Title: **Health, Education, and Economic Interventions for Orphans and Vulnerable Children in Mozambique**

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<u>Abstract</u>

The HIV/AIDS crisis in Sub-Saharan Africa has left millions of children orphaned, and millions more suffer direct and indirect effects of the crisis. These children, who are potentially infected with HIV themselves, are highly vulnerable and face a number of serious risks to their health and overall well-being. This project aims to evaluate programs to improve the health and overall outcomes of orphans and vulnerable children (OVCs) in Mozambique. A variety of health and economic interventions to help OVCs and the households in which they live, funded by the U.S. government via PEPFAR, are being carried out in Mozambique. Health interventions involve a bundle of integrated programs aimed at identifying and referring children to public health centers for HIV testing and anti-retroviral therapy (ART). Economic interventions involve village savings and loan (VSL) programs to improve income, consumption, and risk-coping in OVC households. Health, education, and economic outcomes will be measured for representative samples of OVC households in baseline (pre-treatment) and follow-up (post-treatment) surveys. Random assignment will allow estimation of the causal impact of the health interventions, the economic interventions, and the interaction of the two.

Narrative Description

Out of an estimated 35.2 million people living with HIV worldwide in 2012, 25.0 million are in Sub-Saharan Africa. The region also accounts for a dominant share of new HIV infections: 1.6 million out of a global total of 2.3 million in that year.[1] In Mozambique in 2012, 1.6 million people out of a population of 25.2 million were living with HIV, out of which 200,000 were children (aged 14 or below). The country has an estimated 120,000 new HIV infections annually, and one-sixth of these are children.

The U.S. Government's most important programmatic response to the HIV/AIDS crisis is the President's Emergency Plan for AIDS Relief (PEPFAR), initiated in 2003. Recognizing that children are among the most vulnerable populations to the HIV/AIDS pandemic,[2] PEPFAR mandates part of its funding be devoted to programs benefiting children orphaned or made vulnerable by HIV/AIDS ("orphans and vulnerable children," or OVC).[3] PEPFAR's programs for OVCs take an integrated approach, with interventions at child, family, and community levels; that target child needs at different developmental stages; and that are connected to other development programs related to education, nutrition, and household economic development.[4]

PEPFAR funding is supporting a newly established program in Mozambique, "Strengthening Family and Community Support to Orphans and Vulnerable Children" (SFCS-OVC), which aims to reduce the socio-economic impact of HIV/AIDS on OVC and their caregivers. SFCS-OVC is a five-year program (beginning in late 2015) and is implemented in Mozambique by World Education Inc./Bantwana (WEI/B) (as lead organization) and a set of partner organizations. With an objective to improve families' and communities' ability to support, protect, and care for OVC and caregivers, the program has five components, as follows:

1. Strengthened coordination and harmonization of care, protection and support services for OVC households at the district and community levels
2. Increased access to education and improved learning outcomes for OVC
3. Increased access to healthcare and nutritional support for OVC and caregivers
4. Improved coping mechanisms for OVC and caregivers
5. Improved socio-economic status of OVC households

In the context of economic development interventions, the SFCS-OVC program can be thought of as having two broad components. First, the program aims to improve access to health

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[1] Figures in this paragraph are from the UNAIDS Global Report 2013.
http://www.unaids.org/sites/default/files/media_asset/UNAIDS_Global_Report_2013_en_1.pdf
[2] Across Sub-Saharan- Africa, roughly 15 million children have been orphaned by AIDS, having lost one or both parents. (Data from the UNAIDS Report on the Global AIDS Epidemic 2010, in which the definition for children is below 18 years of age.)
[3] In PEPFAR's 2008 reauthorization, 10% of funds were mandated to be spent on assistance to OVCs. PEPFAR defines children as those below 18 years of age. These funds amounted to more than $1 billion in 2006-09, and $672 million in 2010-11. (PEPFAR Operational Plans for fiscal years 2006-2011, available at http://www.pepfar.gov.)
[4] President's Emergency Plan for AIDS Relief. Orphans and Other Vulnerable Children: programming guidance for United States Government in-country staff and implementing partners. Washington (DC): PEPFAR; July 2006. http://www.pepfar.gov/documents/organization/83298.pdf

