</td>
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<tr>
<td></td>
<td>N=7</td>
<td>N=1</td>
<td>N=77</td>
</tr>
</tbody>
</table>

Null hypothesis that the difference between predicted and actual outcomes is zero is represented by the p-value in parentheses. Note that because the values are actual minus expected that positive numbers represent underestimates and negative numbers represent overestimates.
A.6 Discount Rates

Round 6

![Discount Factor Tree]

**Figure A.1:** Discount Factor Tree

![Distribution of Elicited Discount Factors]

**Figure A.2:** Distribution of Elicited Discount Factors

Higher discount factor (closer to 1) indicates greater patience.
Round 6

Figure A.3: Mean of Elicited Discount Factors by Sex, Age, and HIV status

Table A.17: Average Discount Factors - Round 6

<table>
<thead>
<tr>
<th>Age 20-29</th>
<th>Female</th>
<th>Male</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV-</td>
<td>0.74</td>
<td>0.66</td>
<td>0.08</td>
</tr>
<tr>
<td>HIV+</td>
<td>0.36</td>
<td>0.27</td>
<td>0.09</td>
</tr>
<tr>
<td>Diff</td>
<td>0.38***</td>
<td>0.39**</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 30-39</th>
<th>Female</th>
<th>Male</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV-</td>
<td>0.78</td>
<td>0.68</td>
<td>0.09</td>
</tr>
<tr>
<td>HIV+</td>
<td>0.38</td>
<td>0.49</td>
<td>-0.12</td>
</tr>
<tr>
<td>Diff</td>
<td>0.40***</td>
<td>0.19**</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 40-49</th>
<th>Female</th>
<th>Male</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV-</td>
<td>0.73</td>
<td>0.70</td>
<td>0.03</td>
</tr>
<tr>
<td>HIV+</td>
<td>0.49</td>
<td>0.51</td>
<td>-0.02</td>
</tr>
<tr>
<td>Diff</td>
<td>0.24***</td>
<td>0.19**</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 50 plus</th>
<th>Female</th>
<th>Male</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV-</td>
<td>0.85</td>
<td>0.79</td>
<td>0.06</td>
</tr>
<tr>
<td>HIV+</td>
<td>0.45</td>
<td>0.50</td>
<td>-0.05</td>
</tr>
<tr>
<td>Diff</td>
<td>0.40***</td>
<td>0.29***</td>
<td></td>
</tr>
</tbody>
</table>

Asterisks denote significant differences between groups at the 10 (*), 5 (**), and 1 (***%) percent level.
## A.7 Predictors of Expectations

### Table A.18: Predictors of Round 5 Expectations

<table>
<thead>
<tr>
<th>Probability of Death within the next <strong>12 months</strong></th>
<th>(1) Assume Perfect Adherence</th>
<th>(2) Assume 95% Adherence</th>
<th>(3) Assume No ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect Past Adherence</td>
<td>0.035</td>
<td>0.031</td>
<td>0.202***</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>0.011</td>
<td>-0.094</td>
<td>-0.011</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.021</td>
<td>0.030</td>
<td>0.055</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.101***</td>
<td>-0.002</td>
<td>-0.129</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.005</td>
<td>-0.067</td>
<td>0.127</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Nausea</td>
<td>0.003</td>
<td>0.018</td>
<td>-0.032</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Headaches</td>
<td>0.048</td>
<td>-0.008</td>
<td>0.068</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Fatigue</td>
<td>-0.036</td>
<td>0.103</td>
<td>0.062</td>
</tr>
<tr>
<td>Nausea</td>
<td>-0.008</td>
<td>0.057</td>
<td>-0.009</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.026</td>
<td>-0.023</td>
<td>-0.072</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.095***</td>
<td>-0.000</td>
<td>0.082</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001</td>
<td>0.001</td>
<td>-0.000</td>
</tr>
<tr>
<td>Male</td>
<td>0.021</td>
<td>0.037</td>
<td>0.007</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.012</td>
<td>-0.050**</td>
<td>-0.067***</td>
</tr>
<tr>
<td>Married</td>
<td>-0.003</td>
<td>0.013</td>
<td>0.023</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.001</td>
<td>-0.006</td>
<td>-0.003</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.002**</td>
<td>0.002**</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.092</td>
<td>-0.013</td>
<td>0.185</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>0.000</td>
<td>0.123***</td>
<td>0.097***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.003</td>
<td>0.171***</td>
<td>0.013</td>
</tr>
<tr>
<td>Constant</td>
<td>0.138**</td>
<td>0.294**</td>
<td>0.381***</td>
</tr>
<tr>
<td>Observations</td>
<td>576</td>
<td>568</td>
<td>567</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.044</td>
<td>0.141</td>
<td>0.108</td>
</tr>
<tr>
<td>Mean</td>
<td>0.065</td>
<td>0.487</td>
<td>0.693</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table A.19: Predictors of Round 5 Expectations

Probability of Death within the next 5 years

<table>
<thead>
<tr>
<th>Predictor</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume Perfect Adherence</td>
<td>0.076**</td>
<td>0.053</td>
<td>0.194***</td>
</tr>
<tr>
<td>Assume Less than Perfect Adherence</td>
<td>0.014</td>
<td>-0.019</td>
<td>-0.030</td>
</tr>
<tr>
<td>Assume No ART</td>
<td>0.007</td>
<td>0.009</td>
<td>0.081</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.131***</td>
<td>-0.020</td>
<td>-0.109</td>
</tr>
<tr>
<td>&lt;95% Past Adherence</td>
<td>-0.001</td>
<td>-0.022</td>
<td>0.139**</td>
</tr>
<tr>
<td>&lt;95% Adherence x Nausea</td>
<td>0.042</td>
<td>-0.101</td>
<td>-0.053</td>
</tr>
<tr>
<td>&lt;95% Adherence x Headaches</td>
<td>0.022</td>
<td>-0.041</td>
<td>0.049</td>
</tr>
<tr>
<td>&lt;95% Adherence x Fatigue</td>
<td>-0.002</td>
<td>0.141</td>
<td>0.040</td>
</tr>
<tr>
<td>Nausea</td>
<td>-0.015</td>
<td>0.013</td>
<td>-0.001</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.004</td>
<td>0.015</td>
<td>-0.062</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.109**</td>
<td>0.015</td>
<td>0.073</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001</td>
<td>0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td>Male</td>
<td>0.026</td>
<td>0.033</td>
<td>0.023</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.005</td>
<td>-0.073***</td>
<td>-0.081***</td>
</tr>
<tr>
<td>Married</td>
<td>-0.001</td>
<td>0.018</td>
<td>0.004</td>
</tr>
<tr>
<td>Number of household members</td>
<td>0.003</td>
<td>-0.008</td>
<td>-0.001</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.001</td>
<td>0.001*</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.117</td>
<td>-0.003</td>
<td>0.193*</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>0.018</td>
<td>0.082**</td>
<td>0.083***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.013</td>
<td>0.229***</td>
<td>0.029</td>
</tr>
<tr>
<td>Constant</td>
<td>0.120</td>
<td>0.371***</td>
<td>0.508***</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table A.20: Predictors of Round 5 Expectations

