# The (Potential) Role of Economic Policy in Combating Neglected Tropical Diseases: A Case Study of Schistosomiasis in Uganda

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Current version: August 24, 2023

Despite decades of efforts by policymakers, NGOs, and others, Neglected Tropical Diseases (NTDs) persist around the world (Ogongo et al., 2022; World Health Organization, 2015). The 2nd most common NTD in the world after Malaria is Schistosomiasis (shortened to Schisto below), and it is widely considered as an infectious disease of poverty (World Health Organization, 2015; Centers for Disease Control, 2018). In many countries a poor household is more likely to lack proper sanitation and access to adequate health care (Stevens 2014), both of which have been shown to be correlated with Schisto prevalence (Grimes et al. 2014). In addition, Schisto and similar diseases can negatively impact both the accumulation process and the stock of an individual's health capital, making it even more difficult for vulnerable and poor households to avoid being trapped in a state of poverty (Bonds et al., 2010).

Previous studies have shown empirical relationships between aggregate measures of economic activity and disease burden. Gallup and Sachs (2001) identify correlations between country-level economic growth and malaria prevalence. Cole and Neumayer (2006) find that health impacts total factor productivity. Ismahene (2022) conclude that infectious diseases can hamper economic growth and trade in developed and developing countries.

Building off of these empirical studies, a number of authors have modeled the relationship between income as a function of disease prevalence. Specifically, Bonds et al. (2010), Ngonghala et al. (2014), and Garchitorena et al. (2017) express model parameters in systems of disease dynamics as functions of aggregate measures of economic activity. Using a general Susceptible-Infected-Susceptible (SIS) model of infection, Bonds et al. (2010) identify two stable equilibria—one that is characterized by high income and no disease prevalence, and one that is characterized by low income and high disease prevalence—and a critical threshold that divides the parameter space of the model between the two stable equilibria. Ngonghala et al. (2014) further develop this approach using an aggregate production function, where capital accumulation is expressed as a function of disease prevalence and disease transmission as a function of aggregate income. Using a similar modeling approach, Garchitorena et al. (2017) model diseases by the degree to which they are either environmentally transmitted or transmitted between individuals.

My dissertation builds on the methods in Bonds et al. (2010), Ngonghala et al. (2014), and Garchitorena et al. (2017) with two important additions. First, I connect a system of disease dynamics for Schistosomiasis to a general equilibrium (GE) model of a small economy. The GE model allows me to account for differences in sectoral-level contributions to overall output, which is not possible using aggregate measures of output. This heterogeneity can be of first-order importance when the amount of labor employed in a particular sector, such as fishing, correlates with disease transmission. Furthermore, the coupled natural-human model provides a powerful tool for understanding how policies that target one domain (e.g. the local economy) can result in ancillary consequences for another domain (e.g. the ecosystem).

Second, I explicitly account for exposure time to the disease in the system of disease dynamics. This addition is critical when labor time in one sector is correlated to exposure to the disease. It is generally accepted that behavioral decisions—along with socioeconomic status, gender, and even ethnicity (Moira et al., 2007)—play a role in transmission of diseases such as Schisto. In many communities where Schisto is prevalent, specific economic sectors such as fishing represent both a significant source of income for the local economy and a significant source of exposure time to the parasite that causes the disease. In these settings, including a measure of exposure time is necessary to understand whether and how policy shocks could influence welfare outcomes via disease dynamics.

To highlight the importance of these two additions: consider a change in fisheries management policy that results in a relaxation of restrictions on fishing effort and an increase in labor demand (and thus output) in the fishing sector. Ignoring possible price effects, this would result in an increase in aggregate output. If one were to simulate the impact of this policy change using a model built with an assumption that disease prevalence declines over time as aggregate income increases, the results might suggest that such a policy change would unambiguously lead to a decline in disease prevalence. However, the amount of fishing labor, and therefore exposure time to the disease, has actually increased. This increase in exposure time could dampen, or perhaps even reverse, the reduction in disease prevalence accruing from the increase in aggregate output.

The contribution of the GE model stems from its ability to capture both direct and indirect effects of policy interventions, particularly when experimental designs are infeasible. Examples of previous country-level studies using a GE model to examine the impact of health on labor productivity include Rutten and Reed (2009) and Verikios et al. (2013). Applying a local economy-wide impact evaluation (LEWIE) model of the local economy to a range of research questions, Taylor and Filipski (2014) provide estimates of the value that a natural resource brings to a local economy, how migration flows can alter local economy impacts of policy interventions, and the impact of cash-transfer programs on non-beneficiary households. More recent studies have coupled a LEWIE model with dynamic models of fish stocks, showing that 1) changes in fisheries management policies that impact fishing effort can impact input use in all productive sectors and 2) changes in the fish stock can influence effort in the fishing sector and other productive sectors, with welfare implications for households across the income distribution (Manning, Taylor, and Wilen, 2018; Gilliland, Sanchirico, and Taylor, 2019; Lindsay et al., 2020).

My dissertation also offers a unique perspective on the role that economic policy might play in disease mitigation efforts. For diseases like Schistosomiasis, efforts to combat the disease have largely focused on reducing prevalence in human hosts via the implementation of mass drug administrations (MDA) of inexpensive treatments such as Praziquantel. Integrated approaches to management of Schisto prevalence have combined MDA programs with other methods, including: environmental interventions, such as molluscicides or reintroduction of natural predators; improved WASH facilities; and information-based interventions. Results from previous studies demonstrate the importance of a multidisciplinary approach to combating prevalence of the disease (Castonguay et al., 2020; Sun et al., 2017; Inobaya et al., 2014). However, the potential role that economic policy can play as a means to influence behavior in this context has received less attention.

In this study, I examine how three types of policies interact with prevalence of Schisto. I develop an integrated epidemiological-biological general equilibrium model of an economy. I model labor employed in each sector as a function of disease prevalence. In the epidemiological component, I model the two parameters as a function of aggregate output and include an explicit measure of exposure time. To account for the relationship between fishing effort and the fish stock, I also include a dynamic model of the fish stock targeted by the local fishing industry. Using this novel coupled natural-human model, I simulate the impact of three different types of policy shocks: a policy designed to increase yields in cash-crop production by smallholder households, a fisheries management policy designed to reduce overfishing, and a community-wide distribution of treatment for Schisto. For each type of policy, I identify the primary effects of the policy shock and any ancillary consequences of the policy for other components of the model.

In the remainder of the chapter, I provide details on the background of the disease and the study area, followed by a review of previous literature relevant to the subject matter and methodology found in my dissertation.

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