and education (components 1-4 above). These components involve a bundled set of interrelated interventions that aim to improve access to health care and education for OVCs and caregivers. Component 1 involves establishing and strengthening referral networks within communities to identify and refer OVCs to public health clinics. Component 2 works with schools in beneficiary communities to integrate them in to the referral network, train school councils on ways to help OVCs, and provides schools with grants conditional on meeting OVC schooling objectives. Component 3 involves strengthening links between the community referral networks and the public health clinics conducting HIV testing and treatment. Component 4 creates school-based networks to provide psychosocial support for OVCs and their caregivers, and to bolster the community and school referral networks. The study will examine the impact of this bundle of health and education interventions broadly on the outcomes of OVCs and their households. The study does not have the power to examine the impact of sub-components of the bundle separately. Our objective is the estimate the impact of a multifaceted "health and education access" program for OVC households. Follow-up survey work can help identify which subcomponents appear to be active mechanisms through which impacts are channeled, and future work in subsequent studies can take these findings as inputs into design of programs that directly randomize and test the impacts of subcomponents of the bundle.

   The second component of the SFCS-OVC program involves improving the socio-economic status of OVC households (component 5 above). This component will involve implementing village savings and loan (VSL) programs in beneficiary communities. VSL programs involve organizing and training individuals to organize themselves into simple savings and credit groups, with the aim of improving access to savings and credit in populations that are poorly served by formal institutions. Facilitators provide training and guidance to volunteer members who elect their own officers, set by-laws, meet regularly, and collect savings from participants. Members can take loans from the communal pool of savings, upon review and approval by the group. Loans are repaid with interest, at an interest rate decided upon by the group. Groups manage their own funds, which are all internally generated from savings and interest earnings from loans. All transactions occur in public with full transparency in front of group members. Benefits may derive from improvements in household income prospects as well as improvements in ability to cope with risk. In particular, buffer stock savings may be especially important for households close to the edge of subsistence, or with serious chronic health conditions such as HIV. In a recent study conducted in Mozambique in Manica province (one of the SFCS-OVC provinces) by PI Dean Yang, facilitation of formal savings for rural households was found to raise consumption levels and improve household ability to cope with agricultural shocks.[5] A recent randomized controlled trial on the impact of VSL programs in Mali found that the program led to improved food security, consumption smoothing, and buffer stock savings.[6] In this context, this study has the opportunity to reveal whether the risk-coping benefits from informal group-savings

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[5] Carter, Michael, Rachid Laajaj, and Dean Yang, "Subsidies, Savings, and Sustainable Technology Adoption: Field Experimental Evidence from Mozambique," working paper, 2016. http://sites.lsa.umich.edu/deanyang/wp-content/uploads/sites/205/2016/03/carter-laajaj-yang-2016-subsidies-savings-technology-adoption.pdf
[6] Beaman, Lori, Dean Karlan, and Bram Thuysbaert, "Saving for a (Not So) Rainy Day: A Randomized Evaluation of Savings Groups in Mali," NBER Working Paper 20600, October 2014.

programs can bring benefits to OVCs and their households. OVC households, due to the presence of individuals who may be HIV positive, have chronic health conditions that make access to financial mechanisms (such as buffer stocks of savings, and access to credit) potentially useful for coping with the particular health shocks associated with HIV/AIDS. This will be the first study (to our knowledge) of the impact of a widely-implemented financial access intervention on the outcomes of OVCs and their households (a vulnerable population with particularly pressing needs for risk-coping mechanisms).

Implementation of the program will be carried out by WEI/B and partner organizations. Evaluation of the impact of SFCS-OVC will be done by the Population Studies Center, Institute for Social Research, University of Michigan, under Principal Investigator Dean Yang. This proposal outlines the impact evaluation plan for SFCS-OVC.

Questions

The central questions of interest in this study are as follows:

1. What is the impact of the SFCS-OVC program on the outcomes of OVCs?
    -   What effect does the program have on health care utilization (health center visits, HIV testing, diagnosis, and treatment)?
    -   What are subsequent effects on health outcomes (anthropometrics, morbidity, mortality)?
    -   What are the impacts on education outcomes (attendance, performance, grade progression)?
    -   What are impacts on household economic conditions (investment in agricultural and non-agricultural activities, use of modern agricultural inputs, farm income, non-farm income, consumption per capita)?
    -   Do the economic strengthening interventions affect household ability to cope with health and other (e.g., agricultural, weather) types of shocks? If so, what financial instruments do households use to cope with shocks (credit, savings, asset accumulation and decumulation)?