Probability of **Worse Health** in 6 months

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect Past Adherence</td>
<td>0.028</td>
<td>0.146**</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.026</td>
<td>0.023</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.037</td>
<td>0.031</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.010</td>
<td>-0.144</td>
</tr>
<tr>
<td>&lt;95% Past Adherence</td>
<td>0.008</td>
<td>0.003</td>
</tr>
<tr>
<td>&lt;95% Adherence x Nausea</td>
<td>-0.016</td>
<td>0.030</td>
</tr>
<tr>
<td>&lt;95% Adherence x Headaches</td>
<td>0.055</td>
<td>0.147</td>
</tr>
<tr>
<td>&lt;95% Adherence x Fatigue</td>
<td>0.028</td>
<td>0.061</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.020</td>
<td>-0.057</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.026</td>
<td>-0.115</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.007</td>
<td>0.160*</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001**</td>
<td>-0.001</td>
</tr>
<tr>
<td>Male</td>
<td>0.011</td>
<td>0.023</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.020**</td>
<td>-0.053**</td>
</tr>
<tr>
<td>Married</td>
<td>0.010</td>
<td>0.022</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.000</td>
<td>0.002</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.001</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.094**</td>
<td>-0.024</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>-0.002</td>
<td>0.113***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>-0.013</td>
<td>0.124***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.133***</td>
<td>0.325**</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
<table>
<thead>
<tr>
<th>Predictor</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect Past Adherence</td>
<td>0.055</td>
<td>0.115*</td>
<td>0.135**</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.043</td>
<td>-0.014</td>
<td>-0.034</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.065</td>
<td>0.054</td>
<td>0.014</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.024</td>
<td>-0.132*</td>
<td>-0.041</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.048</td>
<td>0.011</td>
<td>0.117</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Nausea</td>
<td>-0.044</td>
<td>-0.019</td>
<td>-0.053</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Headaches</td>
<td>0.106**</td>
<td>0.126</td>
<td>0.145</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Fatigue</td>
<td>-0.006</td>
<td>0.019</td>
<td>0.050</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.032</td>
<td>-0.005</td>
<td>-0.017</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.069*</td>
<td>-0.119</td>
<td>-0.091</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.051</td>
<td>0.136*</td>
<td>0.063</td>
</tr>
<tr>
<td>Age</td>
<td>-0.002***</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td>Male</td>
<td>0.015</td>
<td>-0.003</td>
<td>-0.004</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.004</td>
<td>-0.051**</td>
<td>-0.068***</td>
</tr>
<tr>
<td>Married</td>
<td>0.013</td>
<td>0.036</td>
<td>0.037</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.000</td>
<td>-0.002</td>
<td>0.000</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.002**</td>
<td>0.002*</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.178***</td>
<td>0.085</td>
<td>0.212*</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>0.018</td>
<td>0.118***</td>
<td>0.113***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.035**</td>
<td>0.145***</td>
<td>-0.044</td>
</tr>
<tr>
<td>Constant</td>
<td>0.218***</td>
<td>0.331***</td>
<td>0.456***</td>
</tr>
<tr>
<td>Observations</td>
<td>568</td>
<td>568</td>
<td>567</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.081</td>
<td>0.145</td>
<td>0.118</td>
</tr>
<tr>
<td>Mean</td>
<td>0.101</td>
<td>0.576</td>
<td>0.696</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table A.22: Predictors of Round 5 Expectations

Probability of Having **Headaches** within 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume Perfect Adherence</td>
<td>Assume Less than 95% Adherence</td>
<td>Assume No ART</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.064*</td>
<td>0.111*</td>
<td>0.163***</td>
</tr>
<tr>
<td>Perfect Adherence x Nausea</td>
<td>-0.038</td>
<td>0.008</td>
<td>-0.036</td>
</tr>
<tr>
<td>Perfect Adherence x Headaches</td>
<td>0.029</td>
<td>0.036</td>
<td>-0.045</td>
</tr>
<tr>
<td>Perfect Adherence x Fatigue</td>
<td>-0.039</td>
<td>-0.128*</td>
<td>-0.067</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.039</td>
<td>0.034</td>
<td>0.084</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Nausea</td>
<td>-0.004</td>
<td>0.012</td>
<td>-0.016</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Headaches</td>
<td>0.105*</td>
<td>0.108</td>
<td>0.088</td>
</tr>
<tr>
<td>&lt;95 % Adherence x Fatigue</td>
<td>-0.024</td>
<td>-0.005</td>
<td>0.043</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.014</td>
<td>-0.022</td>
<td>-0.008</td>
</tr>
<tr>
<td>Headaches</td>
<td>-0.046</td>
<td>-0.091</td>
<td>-0.023</td>
</tr>
<tr>
<td>Fatigued</td>
<td>0.063</td>
<td>0.133*</td>
<td>0.073</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001*</td>
<td>-0.001</td>
<td>-0.000</td>
</tr>
<tr>
<td>Male</td>
<td>0.012</td>
<td>-0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>-0.022*</td>
<td>-0.078***</td>
<td>-0.073***</td>
</tr>
<tr>
<td>Married</td>
<td>0.007</td>
<td>0.033</td>
<td>0.035</td>
</tr>
<tr>
<td>Number of household members</td>
<td>0.002</td>
<td>-0.000</td>
<td>-0.001</td>
</tr>
<tr>
<td>Distance to clinic (km)</td>
<td>-0.000</td>
<td>0.002*</td>
<td>0.002*</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.157**</td>
<td>0.079</td>
<td>0.274***</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>0.013</td>
<td>0.099***</td>
<td>0.111***</td>
</tr>
<tr>
<td>Clinic Cohort</td>
<td>0.047***</td>
<td>0.133***</td>
<td>-0.031</td>
</tr>
<tr>
<td>Constant</td>
<td>0.171**</td>
<td>0.365***</td>
<td>0.406***</td>
</tr>
</tbody>
</table>

Observations: 568 568 567
R-squared: 0.081 0.133 0.118
Mean: 0.107 0.596 0.722

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

148
### Table A.23: Updating Expectations
**Probability of Death within 12 months**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume Perfect Adherence</td>
<td>Assume Less than 95% Adherence</td>
<td>Assume No ART</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>0.071</td>
<td>-0.048</td>
<td>0.210*</td>
</tr>
<tr>
<td>Prior x &lt;95% Adherence</td>
<td>-0.025</td>
<td>-0.017</td>
<td>0.253*</td>
</tr>
<tr>
<td>Prior</td>
<td>-0.026</td>
<td>0.256*</td>
<td>0.129</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.003</td>
<td>-0.007</td>
<td>-0.090</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.018</td>
<td>0.044</td>
<td>-0.136</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.105**</td>
<td>-0.083</td>
<td>0.236**</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.007</td>
<td>0.001</td>
<td>0.017</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.014</td>
<td>-0.064**</td>
<td>-0.070***</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.007</td>
<td>0.086***</td>
<td>0.059***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.086*</td>
<td>0.235</td>
<td>0.304**</td>
</tr>
<tr>
<td>Observations</td>
<td>478</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.043</td>
<td>0.210</td>
<td>0.373</td>
</tr>
<tr>
<td>Mean</td>
<td>0.027</td>
<td>0.477</td>
<td>0.745</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

### Table A.24: Updating Expectations
**Probability of Death within 5 years**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume Perfect Adherence</td>
<td>Assume Less than 95% Adherence</td>
<td>Assume No ART</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>0.020</td>
<td>0.040</td>
<td>0.130</td>
</tr>
<tr>
<td>Prior x &lt;95% Adherence</td>
<td>-0.189</td>
<td>-0.013</td>
<td>0.055</td>
</tr>
<tr>
<td>Prior</td>
<td>0.046</td>
<td>0.167</td>
<td>-0.057</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>-0.012</td>
<td>0.013</td>
<td>-0.052</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.044</td>
<td>0.069</td>
<td>0.033</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.219***</td>
<td>0.055</td>
<td>0.071</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.018</td>
<td>0.013</td>
<td>0.019</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.040**</td>
<td>-0.058**</td>
<td>-0.031*</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.004</td>
<td>0.094***</td>
<td>0.023</td>
</tr>
<tr>
<td>Constant</td>
<td>0.262***</td>
<td>0.208</td>
<td>0.714***</td>
</tr>
<tr>
<td>Observations</td>
<td>478</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.104</td>
<td>0.286</td>
<td>0.153</td>
</tr>
<tr>
<td>Mean</td>
<td>0.057</td>
<td>0.676</td>
<td>0.884</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***) percent level. Self-reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table A.25: Updating Expectations
Probability of **Worse Health** in 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume</td>
<td>Assume</td>
<td>Assume</td>
</tr>
<tr>
<td></td>
<td>Perfect Adherence</td>
<td>Less than Perfect Adherence</td>
<td>95% Adherence</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>-0.104</td>
<td>0.010</td>
<td>0.068</td>
</tr>
<tr>
<td>Prior &lt;95% Adherence</td>
<td>0.256</td>
<td>0.036</td>
<td>-0.007</td>
</tr>
<tr>
<td>Prior</td>
<td>0.077</td>
<td>0.302***</td>
<td>0.351***</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.015</td>
<td>-0.006</td>
<td>-0.043</td>
</tr>
<tr>
<td>&lt;95% Past Adherence</td>
<td>0.006</td>
<td>0.009</td>
<td>0.029</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.139****</td>
<td>0.163</td>
<td>0.305***</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.004</td>
<td>0.014</td>
<td>0.039</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.007</td>
<td>-0.023</td>
<td>-0.064***</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.013</td>
<td>0.080***</td>
<td>0.069***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.120***</td>
<td>0.022</td>
<td>0.061</td>
</tr>
<tr>
<td>Observations</td>
<td>473</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.071</td>
<td>0.405</td>
<td>0.494</td>
</tr>
<tr>
<td>Mean</td>
<td>0.023</td>
<td>0.547</td>
<td>0.679</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

