

Procedures and analysis plan - Quantifying the economic benefits of privately funded malaria control interventions in Maragra, Mozambique

Joe Brew
Laia Cirera
Elisa Sicuri

Summary

The eradication of malaria could be accelerated by enlisting multiple non-governmental actors, including large private firms operating in endemic regions. Participation, however, relies on a clear and accurate quantification of the cost and impact of malaria control activities on economic output. This project proposes to use the case of the sugar mill of Maragra Açúcar CA (southern Mozambique) to assess the impact of privately-managed indoor residual spraying on workers' economic output (in terms of both absenteeism and productivity). This document gives an overview of both the plan for data collection and analysis.

Background

The burden of malaria is extremely high in Mozambique, even by regional standards (Brundtland, 1999). With a prevalence as high as 40%, malaria accounts for 29% of all deaths, and 42% of deaths among children under five (USAID, 2011). Nearly a quarter of maternal deaths are due to malaria (K. Singh *et al.*, 2014). Along with HIV/AIDS (A. Berg *et al.*, 2014), malaria is one of the greatest threats to public health in southern Mozambique.

In addition to malaria's impact on the health of its victims, the illness also has major economic consequences for the ill. Children who survive malaria face hurdles which can have life-long economic repercussions, particularly those related to intellectual development (such as cerebral malaria) (Idro *et al.*, 2010) and general growth anemia (Mabunda *et al.*, 2008). Their families also pay economically - 32-34% of households incur malaria-related costs which rise to the level of "catastrophic" per the World Health Organization's standards (ie, 10% of household income or 40% of non-food income) (Castillo-Riquelme *et al.*, 2008). Though the burden of malaria is decreasing (Murray *et al.*, 2014), the costs of the disease at the individual level remain enormous, given that the disease affects primarily those with low socioeconomic status.

The economic effects of malaria are not only absorbed by its direct victims, but also by the economy as a whole. Malaria control has been found to be associated with population-level economic growth in multiple studies (Barofsky *et al.*, 2015). By eliminating early-life blocks on the development of a population's human capital, the returns on a reduction in malaria's burden are long-term and exponential.

From a public health perspective, the case for the need to control and eventually eradicate malaria is strong and has been made clear in multiple studies across time and geography. However, the role which private firms which operate in malaria endemic regions can be expected to play is less obvious, given the current lack of compelling evidence regarding the return on investment in short- and medium-terms for privately-funded malaria control activities. To the extent that many firms already carry out some form of "in-house" malaria control, analyzing those firms' data offers the unique opportunity to assess whether the benefits (in purely economic terms) of those activities outweigh the costs, or vice-versa.

Study Rationale

In recent years, much of the discourse regarding malaria in endemic regions has shifted from control to eradication (Tanner *et al.*, 2015). This shift will require changes not only in the implementation of public health interventions, but also the recruitment and sustenance of multiple and novel fronts in the fight against malaria. One potential new front and source of funding would be private firms, especially given the astounding growth of foreign direct investment in Mozambique over the last two decades.

Though private, foreign-owned firms are a potential source of funding for malaria control and eradication, it is not reasonable to expect significant participation at the population level without a clear demonstration of the value proposition from a private perspective. Though the non-tangible benefits of "corporate social responsibility" (good publicity, etc.) are certainly appealing to private firms, investment would likely increase significantly if the costs and benefits of malaria control from a purely economic perspective were quantified. On the one hand, if it can be compellingly demonstrated that privately-funded malaria control interventions offer a significant return on investment, this evidence could entail an organic/spontaneous investment increase across the country. On the other hand, if it were found that private foreign investment is not cost-effective from the perspective of private foreign firms, then this may spur donors and the public sector to better coordinate, scale, and work with firms to fill the gaps.

Ultimately, the justification for this study is opportunity. The presence in Mozambique of large, foreign firms with sophisticated systems for inventory, employee activities, and (in some cases) even on-site clinics means that, for the first time, there exist data which can shed light on the feasibility and scalability scaling up non-traditional fronts in the fight against malaria.