2. How do the impacts of the economic strengthening interventions (component 5), compare with impacts of the community support interventions (components 1-4)?

3. How do the economic strengthening and community support interventions interact? Do the two types of interventions complement or substitute for one another?

Methodology

This study aims to provide convincing estimates of causal effects of a PEPFAR program that exploits randomized selection of beneficiary sites. SFCS-OVC will be implemented in randomly-

selected communities across nine districts in central Mozambique (Manica, Sofala, and Zambezia provinces). Random assignment allows the causal effect of the interventions to be identified in a convincing fashion. Past studies of PEPFAR programs have not been able to exploit a prospectively randomized intervention design, and instead have relied on retrospective analysis with control or comparison groups that were not randomly selected. In addition, past studies have not tracked defined groups of individuals over time (from before to after program implementation), and so have difficulty shedding light on mortality (one of the most important outcomes to examine in this context), and in addition are subject to attrition biases.[7]

Another key aspect of the study is estimation of the economic strengthening component (component 5) of the SFCS-OVC program, separately and in interaction with the community support components (components 1-4). This will be achieved via randomization of the economic strengthening component separately from the community support components. The independent effect of these components, and their interaction, have not previously been estimated.

Research design

Causal impacts will be identified using the randomized controlled trial (RCT) methodology. This methodology is the gold-standard in impact evaluation, as random selection of beneficiaries helps ensure that treatment and control groups are similar to one another on average on baseline characteristics. Because it is randomly selected, the control group serves as the counterfactual for the treatment group, representing the time-path of outcomes of interest that the treatment group would have followed had it not been treated.

Recognizing that all SFCS interventions are implemented at the community level, treatments will be randomly assigned at that level. A large number (ideally, at least twice the number of treated communities) of communities will be pre-qualified as eligible communities. This will allow some degree of targeting towards the most desirable or deserving communities from the standpoint of the program, while allowing gold-standard impact evaluation in the context of an RCT. The subset of treated communities will then be selected via random lottery. If desired, randomization can occur within districts, to ensure an even distribution of treated communities across districts.[8]

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[7] Malcolm Bryant, Jennifer Beard, Lora Sabin, Mohamad I. Brooks, Nancy Scott, Bruce A. Larson, Godfrey Biemba, Candace Miller and Jonathon Simon. "PEPFAR's Support For Orphans And Vulnerable Children: Some Beneficial Effects, But Too Little Data, And Programs Spread Thin," *Health Affairs*, 31, no.7 (2012): pp. 1508-1518. http://content.healthaffairs.org/content/31/7/1508.full.html
[8] The implementing agency, World Education Inc./Bantwana, is currently planning to randomly select SFCS-OVC beneficiary communities in central Mozambique. If for unforeseen reasons this proves to be infeasible, the study will implement an alternative research design for identifying causal treatment effects that does not involve randomization of treatments. This will most likely involve propensity score matching (PSM). A PSM research design would involve collection of community-level data on the determinants of inclusion in the SFCS-OVC program. An index or "propensity score" will be calculated that predicts the likelihood of inclusion as a treatment community. Communities that were actually treated will be compared with those that were not treated but that had similar propensity scores (similar probabilities of treatment).

If feasible, community support interventions (IR1-IR4) will be randomized independently of the economic strengthening interventions (IR5). This would yield four possible treatment combinations, as in Table 1 below: 25% in a pure control group, which receives no treatments, 25% receiving only the community support interventions (IR1-IR4), 25% receiving only the economic strengthening interventions (IR5), and 25% receiving both types of interventions.

Table 1: Proportion of Eligible Communities by Treatment Condition

		Economic Strengthening Treatments	
		No	*Yes*
Community Support	*No*	25%	25%
Treatments	*Yes*	25%	25%

Key outcomes

- Engagement with SFCS interventions (take-up): Contact with CCPCs, participation in CRCs, etc.
- Health care utilization: health center visits, HIV testing, diagnosis, and treatment
- Health outcomes: anthropometrics, morbidity, mortality
- Education outcomes: attendance, performance, progression
- Economic outcomes: investment, technology adoption, farm income, non-farm income, consumption, assets, savings, risk-coping

These outcomes will be examined for key sub-populations, defined by gender, age, and household socio-economic status.