Table A.26: Updating Expectations
Probability of Having **Headaches** within 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume</td>
<td>Assume</td>
<td>Assume</td>
</tr>
<tr>
<td></td>
<td>Perfect Adherence</td>
<td>Less than Perfect Adherence</td>
<td>95% Adherence</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>0.005</td>
<td>0.023</td>
<td>-0.091</td>
</tr>
<tr>
<td>Prior &lt;95% Adherence</td>
<td>0.105</td>
<td>0.060</td>
<td>-0.123</td>
</tr>
<tr>
<td>Prior</td>
<td>0.089</td>
<td>0.164</td>
<td>0.249***</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.023</td>
<td>-0.001</td>
<td>0.084</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.015</td>
<td>-0.029</td>
<td>0.116</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.241****</td>
<td>0.189**</td>
<td>0.303***</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.017</td>
<td>0.017</td>
<td>0.032</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.004</td>
<td>-0.001</td>
<td>-0.004</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.000</td>
<td>0.065***</td>
<td>0.041**</td>
</tr>
<tr>
<td>Constant</td>
<td>0.191***</td>
<td>0.265**</td>
<td>0.235**</td>
</tr>
<tr>
<td>Observations</td>
<td>473</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.105</td>
<td>0.274</td>
<td>0.307</td>
</tr>
<tr>
<td>Mean</td>
<td>0.052</td>
<td>0.683</td>
<td>0.816</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
Table A.27: Updating Expectations
Probability of **Higher Viral Load** in 6 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assume</td>
<td>Less than</td>
<td>Assume</td>
</tr>
<tr>
<td></td>
<td>Perfect Adherence</td>
<td>95% Adherence</td>
<td>No ART</td>
</tr>
<tr>
<td>Prior x Perf Adherence</td>
<td>-0.063</td>
<td>-0.032</td>
<td>-0.062</td>
</tr>
<tr>
<td>Prior x &lt;95% Adherence</td>
<td>-0.025</td>
<td>0.079</td>
<td>-0.137</td>
</tr>
<tr>
<td>Prior</td>
<td>0.021</td>
<td>0.188*</td>
<td>0.088</td>
</tr>
<tr>
<td>Perfect Past Adherence</td>
<td>0.016</td>
<td>0.025</td>
<td>0.043</td>
</tr>
<tr>
<td>&lt;95 % Past Adherence</td>
<td>0.030</td>
<td>-0.105</td>
<td>0.123</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>-0.264***</td>
<td>0.305***</td>
<td>0.252***</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.003</td>
<td>0.002</td>
<td>0.010</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.001</td>
<td>0.020</td>
<td>-0.002</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.018</td>
<td>0.074***</td>
<td>0.052***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.260***</td>
<td>0.156</td>
<td>0.520***</td>
</tr>
<tr>
<td>Observations</td>
<td>473</td>
<td>473</td>
<td>472</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.068</td>
<td>0.271</td>
<td>0.158</td>
</tr>
<tr>
<td>Mean</td>
<td>0.029</td>
<td>0.784</td>
<td>0.896</td>
</tr>
</tbody>
</table>

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***%) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).

Table A.28: Static Model Estimation
Cost in Hours

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Clinic Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>SE</td>
</tr>
<tr>
<td><strong>Round 5</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δu for 6 month mortality</td>
<td>-0.71</td>
<td>0.39</td>
</tr>
<tr>
<td>Δu for worse health</td>
<td>1.39</td>
<td>0.71</td>
</tr>
<tr>
<td>Δu for fatigue</td>
<td>1.41</td>
<td>0.96</td>
</tr>
<tr>
<td>Δu for headaches</td>
<td>-1.31</td>
<td>0.71</td>
</tr>
<tr>
<td>Δu for nausea</td>
<td>-2.13</td>
<td>1.07</td>
</tr>
<tr>
<td>α - cost of adhering*</td>
<td>-0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>N</td>
<td>573</td>
<td></td>
</tr>
<tr>
<td><strong>Round 6</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δu for 6 month mortality</td>
<td>-1.05</td>
<td>0.59</td>
</tr>
<tr>
<td>Δu for worse health</td>
<td>-0.18</td>
<td>0.88</td>
</tr>
<tr>
<td>Δu for fatigue</td>
<td>1.59</td>
<td>1.47</td>
</tr>
<tr>
<td>Δu for headaches</td>
<td>-3.44</td>
<td>1.14</td>
</tr>
<tr>
<td>Δu for nausea</td>
<td>1.66</td>
<td>1.28</td>
</tr>
<tr>
<td>α - cost of adhering*</td>
<td>-0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>N</td>
<td>491</td>
<td></td>
</tr>
</tbody>
</table>
## A.9 Population Transition Probabilities

<table>
<thead>
<tr>
<th>Round 5</th>
<th>Round 4 Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No ART</td>
</tr>
<tr>
<td>P(Worse Health)</td>
<td>0.34</td>
</tr>
<tr>
<td>P(Fatigued)</td>
<td>0.57</td>
</tr>
<tr>
<td>P(Headaches)</td>
<td>0.40</td>
</tr>
<tr>
<td>P(Nauseous)</td>
<td>0.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round 6</th>
<th>Round 5 Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No ART</td>
</tr>
<tr>
<td>P(Worse Health)</td>
<td>0.19</td>
</tr>
<tr>
<td>P(Fatigued)</td>
<td>0.57</td>
</tr>
<tr>
<td>P(Headaches)</td>
<td>0.44</td>
</tr>
<tr>
<td>P(Nauseous)</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Appendix B

CHAT: Survey Construction and Focus Group Discussions

Delavande et al. (2011) suggest a method which elicits an entire distribution of several possible future states using 10 beans on a plate, and asking the respondents to choose the number of beans that corresponds to the probability of an event occurring.

While this method is straightforward and easy to implement, the existing CHAT survey utilized a laminated paper scale, where the respondents had been asked (repeatedly over the previous four rounds of data collection) to rate their overall health, percent of HIV medication taken and percent of HIV medication missed or taken late. Because the respondents were already familiar with linking the laminated scale with percentages, the same scale was used when they were asked about probabilistic expectations.

Because correct translation and interpretation of survey questions is necessary in order to assure meaningful responses, probabilistic expectations questions, in particular, need to be validated in the field. In August of 2010 I spent 2 weeks in Moshi, Tanzania at the project site with the project manager (and my personal translator),
Bernard Agala (Berny, hereafter), conducting focus groups. Prior to arriving, I had prepared a draft of the survey module including questions and phrasing that I believed would elicit thoughtful and meaningful responses. There were a total of 18 HIV-positive participants, divided into three focus groups held on separate days. A group of six was determined to be an appropriate size that would be small enough to create a safe and comfortable environment to encourage conversation, but large enough to observe heterogeneous reactions and perspectives. In each of the groups there were four women and two men, mimicking the gender composition of the existing CHAT participants. They were told to be prepared to stay the entire day and were given lunch in addition to monetary compensation for their time and travel costs.

In order to increase efficiency, the translation was done instantaneously, with Berny translating and back translating between me and the participants. I began with the first draft of the module I had written, and proceeded to have Berny ask the questions of the group. He would translate their responses for me, and I would take notes. Then, I would have the opportunity to ask questions (again through Berny) of the group based on their answers. I was able to experiment by varying the wording, values, instructions, allowed responses, and translation of each question, in order to find the most effective combination that would produce the most meaningful responses.

After the first day, I studied the notes I had taken, and revised the module accordingly. I then started with this revised module for the second group, and proceeded as with the first group. The third and final group went smoothly and quickly, as I had honed the module from the previous two groups. Overall, the participants were enthusiastic, communicative, forthcoming, and invaluable to this project.
B.1 General Questions

Adherence measures were taken using the following survey questions:

1. For each drug, respondents are asked the following:
   • How many times per day are you supposed to take this drug?
   • At each of these times, how many pills are you supposed to take?
   • How many times per day do you usually take this drug?

2. When was the last time you missed any of your antiretroviral drugs?

3. Using the line as a guide, in the past month, about how much of your antiretroviral drugs have you taken?

4. Using the line, in the past month, about how many doses of your antiretroviral drugs have you missed, forgotten about, or skipped?

5. Using the line below, in the past month, about how much of the time have you taken your antiretroviral drugs either early or late, meaning at least an hour before or after you were supposed to?