Objectives

Primary objective

The primary objective is to quantify the direct economic costs and benefits of malaria interventions carried out by private firms, using the case of Maragra Açucar CA.

Specific objectives

In addition, and in complementarity to the primary objective, secondary objectives include:

- The quantification of worker absenteeism over time, and in association with malaria control activities.
- The quantification of worker *productivity* over time, and in association with malaria control activities.
- The quantification of worker *illness* over time, specifically in regards to those diseases directly related to vector control, and the corresponding estimation of the direct treatment costs.
- The estimation of costs associated with privately-funded malaria control activities.
- The overall and intervention-specific return on investment for privately-funded malaria control activities.

- Worker absenteeism data.
- Worker illness data (from on-site clinics).
- Worker sociodemographic and residential data.
- Worker performance/output data (if available).
- Worker wages and indirect costs (if available).

Additionally, to account for confounding factors in terms of both population characteristics and interventions, both census and MALTEM activities data will be utilized.

Finally, to account for outside factors, precipitation and temperature data will be used for the purposes of modeling and adjusting for seasonality.

Study area

The study area pertains to the sugar plantation and factory of Maragra.

Study design

This study is purely retrospective, using existing data sources, with no intervention. It relies on the “natural experiment” of differential applications of a treatment (IRS) by time and geography in relation to economic outcomes (absenteeism and productivity). It has both a descriptive (correlational) component, as well as an analytical component (a retrospective cohort study).

Methods

General

The data

In the spring and summer of 2016, under the auspices of the MALTEM (Mozambican Alliance Towards the Elimination of Malaria), and in cooperation with the CISM (Centro de Investigaçao em Saude de Manhica) and Maragra Açucar CA, data will be collected pertaining to:

- All vector-control activities carried out by Maragra (indoor residual spraying and bednets distribution), specifically in relation to time and location.
- The costs (both direct and indirect) associated with the above activities.

Study population

The study population consists of all workers of Maragra Açucar CA from the period of 2010 through 2015.

Timing and duration of the study

Data collection will take place in May-June of 2016. Analysis will be carried out in July-August of 2016. Results and manuscript writing can be expected to be finished by the end of August 2016. Internal vetting of manuscript and submission for publication will be finished by the end of September, 2016.

Data collection and management

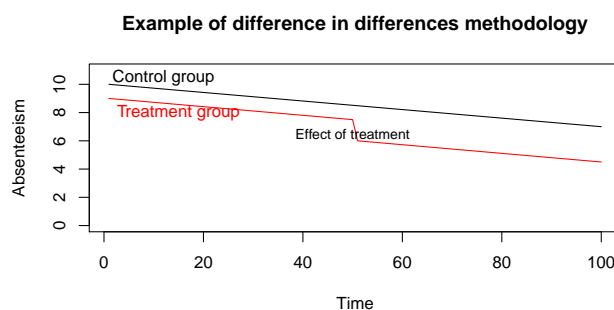
All data are retrospective and already in existence. In this sense, data are to be “compiled” rather than

collected. Compiled data will be stored on an encrypted drive to which only the PI (Elisa Sicuri) and researcher (Joe Brew) will have access.

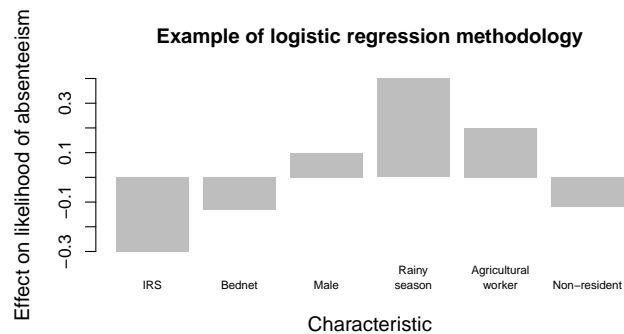
Data analysis

Two analytical approaches are envisioned for the impact evaluation and cost quantification of Maragra's malaria control initiatives on economic outcomes, respectively:

1. A "difference in differences" approach to assess the impact of IRS in terms of the aggregated before/after blocks, accounting for omitted variable bias.