Different outcomes will be relevant for different age groups. For the key health outcomes (anthropometrics, morbidity, and mortality), children aged 5 or below will be the main focus. Education outcomes will be relevant for children aged 6 and older, to be divided into primary-school age (6-11) and secondary-school age (12-17) children.

Data sources

Administrative data from World Education Inc./Bantwana and public health centers will allow measurement of participants' engagement with SFCS interventions and health care utilization outcomes.

Survey data will provide information on health and education outcomes of OVCs, as well as data on economic and social conditions in OVC households. Prior to the implementation of interventions, baseline survey data will be collected on a sample of OVC households in each eligible community. OVC households will be identified via door-to-door enumeration of households with a predefined list of questions that are aimed at identifying children with one or

both parents deceased and whose mortality is likely to have been due to AIDS. Due to the sensitive nature of such questions, the protocol for identifying OVCs and their households will be designed in close consultation with local partner organizations and field-tested to ensure cultural acceptance and recognition of cultural sensitivities. The baseline survey will allow confirmation that communities are on average similar prior to implementation of treatments, and will also allow identification of households and individuals who are to be tracked over time in subsequent post-treatment survey waves. Tracking a consistent set of individuals identified at baseline aids greatly in minimizing selection bias (and other biases) that could confound estimation of causal effects of the program. The follow-up surveys will aim to track OVCs even if they move to different households. Such cross-household mobility is an outcome of interest as a potential contributor to OVC well-being, and may be affected by the treatments.

Regression analyses

Randomization of treatments across communities officers allows identification of the causal impact of the program on various outcomes of interest. These regression analyses will be detailed in a pre-analysis plan to be submitted to the American Economic Association's RCT Registry (www.socialscienceregistry.org).

Primary regression analyses will be at the level of individuals and households in our survey sample (whose exposure to the treatments are also randomly assigned via randomization of their communities, as in Table 1). Outcomes of interest will include health care utilization, testing, and treatment, all of which will come from administrative data. In addition, we will examine outcomes from survey data, such as mortality and morbidity, anthropometrics, and household income, consumption, and poverty metrics. The impacts of the community-support and economic strengthening treatments will be estimated via the following regression equation:

(1) $Y_{ijs} = \alpha + \beta C_{js} + \phi E_{js} + \rho(C_{js} * E_{js}) + \gamma_s + \varepsilon_{ijs,}$

where Y_{ijs} = the outcome for individual or household i in locality j in stratification cell s, C_{js} is the indicator for locality j receiving the community support treatment (1 if in the treatment group, and 0 if not), E_{js} is the indicator for locality j receiving the economic strengthening treatment, and γ_s is a fixed effect for stratification cell s.[9] ε_{ijs} is a mean-zero error term. Treatment assignment is common for all households in the same community, so standard errors will be clustered at the level of the community to account for within-group correlation of dependent variables among those individuals.[10] The coefficient β on the treatment indicator is the intent to treat (ITT) effect of the community support treatment (alone), ϕ is the effect of the economic

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[9] Inclusion of the stratification cell fixed effects can reduce standard errors by absorbing residual variation. Stratification will likely be at the level of 9 administrative districts included in the project, and stratification cell fixed effects will be equivalent to district fixed effects.

[10] Moulton, Brent, "Random Group Effects and the Precision of Regression Estimates," *Journal of Econometrics*, 1986, 32 (3), 385-397.

strengthening treatment alone, and ρ represents the interaction of the two treatments.[11] If the interaction is positive ($\rho > 0$), the treatments complement one another, while if the interaction is negative ($\rho < 0$), the treatments substitute for one another or interfere with one another in some way.

Power calculations

The study has a cluster-randomized experimental design. The household survey will have a total sample size of 2,200 OVC households across 110 communities. With communities as clusters, we therefore have about 20 OVC households per cluster.

The study has sufficient power to detect effects of reasonable size on the key outcomes of interest. Power calculations are based on a baseline survey and single follow-up, and were done using the Optimal Design program.[12] Effect sizes, standard deviations and intracluster correlations are calculated using 2013 survey data from Carter, Laajaj, and Yang (2016), an RCT examining the impacts of agricultural input subsidy and formal savings interventions in Manica province (one of the provinces included in the SFCS-OVC project).[13]

The following power calculation is for detecting an increase in log household consumption per capita. We make the following assumptions: statistical significance level 0.05; 110 clusters; intracluster correlation coefficient 0.057; 20 households per cluster; standard deviation 0.530; treatment effect on consumption 0.106 (0.2 standard deviations). Our study design has power of 0.892 to detect an effect of this size. At power of 0.80, the minimum detectable effect size on this outcome would be 0.174 standard deviations of log household consumption per capita.