Prior to the expectations and health time discounting questions, I included two general questions in order to better understand the information set of the respondent. First, prior to the inclusion of this module, respondents were only asked whether they were on anti-retroviral therapy. Of the HIV-positive respondents that answered “no” there were individuals who made the decision not to take any drugs, and there were those who were never prescribed therapy (for instance if the doctors determined that their CD4 count was not low enough to warrant ART). Individuals who were never prescribed ART therefore should be excluded from the set of people who chose not to take ART. This information was ascertained through the answer to the following question:

“Has a doctor or medical professional ever told you that you should take any antiretroviral (ART) medications?”

1 During the focus groups I also tested questions concerning time discounting as it relates to money and risk preferences for health outcomes. Due to survey length limitations, these questions were not included in the final survey instrument, but a detailed description of those sections and focus group responses can be found in the Appendix (Section B).
This question did not raise any issues with translation, comprehension, or clarity in any of the focus groups. The second background question provides a measure of how familiar the respondent is with HIV/AIDS-related mortality:

“Has a friend or family member ever died from HIV or AIDS?”

Again, this question was not revised from its original wording as a result of the focus groups. However, the respondents brought up a number of interesting thoughts. First, the cause of death is never listed as HIV/AIDS on a person’s death certificate because it is actually an opportunistic infections which ultimately causes death. They explained that this would likely not cause a problem with interpretation, though, because most families know if their relative had HIV/AIDS and will interpret the question accordingly. When I inquired as to whether it would be helpful to have a more detailed description in the question, they assured me that it would be interpreted correctly as it was.

B.2 Instructions for Probabilistic Expectations

Due to the complex nature of probabilistic questions, I took great care in designing the instructions and examples to facilitate quick comprehension. I considered numerous examples and methods of explanation, before ultimately choosing the following script. The examples about the sun rising and the likelihood of rain tomorrow come from Tarozzi et al. (2011). I used this script for the second and third focus group sessions, and the participants affirmed that they understood these instructions. First I showed them a laminated paper scale (as seen in Figure B.1) and read the following instructions:

I will ask you several questions about the chance or likelihood that certain events are going to happen. These questions will ask you about health, ART medication, and death. There are 10 numbers on the scale in front of you. I would like you to choose a number on this scale to express what you think the likelihood or chance of a specific event happening.

For example:
• If I ask you: In your opinion, how likely is it that the sun will rise tomorrow? This is certainly going to happen, so you would probably choose the number 10.

• If I ask you: In your opinion, how likely is it that there will be two suns in the sky tomorrow? This is certainly not going to happen, so you will likely choose the number 0.

• If I ask you: In your opinion, how likely is it to rain tomorrow?
  
  – If you think it will certainly rain tomorrow, choose number 10.
  
  – If you think it will certainly not rain tomorrow, choose number 0.
  
  – If you think it is more likely to rain than not, choose a number higher than 5, perhaps 6 or 7 or more. The more confident you are that it will rain, the higher number you should choose.
  
  – If you think it is more likely not to rain, choose a number smaller than 5, perhaps 4 or 3 or less. The more confident you are that it will not rain, the lower number you should choose.

There is no right or wrong answer; I just want to know what you think.

B.3 Comprehension Questions

After being read the instructions above and before they are asked about expectations concerning health and ART adherence I asked a series of questions to practice thinking about future events in a probabilistic setting, and also to test their overall comprehension of the questions.

During the first focus group I asked for examples of events with uncertain outcomes, and they provided the scenario which appears in the final survey, the likelihood that Tanzania would win in a football match against Brazil. Football is a popular game, well known and understood in Tanzanian culture. It is known that even though one team may be significantly more skilled and experienced than another (Brazil in this case), on any given day, there is a chance that the “underdog” team (Tanzania) may prevail, giving the respondents a natural way to think about a probabilistic event. I asked the following probability question:
Pick the number that reflects how likely you think it is that Tanzania would win in a football match against Brazil.

The level of comprehension was encouraging. One man explained why he chose number 2: “Brazil is very skillful in playing soccer. They are more skilled than Tanzanian players, [but] you can never know because everyone has the same number of players. Either team may win.”

To further test whether the respondents understood the instructions and the concept of probability, they were then asked about two nested events: going to the market within (a) two days and (b) two weeks. If respondents understand the concept of probability, their probability of going to the market in two weeks should be greater than or equal to the probability of going to the market within two days. If the respondent violated the monotonicity property, the interviewer was instructed to explain the incoherency of the answers with the following statement: “Remember, as time goes by, you may find more time to go to the market. Therefore, you should have chosen a higher number.” The respondent was then asked to provide a new answer for the probability that they would go to the market in the next two weeks.

I was initially concerned that the event “going to the market” might be problematic due to seasonal variation and pre-existing household patterns of shopping and decision-making. After discussing with all three focus groups, we did not discover an event that would work any better, and so the questions remained unchanged in the finished survey.²

B.4 Expectations Questions

I then asked the group a series of probabilistic expectations questions related to health outcomes for each of three levels of adherence (1) full adherence, (2) miss 6% or more medication per month, and (3) complete non-adherence (no medication).³

² Analysis of responses to the comprehension questions can be found in Section 3.4.2.

³ Recall from the introduction that 95% adherence is the commonly accepted threshold for effective adherence.
Instructions for adherence levels:

1. full adherence: “Suppose that you take EVERY dose of your ART medication on time from now on:”
2. miss 6% or more: “Now, suppose that you miss or delay 2 days or more worth of your ART medication in each month from now on:”
3. non-adherence: “Now, suppose that you do not take any of your ART medication from now on:”

For each adherence level listed above, respondents were asked this set of health outcome questions: “In your opinion, choose the number that reflects how likely it is that you will:

- die within a six-month period beginning today.
- die within a one-year period beginning today.
- die within a five-year period beginning today.
- be in worse health than you are today in six months.
- feel nauseous at any time within a six-month period beginning today.
- feel fatigued at any time within a six-month period beginning today.
- have a headache at any time within a six-month period beginning today.
- have a higher viral load than you have today in six months.”

Contrary to my expectations, the participants in each of the three focus groups answered these questions quickly, and without many questions. In general, the first question took longer to elicit a response, and in these cases it merely required reading the question again, and slower, for acceptable comprehension. Once past the first question it was clear, for each group, that they understood the only difference was the health outcome. These questions appeared as written above in the final survey instrument.

B.5 Health Discount Rate Questions

I also developed a series of questions allowing me to estimate a discount factor, a measure of patience, for each individual as it related to their health.
potential for an individual’s health time discount rate to have significant impact on her decisions, it is important to include an analysis of these data.

While the time value of money is a common economic principle, thinking about the time value of good health requires a different way of thinking. In fact, there are studies which suggest that intertemporal preferences for money and health are most often not the same (Chapman, 1996). The most important difference between health and monetary outcomes is that health is not as easily transferrable over time (Bleichrodt and Johannesson, 2001). This implies that decisions about health outcomes may not be distorted by investment and savings decisions. For illustration, assume the following lifetime utility model:

$$U_t = \sum_{k=0}^{T-t} \beta^k u(h_{t+k})$$

(B.1)

In this case, each time period in the future is discounted by a factor of $\beta$, the relative weight a person attaches in period $t$ to their well-being (utility) in period $t + k$. The discount factor can also be written as a discount rate ($r$), $\beta = \frac{1}{1+r}$. This paper, however, considers health (instead of consumption) as the main input into an individual’s utility function. The most common way to model the impact of time on the valuation of health is with the constant rate discounted utility model, as described above.\(^5\)

Analyzing health time discount rates is particularly relevant in the context of medication decisions due to the inherent quality versus quantity tradeoff nature of ART adherence. While adherence to an antiretroviral therapy treatment cannot change an individual’s HIV status, as discussed in Section 3.2, it has the ability to improve quality of life, and extend life expectancy for an infected individual. Consider an infected individual in the early stages of the disease (with no symptoms or other infections) who believes that perfectly adhering to her ART regimen will extend her life expectancy, but that it will also cause many unpleasant side effects.\(^4\)

\(^4\) Any discount function can be written in the form $\beta(t) = \prod_{n=0}^{t-1} \frac{1}{1+r_n}$, but I will assume, as is common, that $\beta$, and therefore $r$ is constant over time.

\(^5\) See Section 3.4.3 (Hyperbolic Discounting) for a discussion of the validity of assuming a constant-discount rate and factor over time.
Her decision of whether to adhere to their medication or not will be largely influenced by how much she discounts the value of future health. If this individual has a very high discount rate for future health, then she is more likely to make health decisions based on short-term outcomes. This person may decide not to take her medications, not because she doesn’t believe it will be effective, but because the extension in life expectancy is not “worth” experiencing the side effects in the short run.