2. Logistic regression to assess the likelihood of worker absence as a function of time since indoor residual spraying, adjusting for confounding variables (weather/seasonality, sociodemographic characteristics, worker type, etc.), thereby assessing IRS' waning impact over time.



Following these two analyses, the extension to the costing portion will be relatively simple, requiring only basic arithmetic and counterfactual scenario generations.

Ethics clearance

This project falls under the auspices of the already-approved protocol of the MALTEM economic evaluation.

Confidentiality

All data will be stored on encrypted disks, and identifiable data will only be accessible to the PI and main researcher.

Details on and qualifications of research team

Details on members of the research team are available at www.economicsofmalaria.com.

References

- Barofsky, J., Anekwe, T. D. and Chase, C. (2015), 'Malaria eradication and economic outcomes in sub-saharan africa: Evidence from uganda', *Journal of Health Economics*. Elsevier BV, **44**: 118–136. <http://dx.doi.org/10.1016/j.jhealeco.2015.08.002>.
- Berg, A., Patel, S., Aukrust, P., David, C., Gonca, M., Berg, E. S., Dalen, I. and Langeland, N. (2014), 'Increased severity and mortality in adults co-infected with malaria and HIV in maputo, mozambique: A prospective cross-sectional study', *PLoS ONE*. Public Library of Science (PLOS), **9**(2): e88257. <http://dx.doi.org/10.1371/journal.pone.0088257>.
- Brundtland, G. H. (1999), 'WHO on Health and Economic Productivity', **25**(2): 396–402.
- Castillo-Riquelme, M., McIntyre, D. and Barnes, K. (2008), 'Household burden of malaria in south africa and mozambique: Is there a catastrophic impact?', *Tropical Medicine & International Health*. Wiley-Blackwell, **13**(1): 108–122. <http://dx.doi.org/10.1111/j.1365-3156.2007.01979.x>.
- Idro, R., Marsh, K., John, C. C. and Newton, C. R. J. (2010), 'Cerebral malaria: Mechanisms of brain injury and strategies for improved neurocognitive outcome', *Pediatr Res*. Nature Publishing Group, **68**(4): 267–274. <http://dx.doi.org/10.1203/PDR.0b013e3181eee738>.
- Mabunda, S., Casimiro, S., Quinto, L. and Alonso, P. (2008), 'A country-wide malaria survey in mozambique. i. plasmodium falciparum infection in children in different epidemiological settings', *Malar J*. Springer Science + Business Media, **7**(1): 216. <http://dx.doi.org/10.1186/1475-2875-7-216>.
- Murray, C. J. L., Ortblad, K. F., Guinovart, C., Lim, S. S., Wolock, T. M. and Roberts, D. A. *et al.* (2014), 'Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990–2013: A systematic analysis for the global burden of disease study 2013', *The Lancet*. Elsevier BV, **384**(9947): 1005–1070. [http://dx.doi.org/10.1016/S0140-6736\(14\)60844-8](http://dx.doi.org/10.1016/S0140-6736(14)60844-8).
- Singh, K., Moran, A., Story, W., Bailey, P. and Chavane, L. (2014), 'Acknowledging HIV and malaria as major causes of maternal mortality in mozambique', *International Journal of Gynecology & Obstetrics*. Elsevier BV, **127**(1): 35–40. <http://dx.doi.org/10.1016/j.ijgo.2014.05.002>.
- Tanner, M., Greenwood, B., Whitty, C. J. M., Ansah, E. K., Price, R. N. and Dondorp, A. M. *et al.* (2015), 'Malaria eradication and elimination: Views on how to translate a vision into reality', *BMC Medicine*. Springer Science + Business Media, **13**(1). <http://dx.doi.org/10.1186/s12916-015-0384-6>.
- USAID (2011), 'Demographic and Health Survey in Mozambique'.