Some outcomes are relevant for only subsets of households, because not all households will have children in age ranges relevant for certain outcomes. Health outcomes such as anthropometrics, for example, will be most relevant for younger children (aged 5 or below). We presume that children aged 5 or below will be present in one-half of sample households (10 households per cluster). We make the following additional assumptions: statistical significance level 0.05; 110 clusters; intracluster correlation coefficient 0.05; treatment effect of 0.2 standard deviation. Under these assumptions, our study design has power of 0.80 to detect an effect of this size.

Policy Relevance

The HIV/AIDS pandemic has been one of the largest global health crises of the last few decades. This study aims to shed light on the effectiveness and impact of one of the most prominent and well-funded efforts at ameliorating the impacts of the crisis, the set of PEPFAR community and

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[11] The impact of both treatments in combination is therefore $\beta + \phi + \rho$.

[12] Available at http://hlmsoft.net/od/

[13] Carter, Michael, Rachid Laajaj, and Dean Yang, "Subsidies, Savings, and Sustainable Technology Adoption: Field Experimental Evidence from Mozambique," working paper, 2016. http://sites.lsa.umich.edu/deanyang/wp-content/uploads/sites/205/2016/03/carter-laajaj-yang-2016-subsidies-savings-technology-adoption.pdf

economic interventions for orphans and vulnerable children. The results will therefore be of direct relevance for policy, by allowing cost-benefit analyses of this program so as to best prioritize scarce aid resources in the context of the HIV/AIDS crisis.

Contribution to USAID objectives and initiatives

The U.S. government has defined five strategic goals for development aid in Mozambique. The goals are:
> 1) Strengthened democratic governance in Mozambique
> 2) Improved competitiveness of key economic sectors
> 3) Improved health of Mozambicans
> 4) Expanded opportunities for quality education and training
> 5) Enhanced capabilities of Mozambican security forces.

The SFCS-OVC program contributes most directly to goal #3, "Improved health of Mozambicans," as well as contributing to goal #4, "Expanded opportunities for quality education." Impact evaluation of the SFCS-OVC program will help the U.S. government prioritize its development aid resources so as to allocate funds towards the most cost-effective programs.

As a PEPFAR-funded program, the SFCS-OVC initiative contributes most clearly and directly to that program. PEPFAR is a joint effort of several U.S. government entities: USAID, U.S. Center for Disease Control and Prevention (CDC), U.S. Department of Defense (DOD), U.S. Department of State, and Peace Corps. Within the context of PEPFAR programs, the SFCS-OVC initiative contributes to three goals outlined in the U.S. government's agreement with the government of Mozambique in its Partnership Framework: Goal 1, "Reduce new HIV infections in Mozambique"; Goal 4, "Improve access to quality HIV treatment services for adults and children"; and Goal 5, "Ensure care and support for pregnant women, adults and children infected or affected by HIV in communities and health and social welfare systems."[14] More broadly, the SFCS-OVC program activity supports PEPFAR's overall objective of strengthening the abilities of families and communities to care for orphans and vulnerable children.

Anticipated Outputs

Dissemination Activities Targeted at Policy Makers

The main focus during the dissemination stage at the end of the project is to present our findings regarding the impact of the community support and economic strengthening interventions in Mozambique. Press releases, radio interviews, and presentations at various

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[14] PEPFAR, "Partnership Framework to Support Implementation of the Mozambique National HIV/AIDS Response between the Government of the Republic of Mozambique and the Government of the United States of America: A Five Year Strategy 2009-2013," August 2010. http://www.pepfar.gov/documents/organization/148818.pdf

events in Mozambique and beyond will ensure diffusion of results and lessons learned within the national as well as regional development and public health communities.

The project plans for dissemination workshops at the provincial and national levels. In organizing these events, we will seek out partnerships with provincial and national public health agencies of the Mozambican government, the USAID Mission in Mozambique, relevant USAID headquarters departments, and with development and public health nongovernmental organizations (NGOs) in Mozambique and beyond.