It was particularly important that I validate the following questions in a focus group setting for two reasons. First, in order to speak about health today versus health tomorrow, we must ask purely hypothetical questions asking the respondents to choose between receiving good health today and good health in the future, a scenario which clearly, cannot actually occur in a survey setting. For this reason, it was particularly critical to collect input from focus groups concerning comprehension and wording. The respondents were read the following instructions:

“Suppose that you were given a chance to choose between having some extra days in perfect health (and, thus, fewer days in poor health) this year, or 6 months from now. Assume that choosing either option won’t change your health for the rest of the days this year or next year. For the next few questions, please indicate which option you prefer assuming that you are given these days at your current health status, and that you will be alive in 6 months to collect your healthy days.”

The italicized text indicates additional wording that was added to help comprehension as a result of questions during the focus groups.

Second, in order to distinguish between different levels of patience, it necessary to ask these tradeoff questions for different values of rewards in the current period. Ideally, the respondent will be willing to trade small values of health today for large values in the future, and as the values of health today increase, the respondent will be less likely to be willing to wait for the reward in the future. It is critical to identify this threshold to ensure sufficient heterogeneity in elicited discount rates. Identifying appropriate values in order to find this threshold proved difficult. I began the first focus group with the following set of values:
“Would you prefer:

- Option A = 100 extra days in perfect health one year from now
- Option B = X extra days in perfect health now”

where X decreases from 100, 80, 60, 40, to 20.

Would you prefer:

1. Option A = 50 extra days in perfect health six months from now
   Option B = 40 extra days in perfect health now
2. Option A = 50 extra days in perfect health six months from now
   Option B = 25 extra days in perfect health now
3. Option A = 50 extra days in perfect health six months from now
   Option B = 5 extra days in perfect health now
4. Option A = 50 extra days in perfect health six months from now
   Option B = 1 extra day in perfect health now

In the first focus group, every individual quickly chose the option to receive fewer days today rather than wait for the larger reward. The most common reason for choosing the earlier days in perfect health was that they could accomplish a lot with their perfect health now and accumulate income for the future when they have health problems. The values I had chosen did not account for high enough discount rates, and so on the second day, I allowed the number of days in perfect health now to drop to 10. Again, the responses were overwhelmingly in favor of receiving the healthy days now. One woman explained “I don’t understand why there is a choice for later. I would always rather have now than later. You have to think about now, there is no later.”

In the final survey I decided to change the time frame to six months, to coincide with the timing of the surveys. In addition, I allowed for the highest possible discount rate, by asking the respondents to choose between 50 days in perfect health 6 months from now, and X days now where X decreases from 40, 25, 5, to 1. This proved to be an appropriate choice of values, as evidenced by the distribution of elicited results (see Section 3.4.3).
Because I was unable to include time-preference questions as they relate to money in the final survey instrument, I included the following question to gauge the respondent’s general financial time horizon.

In planning your savings and spending, which of the following time periods is most important to you and your household?

a) The next few months
b) The next year
c) The next 4 years
d) The next 5-10 years
e) Longer than 10 years

The focus group responses were not unanimous, however most participants indicated that they only think about the next few months because of low and uncertain income. One man went far enough to say that “money that is saved and not circulating is not useful, its not money. Money is only money if it is moving around and it is producing.” There were, however, a handful of people who recognized the value of saving over a longer period of time. The people who chose the next year cited the ability to save a substantial amount of money, natural business cycle, and school calendar. Only one person said that she plans more than 1 year into the future, in fact she answered longer than 10 years. She said she likes to think about life with her children, education, and buying some land where she might build a house.

B.6 Time Preferences Money

I read the participants the following instructions:

The following questions will ask you to choose between different amounts of money at different times. You will not actually be receiving or losing any money based on these questions. For all of these questions, you can think of future money as certain with no risk.

---

6 See Section B for more information about the survey questions included in the focus groups, but not ultimately in the CHAT survey.
You can think about money and time in terms of the amount of business profit you would earn in a period of time. For example, if you are employed, then you can value time based on the amount of money you would have earned if you were working during that time. If you make a monthly salary, you can break it down based on how much you would earn each hour or even each minute.

Because these questions were not included in the final survey, I will omit the details of the different amounts and time frames that were discussed, but I will summarize a few of the key comments and lessons learned from the focus groups.

I first asked the focus group if they would rather win an award now (for example: 100,000 Tanzanian Shillings (Tsh) \(\approx 63\) or a larger amount one month from now (for example: 200,000 Tsh \(\approx 126\)).

In general, people fell into three categories: those who chose to wait for the higher amount, those who chose the lesser amount immediately because “it’s always better to take what you can get right now rather than waiting for later”, and finally, those who chose the lesser amount immediately due to reasons unrelated to time preference.

Economists often interpret the responses to these types of questions as measures of patience, or the extent to which a respondent values her time. Through the focus group discussions, I realized that these types of questions can be interpreted in many different ways. For instance, many people who chose 100,000 Tsh today because they believed they could make more than 100,000 Tsh profit in one month. One woman even went so far as to say “I can for sure earn more than 100,000 Tsh in one month, that is the smart choice.”

An unexpected, but common, reason for choosing the larger amount in the future, was the ability to plan for the income. One woman said, “If I don’t plan for the money and bring it home, it will be gone. If I can have time to plan what to do with it, then I can make something big happen, like maybe planning an addition to my house.” For people who think this way, choosing the money now is not an option because it is as good as wasted, and this choice should still be interpreted as patient, or forward-looking since it implies the respondent prefers to use money as a
longer-term investment for their home or family. Because time preferences for money are rarely symmetric between winning and losing, I also asked them if they would rather lose a small amount now or a larger amount one month from now (with identical amounts as before). Responses to this question relied heavily on the stability of the participant’s financial situation. The overwhelming choice was to lose the larger amount later because they will have the time to plan for the upcoming loss. In fact, one man said “I would choose to lose later because I will be finished if I lose 100,000 Tsh now.” In this case, the response should not be interpreted as patience as much as a statement about the stability of the man’s business.

Based on this response, I asked the group to consider a situation in which their business was established and successful. They had extra capital, and the ability to cover all of their debts. In this case, losing the 100,000 Tsh will not threaten their business. When considering this scenario, all participants changed their answer, and then preferred to take the smaller loss immediately.

B.7 Risk Preferences - Health

There is inherent risk in taking any medication, but it is particularly important to explore risk preferences as it related to ART because false information about ART and HIV/AIDS is so prevalent. People base their decisions on their own perception about the risks and rewards, and understanding how individuals internalize risk is important when analyzing their ultimate decisions. In order to explore risk preferences in a medical context, I created a short module designed to parse out the respondent’s risk aversion as it related to mortality.

I set up the following scenario for the focus group participants:

Suppose you are walking down the road and you get hit by a car. The doctor tells you that you need to take 2 pills to walk again. Without taking the pills, you would have difficulty walking, you would feel tired all the time and you would often feel nauseous. But if the pills work, you would be completely cured. If the pills did not work, you would die immediately, without any pain.
In other words, there are only two things that could happen if you choose to take the pills: a) You would be permanently cured, or b) You would die instantly, without any pain.

We are going to ask you about whether you would want to take these pills. Assume that the pills are free and if you do not die, you are cured instantly. We want you to make each decision only on the basis of how this disease might affect how well you feel or what activities you can do.

I then asked each participant the following questions:

Would you choose to take the pills if the chance of dying was 5% (I also asked using 20%, 40%, and 50%)? This means that 5 percent of the people who take the pills will die. The rest of them would be cured. In other words, if 100 people take the pills, we would expect 5 of them to die. The rest of them would be cured.

Every person, in each focus group, for every mortality probability chose to take the pills. There were a few common themes:

- There’s always possibility of healing or dying. If I fall within the 5% it’s bad luck, and if not, then it’s good luck.
- Optimism that I will be in the lucky group.
- Everyone will die, so I will take the medicine regardless of the risk of dying.
- It is better to use the medicine, because if you can’t walk then you become a burden to the society.
- Don’t want to be a burden on society and her family members.
- Death is a must and being alive is luck because even where we are it just passes us by.
- You should take medicine for treatment and then if you pass away because the treatment didn’t work, then that is meant to be.
Even though these questions were not included in the final survey, the responses from the focus group provided valuable information about the feasibility of the trade-off between death and side effects. In developed countries it seems unrealistic that an individual would rationally choose an action with a high probability of mortality to avoid side effects. I rely on the comments above as an indicator that this is not an unrealistic assumption for HIV-positive individuals in Moshi.

B.8 Reasons for non-Adherence

The following are a list of reasons the focus groups identified as to why they might miss a dose of their ART: get home from work late, go out to fetch water from far away and expects to be home but finds a long line when she gets there, travel, stress, forget, being in so much pain I forget, drug and alcohol abuse cause forgetting, house guests, and hiding HIV status from neighbors.

The following is a list of methods the participants use to remember to take their medications: keep your medications in an open place where you will always see them and not forget, have family member remind you, alarm on my phone, radio, Muslim prayers.

Even though I cannot evaluate these questions in the context of the entire CHAT survey, the responses and discussions of the focus groups were extremely informative, and will aid me in the future to great higher quality survey questions on similar topics.

---

7 I will generalize here to all developed countries even though I acknowledge the heterogeneity in beliefs between and within nations.
Laminated scale shown to respondents when asked the probability of certain events occurring in the future.

**Figure B.1**: Laminated Scale
Appendix C

CHAT: Variable Construction

Household Expenses

sec_a12a How much money do you spend each week on household expenses?
1. 0-2,999 Tsh
2. 3,000-6,999 Tsh
3. 7,000-9,999 Tsh
4. 10,000-19,999 Tsh
5. 20,000-34,999 Tsh
6. 35,000 Tsh or more

expenses = 1500*(sec_a12a==1) + 5000*(sec_a12a==2) + 8500*(sec_a12a==3) + 15000*(sec_a12a==4) + 27500*(sec_a12a==5) + 50000*(sec_a12a==6)

In the first 3 rounds of surveys, respondents were asked whether household expenses fell into the ranges above. As an estimate of overall expenses, I assumed the average value in each bin, and imposed a cap of 50,000 Tsh (≈ $31). In rounds 4 and onward, respondents were able to provide a number for their expenses.
**Number of Household Members**

**sec_a07a** How many people reside in your household? (including yourself)

**sec_a07c** Of those residing in your house, how many are younger than 18 years old?

**Distance from Clinic**

**c16c** How many kilometers do you travel to treatment clinic?

```stata
replace c16c=. if inlist(c16c,1000,8888,.,a,.c,.d,.f)
ren c16c distance
```

**c17a** How long does it take you to get to treatment clinic?

```stata
replace c17a=. if inlist(c16c,1000,8888,.,a,.c,.d,.f)
ren c17a distance_m
```

**Religion (religion)**

**sec_a05a** What is your religion?

1. Muslim
2. Hindu
3. Lutheran
4. Catholic
5. Christian (not Catholic)
6. Other
7. None

```stata
ren a05a religion
gen muslim = religion==1
```
Marital Status (married)

sec_a03a What is your marital status?
1. Married (monogamous)
2. Married (polygamous)
3. Not currently married - widowed
4. Not currently married - divorced
5. Co-habiting
6. Single/never married

gen married = inlist(a03a,1,2)
ren a03a marital_status

Years of Education (yrs EDUC)

sec_a04a How many years of education have you had? [choose highest level completed]
1. No education
2. Primary (1-7 years)
3. Secondary (8-13 years)
4. University (13 years)

gen yrs EDUC = 0 if sec_a04a==1
replace yrs EDUC = 4 if sec_a04a==2
replace yrs EDUC = 10.5 if sec_a04a==3
replace yrs EDUC = 13 if sec_a04a==4

Socio-Economic Status (water)

sec_a14a Does your household have running water?

ren sec_a14a water

Socio-Economic Status (toilet)

sec_a15a Does your household have a flush toilet that flushes to a sewage system or septic tank?

ren sec_a15a toilet
Socio-Economic Status (bicycle)

sec_a16a Does anyone in your household have a bicycle?

ren sec_a16a bicycle

Socio-Economic Status (radio)

sec_a17a Does anyone in your household have a radio?

ren sec_a17a radio

Socio-Economic Status (tv)

sec_a18a Does anyone in your household have a television?

ren sec_a18a tv

Self-Reported Health (health)

sec_b01a Using the line as a guide (0-100), how would you rate your current state of health? (Record percent corresponding to respondent’s mark)

ren sec_b01a health

replace health = health/100

Self-Reported Health (health_1mo)

sec_b01a Overall, how would you rate your health during the past 4 weeks?
1. Excellent
2. Very good
3. Good
4. Fair
5. Poor
6. Very poor

ren sec_b01b health_1mo

replace health_1mo = 1/(health_1mo)
**Self-Reported Health (nausea)**

<table>
<thead>
<tr>
<th>r1_rnd5</th>
<th>During the past 4 weeks, how nauseous have you felt?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Very much</td>
<td></td>
</tr>
<tr>
<td>2. Quite a lot</td>
<td></td>
</tr>
<tr>
<td>3. Some</td>
<td></td>
</tr>
<tr>
<td>4. A little</td>
<td></td>
</tr>
<tr>
<td>5. None</td>
<td></td>
</tr>
<tr>
<td>6. Very poor</td>
<td></td>
</tr>
</tbody>
</table>

gena = 1 if inlist(r1_rnd5,1,2,3,4)
replace nausea1 = 0 if nausea==5

**Self-Reported Health (headaches)**

|i01| Do you have headaches? |

ren i01 headaches

**Self-Reported Health (fatigue)**

<table>
<thead>
<tr>
<th>b09d</th>
<th>In the past two weeks how often have you been bothered by feeling tired or having little energy:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not at all</td>
<td></td>
</tr>
<tr>
<td>2. One day or a few days</td>
<td></td>
</tr>
<tr>
<td>3. More than half the days</td>
<td></td>
</tr>
<tr>
<td>4. Nearly every day</td>
<td></td>
</tr>
</tbody>
</table>

gene = 1 if inlist(b09d,2,3,4)
replace fat = 0 if fatigue==1

**Self-Reported Information**

|r3| Has a friend or family member ever died from HIV or AIDS? |
Adherence (adhere_k)

j02a Which of the following antiretroviral drugs are you currently taking? (choose all that apply)
   1. Stavudine + Lamivudine (Lamivir)
   2. Stavudine + Lamivudine + Nevarapine (Triomune, Emtri)
   3. Zidovudine (Zidovir, Zidine)
   4. Zidovudine + Lamivudine (Duovir, Lazid, Zidovex-1)
   5. Zidovudine + Lamivudine + Nevarapine (Duovir-N)
   6. Efavirenz (Efavir, Stocrin)
   7. Lamivudine (Lamivir, Laminox, Lavir, Lamivirsol)
   8. Nevirapine (Nevimune, Viramune)
   9. Abacavir (Ziagen)
  10. Didanosine (Videx)
  11. Lopinavir + Ritonavir (Kaletra)
  12. Nelfinavir (Viracept)
  13. Stavudine (Stavir, Stadine, Stavex, Zerit)
  14. Saquinavir (Viracept)
  88. Can’t remember

j03a How many times per day are you supposed to take this drug?

j03b At each of these times, how many pills are you supposed to take?

   gen rx_pills = j03a*j03b (# pills prescribed per day per drug)

j03c How many times per day do you usually take this drug?

j03d At each of these times, how many pills do you usually take?

   gen actual_pills=j03c*j03d (# pills actually take per day per drug)

   gen percent_pills=actual_pills*100/rx_pills (% of prescribed pills taken per day per drug)

   egen total_rx_pills=rowtotal(rx*) (Total # of prescribed pills per day)

   egen total_actual_pills=rowtotal(actual*) (Total # of pills taken per day)

   gen percent_total_pills=total_actual_pills*100/total_rx_pills (% of total pills actually taken)
j01a Are you on any antiretroviral drugs, that is, medications to treat HIV/AIDS?

r2 Has a doctor or medical professional ever told you that you should take any anti-retroviral (ART) medications?

replace percent_total_pills = 0 if j01a==2 (Set % pills taken = 0 if not on ART)

j04 When was the last time you missed any of your antiretroviral drugs?
   1. Never miss medications
   2. Within the past week
   3. 1-2 weeks ago
   4. 3-4 weeks ago
   5. 1-3 months ago
   6. More than 3 months ago

j05 Using the line as a guide, in the past month, about how much of your antiretroviral drugs have you taken?

j06 Using the line, in the past month, about how many doses of your antiretroviral drugs have you missed, forgotten about, or skipped?