In addition, we will actively seek out opportunities to present our results at policy-oriented as well as academic conferences, such as those organized by USAID BASIS-AMA-CRSP, Innovations for Poverty Action (IPA), the Jameel Poverty Action Lab (JPAL), the National Bureau of Economic Research (NBER), and regional and multilateral development agencies such as the African Development Bank and the World Bank.

Academic Publications

We will seek to publish the results of this study in in either general interest or top development field journals. Depending on the results of the empirical analysis, the study will result in one or more academic papers. At least one Ph.D. dissertation will be produced under this project which will also contribute additional potential academic studies, and which will also be submitted for publication in appropriate outlets.

Anticipated Impacts

We anticipate that the impacts of this project will be in two major areas. The first area is academic. Dissemination of working papers, submission and presentation at conferences and academic seminars, and submission for publication in journals will inform the larger academic and policy community of the evidence we generate on the effectiveness of the SFCS-OVC community support and economic strengthening treatments on the outcomes of OVCs and the households in which they live. Dissemination of our findings will potentially deepen the understanding of the types of interventions that help vulnerable populations exposed to HIV/AIDS in developing countries, stimulating follow-on research that builds on our findings.

Second, we aim to have an impact on policies and programs aimed at improving the outcomes of OVCs and their households. This research program has been requested by the USAID Mission in Mozambique, and will provide direct insight into the effectiveness of a large-scale development program they are funding. Insight into the impact of the community support treatment, the economic strengthening treatment, and their interaction can influence future roll-out and scale-up of the program. Impacts would be most direct in Mozambique, but could also influence the design and implementation of the policy in other parts of Sub-Saharan Africa and the rest of the developing world.

Timeline

Year 1	Identification of eligible communities. IRB approval at University of Michigan and Government of Mozambique. Random assignment of treatments to communities. Baseline survey of OVCs and their households in treatment and control communities.
Year 2	First follow-up survey conducted. Ongoing collection of administrative data on SFCS-OVC project outcomes. Preliminary report on causal impacts.
Year 3	Tracking surveys to facilitate later follow-up in Year 4. Ongoing collection of administrative data on SFCS-OVC project outcomes.
Year 4	Final follow-up survey conducted. Ongoing collection of administrative data on SFCS-OVC project outcomes. Final report with full estimates of short- and medium-run impacts.

Budget

Budget estimates assume a total of 110 eligible communities (55 treatment and 55 control communities), with 20 sampled households per community, giving a total sample size of 2,200 households. The survey involves a baseline in year 1 and follow-up surveys in years 2 and 4. Annual follow-up surveys have the advantage of allowing a better understanding of the annual time-pattern of impacts, and also potentially allow adjustment of the final follow-up survey to account for prior findings. For cost reasons, however, the research plan omits the middle (year 3) follow-up survey, and instead involves a scaled-down tracking survey that simply aims to maintain contact and update location information for study participants, aiming to reduce attrition in the final (year 4) follow-up survey. (For further detail, please see the Budget Justification document.) Total budget is $1.25 million.

Conditional on successful implementation of the SFCS-OVC program and baseline survey in year 1, we may request additional funding to conduct a midline (year 3) follow-up survey, to replace the currently planned scaled-down tracking survey. We anticipate this would require additional funding in the realm of $350,000-400,000 (direct and indirect costs; includes data collection and research staff time).

Summary of Qualifications

Principal Investigator (PI) Dean Yang is a Professor in the Department of Economics and the Ford School of Public Policy, and a Research Professor at the Population Studies Center at the University of Michigan. His topics of interest include microfinance, international migration, health, disasters, international trade, and political economy. Methodologically, much of his work involves randomized controlled trials in field settings, but other work involves analysis of novel

data sources. He is currently running survey work and field experiments among Filipino migrant workers and their families, and among rural microloan clients in Malawi. His past and current field research locations include El Salvador, Guatemala, Indonesia, Malawi, Mozambique, and the Philippines, as well as migrant populations of Filipinos in Italy, Indians in Qatar, and Salvadorans and Kenyans in the U.S. He teaches courses in development economics and microeconomics at the undergraduate, master, and Ph.D. levels. A native of the Philippines, he received his undergraduate and Ph.D. degrees in economics from Harvard University.