j07 Using the line below, in the past month, about how much of the time have you taken your antiretroviral drugs either early or late, meaning at least an hour before or after you were supposed to?

    gen adhere_chat = percent_total_pills <=100
    percent_total_pills<.

    replace adhere_chat = 1 if j04==1 j05==100 j06==0 j07==0

    replace adhere_chat=. if inlist(j01,2,.a) (Perfect adherence)

Comments: Adherence = 1 if they reported never missing any pills on average from question j03 OR if j04=1 (last time missed any ART drugs = never) and j05 = 100 (taken 100 percent of ART drugs in past month) and j06 = 0 (never missed any) and j07==0 (never taken any late)
gen adhere_k = (j04==1 j05==100 j06==0 j07==0) (Perfect adherence (strictest def))

replace adhere_k = . if inlist(j01,2,.a)

gen adhere = 0 if j01a==2

replace adhere = 1 if j01a==1 adhere_k==0

replace adhere = 1 if j01a==1 adhere_k==0

adhere

0. No ART
1. Less than 95% Adherence
2. Perfect Adherence

Cohort (uconum)

rename cl_cohort uconum

  1. VCT negative
  2. VCT positive
  3. KCMC
  4. Mawenzi
  5. Community

gen clinic = inlist(uconum,3,4)
Discount Factor (d)

r4 Would you prefer:
1. Option 1 = 40 extra days in perfect health now
2. Option 2 = 50 extra days in perfect health six months from now

r5 Would you prefer:
1. Option 1 = 25 extra days in perfect health now
2. Option 2 = 50 extra days in perfect health six months from now

r6 Would you prefer:
1. Option 1 = 5 extra days in perfect health now
2. Option 2 = 50 extra days in perfect health six months from now

r7 Would you prefer:
1. Option 1 = 1 extra day in perfect health now
2. Option 2 = 50 extra days in perfect health six months from now

gen impatient = r4==1 r5==1 r6==1 r7==1
gen patient = r4==2 r5==2 r6==2 r7==2
gen d_r4 = r4==1 r5==2 r6==2 r7==2
ngen d_r5 = r4==1 r5==1 r6==2 r7==2
ngen d_r6 = r4==1 r5==1 r6==1 r7==2
ngen inconsistent = (impatient==0 patient==0 d_r4==0 d_r5==0 d_r6==0)
gen d = 0.88 if patient==1 (0.88=(1/1.125))
replace d = 0.02 if impatient==1 (0.02 = (1/(1+49)))
replace d = 0.1 if d_r6==1 (0.1 = (1/(1+9)))
replace d = 0.5 if d_r5==1 (0.5 = (1/(1+1)))
replace d = 0.8 if d_r4==1 (0.8 = (1/(1+.25)))
gen r = (1/d)-1
gen d_high = (d>.5)
gen d_low = (d<=.5)
Financial Planning

r8 In planning your savings and spending, which of the following time periods is most important to you and your household?

1. The next few months
2. The next year
3. The next 4 years
4. The next 5-10 years
5. Longer than 10 years

\[ \text{gen 1=1 if inlist(r8,2,3,4,5)} \] (Long financial time horizon)

Expectations

In your opinion, choose the number that reflects how likely it is that [...] 

1. 0
2. 1
3. 2
4. 3
5. 4
6. 5
7. 6
8. 7
9. 8
10. 9
11. 10

r9 Pick the number that reflects how likely you think it is that Tanzania would win in a football match against Brazil.

r9.1 Are you sure that this event will surely not happen?
r9.2 Are you sure that this event is equally likely to happen as it is to not happen?
r9.3 Are you sure that this event will surely happen?

r10 Pick the number that reflects how likely you think it is that you will go to the market at least once within the next 2 days.

r11 Pick the number that reflects how likely you think it is that you will go to the market at least once within the next 2 weeks.

r12 Remember as time goes by, you may find more time to go to the market. Therefore, you should have chosen a higher number. Let me ask you again. Now, choose a number that reflects how likely you think it is that you will go to the market at least once within 2 weeks.
r13 P(die wi 6 mo) w perf. adherence
r14 P(die wi 1 yr) w perf. adherence
r15 P(die wi 5 yr) w perf. adherence
r16 P(worse health in 6 mo) w perf. adherence
r17 P(nauseous wi 6 mo) w perf. adherence
r18 P(fatigued wi 6 mo) w perf. adherence
r19 P(headache wi 6 mo) w perf. adherence
r20 P(higher viral load in 6 mo) w perf. adherence
r21 P(die wi 6 mo) w <95% adherence
r22 P(die wi 1 yr) w <95% adherence
r23 P(die wi 5 yr) w <95% adherence
r24 P(worse health in 6 mo) w <95% adherence
r25 P(nauseous wi 6 mo) w <95% adherence
r26 P(fatigued wi 6 mo) w <95% adherence
r27 P(headache wi 6 mo) w <95% adherence
r28 P(higher viral load in 6 mo) w <95% adherence
r29 P(die wi 6 mo) w no ART
r30 P(die wi 1 yr) w no ART
r31 P(die wi 5 yr) w no ART
r32 P(worse health in 6 mo) w no ART
r33 P(nauseous wi 6 mo) w no ART
r34 P(fatigued wi 6 mo) w no ART
r35 P(headache wi 6 mo) w no ART
r36 P(higher viral load in 6 mo) w no ART

foreach var of varlist r9 r10 r11 r12 r13-r36:
    replace 'var' = 0 if 'var'==1
    replace 'var' = 1 if 'var'==2
    replace 'var' = 2 if 'var'==3
    replace 'var' = 3 if 'var'==4
    replace 'var' = 4 if 'var'==5
    replace 'var' = 5 if 'var'==6
    replace 'var' = 6 if 'var'==7
    replace 'var' = 7 if 'var'==8
    replace 'var' = 8 if 'var'==9
    replace 'var' = 9 if 'var'==10
    replace 'var' = 10 if 'var'==11
    replace 'var' = 'var'/10 if inlist('var',1,2,3,4,5,6,7,8,9,10)
    replace r14=1 if r13==1, replace r15=1 if r13==1 | r14==1
    replace r22=1 if r21==1, replace r23=1 if r21==1 | r22==1
    replace r30=1 if r29==1, replace r31=1 if r29==1 | r30==1
Appendix D

CHAT: Focal Point and Anchoring Analysis

D.1 Anchoring effects

There is research which suggests that when respondents are asked to make multiple choices between immediate and delayed rewards, the first choice they face often influences subsequent choices. This is known as an anchoring effect since imputed discount rates tend to be biased in the direction of the discount rate that would equate the first pair of options to which their are exposed (Green et al., 1998).

If discount rates tend to be biased toward the rate that would equate the first pair (40 days today and 50 days in 6 months from now) this is a discount rate of 0.25 and discount factor of 0.8. This implies that the responses will be biased towards being more patient. In this context, especially among a highly HIV positive population, we would expect people to be more impatient, and therefore we wouldn’t want to have patience estimates biased towards impatience, for fear that there would be just one point of mass. This allows us to distinguish between the more patient and less patient.
D.2 Focal points

Expectations questions have been found to exhibit heaping at focal answers of 0, 0.5, and 1.0, implying that respondents are may not revealing their true expectations (Delavande et al., 2011, 1995). In order to evaluate the presence of focal responses in the CHAT survey, I included a series of prompts for each of the three introduction questions. If the respondent provided a focal answer, she was asked one more time if she was sure in order to promote additional thought. If the respondent provided a focal answer to any of the following introduction questions,

- **r9** Pick the number that reflects how likely you think it is that Tanzania would win in a football match against Brazil.
- **r10** Pick the number that reflects how likely you think it is that you will go to the market at least once within the next 2 days.
- **r11** Pick the number that reflects how likely you think it is that you will go to the market at least once within the next 2 weeks.

she was asked again with the corresponding prompt:

- **a.** Are you sure that this event will surely not happen?
- **b.** Are you sure that this event is equally likely to happen as it is to not happen?
- **c.** Are you sure that this event will surely happen?

Table D.1 summarizes the percent of respondents who provided a focal answer, and of those, the percent that changed their response after being prompted. In both rounds exhibit a similar pattern with over half the respondents choosing a focal response to the first question, decreasing to ~35% by the third question. While every focal responder was prompted, only 1-2% changed their response in each round.
However, more important are the focal and repetitive responses to the expectations questions as the majority of analysis in the paper relies on the accuracy of these data. The top panel of Table D.2 displays the percent of respondents, in each round, who provided any of the three focal responses (0.0, 0.5, 1.0) to all questions in that row. For instance, from the first row, 63% of respondents provided focal answers to all three mortality questions (6-month, 12-month, 5-year) assuming perfect adherence, although only 9% provided focal responses to all mortality questions across levels of adherence. The same analysis is done for the health (side-effect) expectations, and we see only 2% of respondents providing focal answers to all expectations questions. A focal response poses a problem for analysis because it is unlikely to be the respondent’s true expectation. Arguably though, a focal response still provides an estimate (albeit coarse) of the true probability.

More problematic are the respondents who merely provide identical responses, either across time frames or health outcomes. True expectations are unlikely to be identical across all time frames and health outcomes, and may be a signal of misunderstanding, unwillingness to thoughtfully process a response, or unwillingness to reveal their true beliefs. The bottom panel of Table D.2 provides the percentage of respondents who provided identical answers to the questions in each row. The pattern is strikingly similar to the focal responses, indicating that most of the identical responses are, in fact, focal points. All but one of the respondents who supplied identical responses to every expectations questions chose 0. This is likely due to uncomfortableness with mortality questions and unwillingness to either reveal true beliefs or tempt fate by providing a non-zero answer. It is important to note that no respondent was coerced into answering, and that every questions provided an option to not answer.  

1 Similar focal point analysis was conducted on the HIV-negative sample and can be found in Table D.4.
Table D.3 further explores the characteristics of respondents who provided identical responses to the expectations questions. In this table, the dependent variable is equal to one if the respondent answered identical responses either (1) to all health expectations questions or (2) to all mortality expectations questions. Significant predictors of identical responses are not being a member of the clinic cohort, being on ART, having a high discount factor, experiencing headaches, and not experiencing fatigue. If identical responses indicate an unwillingness to think about difficult health circumstances, then we would expect the clinic cohort to be less affected, given that they routinely visit the clinic and speak with medical professional about their health. Controlling for being a member of the clinic cohort, taking ART is a predictor of identical responses.

Table D.1: Focal Point Analysis - Intro Questions

<table>
<thead>
<tr>
<th></th>
<th>Round 5</th>
<th>Round 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>557(56%)</td>
<td>446(54%)</td>
</tr>
<tr>
<td>Market (2 days)</td>
<td>367(37%)</td>
<td>261(31%)</td>
</tr>
<tr>
<td>Market (2 weeks)</td>
<td>416(42%)</td>
<td>281(34%)</td>
</tr>
</tbody>
</table>

| Changed Football Response| 13 (2%)| 5 (1%) |
| Changed Market (2 day) Response | 5 (1%)| 2 (1%) |
| Changed Market (2 week) Response | 5 (1%)| 3 (1%) |
Table D.2: Focal Point Analysis - HIV-Positive

<table>
<thead>
<tr>
<th>Focal Points</th>
<th>Round 5</th>
<th>Round 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mortality Questions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfect Adherence</td>
<td>411 (63%)</td>
<td>466 (84%)</td>
</tr>
<tr>
<td>Less than 95%</td>
<td>140 (21%)</td>
<td>83 (15%)</td>
</tr>
<tr>
<td>No ART</td>
<td>203 (31%)</td>
<td>213 (39%)</td>
</tr>
<tr>
<td>All Mortality Questions</td>
<td>59 (9%)</td>
<td>42 (8%)</td>
</tr>
<tr>
<td><strong>Health Questions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfect Adherence</td>
<td>347 (53%)</td>
<td>404 (73%)</td>
</tr>
<tr>
<td>Less than 95%</td>
<td>101 (15%)</td>
<td>65 (12%)</td>
</tr>
<tr>
<td>No ART</td>
<td>185 (28%)</td>
<td>184 (33%)</td>
</tr>
<tr>
<td>All Health Questions</td>
<td>22 (3%)</td>
<td>28 (5%)</td>
</tr>
<tr>
<td>All Expectations Questions</td>
<td>16 (2%)</td>
<td>9 (2%)</td>
</tr>
</tbody>
</table>

| **Identical Responses** |         |         |
| Mortality Questions     |         |         |
| Perfect Adherence       | 400 (61%) | 456 (83%) |
| Less than 95%           | 113 (17%) | 61 (11%) |
| No ART                  | 191 (29%) | 206 (37%) |
| All Mortality Questions | 34 (5%)  | 18 (3%)  |
| Health Questions        |         |         |
| Perfect Adherence       | 346 (53%) | 403 (73%) |
| Less than 95%           | 94 (14%)  | 64 (12%) |
| No ART                  | 181 (28%) | 182 (33%) |
| All Health Questions    | 43 (7%)   | 23 (4%)  |
| All Expectations Questions | 19 (3%) | 7 (1%) |
| **Same Focal Responses to All** | 13 (2%) | 5 (1%) |

**Sample Size**

|         | 652 | 552 |

184
Table D.3: Identical Responses Analysis - HIV-Positive

<table>
<thead>
<tr>
<th>Identical Responses</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic Cohort</td>
<td>-0.108***</td>
</tr>
<tr>
<td>Taking ART</td>
<td>0.207***</td>
</tr>
<tr>
<td>Self-reported current health (0-1)</td>
<td>0.020</td>
</tr>
<tr>
<td>Self-reported health past month (0-1)</td>
<td>-0.044*</td>
</tr>
<tr>
<td>Married</td>
<td>-0.001</td>
</tr>
<tr>
<td>Number HH members under 18</td>
<td>0.011*</td>
</tr>
<tr>
<td>High Discount Factor</td>
<td>0.052***</td>
</tr>
<tr>
<td>Muslim</td>
<td>0.007</td>
</tr>
<tr>
<td>Age</td>
<td>-0.000</td>
</tr>
<tr>
<td>Completed Primary School</td>
<td>0.019</td>
</tr>
<tr>
<td>Nausea</td>
<td>-0.024</td>
</tr>
<tr>
<td>Headaches</td>
<td>0.061***</td>
</tr>
<tr>
<td>Fatigued</td>
<td>-0.032**</td>
</tr>
<tr>
<td>Round 6</td>
<td>-0.004</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.118</td>
</tr>
</tbody>
</table>

Observations: 1,190
R-squared: 0.219
Mean: 0.076

Asterisks denote statistical significance at the 10(*), 5(**) or 1(***)) percent level. Self reported health is measured on a scale from 0 (worse possible health) to 1 (perfect health).
<table>
<thead>
<tr>
<th>Focal Points</th>
<th>Round 5</th>
<th>Round 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality Questions</td>
<td>293 (84%)</td>
<td>248 (90%)</td>
</tr>
<tr>
<td>Health Questions</td>
<td>96 (28%)</td>
<td>54 (19%)</td>
</tr>
<tr>
<td>All Expectations Questions</td>
<td>92 (26%)</td>
<td>52 (19%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Identical Responses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality Questions</td>
<td>288 (83%)</td>
<td>244 (88%)</td>
</tr>
<tr>
<td>Health Questions</td>
<td>86 (25%)</td>
<td>51 (18%)</td>
</tr>
<tr>
<td>All Expectations Questions</td>
<td>83 (24%)</td>
<td>47 (17%)</td>
</tr>
</tbody>
</table>

| Same Focal Responses to All       | 83 (24%) | 47 (17%) |
| Sample Size                       | 348      | 277     |
Bibliography


191


Biography

Kristin Maura Johnson was born in Denver, Colorado on January 17, 1983. She earned the International Baccalaureate degree at Littleton High School in 2001 with an emphasis in music theory and then attended the University of Colorado at Boulder, earning a Bachelor of Arts in Math and Economics in 2005. Traveling to Africa during college inspired a deep interest in the causes and consequences of the HIV epidemic in sub-Saharan Africa, after which she completed an economics honors thesis titled “The Effects of Gender on HIV in Africa”, earning her the distinction Magna Cum Laude.

After graduating, Kristin worked as a Case Design Manager at Financial Designs, Ltd. in Denver, Colorado before beginning graduate school at Duke University in 2007. Kristin earned a Master of Arts degree in Economics in August of 2008 en route to her Ph.D. from Duke University. She worked as a Research Assistant to her advisor, Alessandro Tarozzi, for two years before receiving a 2011 American Dissertation Fellowship from the American Association of University Women.

Kristin spent her summers at Duke teaching undergraduate economics courses, and traveling to India and Tanzania for her research and will earn Duke’s Certificate in College Teaching upon graduation. Kristin will earn her Ph.D. from Duke University in May, 2012 and will begin working as Research Manager for Professor Nava Ashraf at the Harvard Business School in June.