Women with HIV/AIDS in Malawi: The Impact of Antiretroviral Therapy on Economic Welfare[1]

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Abstract

In this paper, we provide a preliminary, in-depth qualitative analysis of the plausible feedback mechanisms contributing to the high HIV/AIDS prevalence amongst young Malawian women by examining the relationship between HIV infections, HIV risk categories, economic welfare (and productivity), and the potential impact of increased access to antiretroviral therapy (ART). For each qualitative model sector, we review the formulation processes involved and seek a greater understanding of the factors contributing to and affecting the AIDS pandemic in Malawi. We hypothesize that ART is fundamental to increasing economic welfare of young, HIV-infected women in Malawi and show that our models do provide useful insights and clarify feedback mechanisms in a way that may encourage future discussion on social policy and problem-solving.

Key words: Malawi, women, HIV/AIDS, antiretroviral therapy, economic welfare, poverty, productivity

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[1] This paper was supported in part by the Center for Social Development, George Warren Brown School of Social Work, Washington University in St. Louis. Awarded the Lupina Young Researchers Award at the 26th International System Dynamics Conference July 20-July 25, 2008 in Athens, Greece.

[2] We are extremely grateful to Dr. Peter Hovmand for his consistent insight, guidance, enthusiasm, and many reviews of our material; Penny Stein for her ever-sharp editor's eye; and Drs. Ezekiel Kalipeni and Linda Semu for their helpful discussion and input.

Introduction

Malawi has ranked among the bottom twenty countries on the Human Development Index since the Index's creation in 1990 (UNDP, 2005). As one of the poorest countries in the world, approximately 65% of the population (nearly 8.8 million people) live below the national poverty line, and 85% of the population live on less than $2 each day (over 11.5 million people) (The World Bank, 2006). Poverty, of course, does not exist in a vacuum. It impacts and is related to numerous other economic and social dilemmas, many of which Malawians find themselves confronting daily. With 34% of the population undernourished, an adult illiteracy rate of 40%, a life expectancy of 42 years, and one of the lowest known rates of physicians per people, Malawi faces significant barriers to development and to increasing its citizens' quality of life (UNDP, 2007/2008). Furthermore, the severity of the HIV/AIDS epidemic in this southern African country both compounds and exacerbates the country's economic and social dilemmas (UNDP, 2005). As is true throughout the world, and as has been particularly evident in Malawi, development and societal well-being are compromised as HIV/AIDS minimizes the capacity of individuals, organizations, communities, and nations. The relationship between HIV/AIDS and societal functioning is dynamic and complex. With one of the highest HIV/AIDS rates in the world, at just over 14%, Malawi faces significant crises in addressing the overreaching, multi-leveled impact of this disease (UNDP, 2007/2008).

While the current situation in Malawi is daunting, leadership and commitment within Malawi and from international aid organizations lends a more optimistic outlook on the progression of the epidemic. The lessons learned from past interventions in Malawi, the coordinated response from the Malawian government, and the creation and implementation of a National HIV/AIDS Strategic Framework in 2000 have begun the battle toward a stronger nation in spite of the aforementioned barriers (Malawi Ministry of Health and Population, 2004). The multifaceted partnerships launched, the financial and technical resources mobilized, the successful scale up of antiretroviral therapy (ART), and an increase in governmental transparency and accountability have already increased knowledge and awareness of HIV/AIDS within Malawi and have improved its people's access to services and support (Avert, 2007; UNDP, 2005). The current environment in Malawi is ripe for action and for further study in tackling the HIV epidemic and its insidious relationship with economic and societal welfare. Our paper provides problem conceptualization and preliminary models of HIV transmission, ART, and economic productivity. It can provide a useful perspective and be used as a tool for refinement by others (e.g., policy analysts, Malawians, NGOs, aid organizations, and researchers) looking to understand and combat the dynamics – economic, social, and cultural – at play in this fatal issue.

To better understand the situation on the ground in Malawi, to focus our perspective on vulnerable populations, and to shed light on an often overlooked group, we center our research and model-building on women between the ages of 15 and 24. Poverty and HIV prevalence rates throughout Malawi are severe. Yet women are disproportionately affected by both poverty and HIV/AIDS, bearing the brunt of these burdens (UNAIDS, 2004). Women constitute approximately 60% of the population in Malawi living with HIV/AIDS (Avert, 2007). Furthermore, younger women exhibit higher HIV rates than their male counterparts, as 14.5% of women between the ages of 15-24 are HIV-positive, compared to 6.5% of men in the same age group (Ntata, 2007; UNAIDS, 2004). The international AIDS charity, Avert (2007), cites that

within Malawi, AIDS affects a third more women than men in the 20-25 age group and among the 15-19 age range, more than four times as many women are affected as men.

This paper provides a preliminary, qualitative in-depth analysis of the plausible feedback mechanisms contributing to the high HIV/AIDS rate amongst young Malawian women by examining the relationship among four different sectors: HIV infections, HIV risk categories, economic welfare (and productivity), and the potential impact of increased access to antiretroviral therapy. Detailed causal loop diagrams (see Figures 1-4) help to tease apart the factors contributing to the complexity of this issue and help to highlight that the issue as a whole is more than just the sum of its parts.

These qualitative model sectors help to create a roadmap of existing research for ourselves and others, and also facilitate opportunities for future use. For each model sector, we review the formulation processes involved. We hypothesize that ART is *fundamental* to increasing economic welfare of young, HIV-infected women in Malawi. Through conceptualizing this dynamic problem and analyzing the relationship between model structure and behavior, we hope to offer the beginnings of a knowledge base by which sustainable policy recommendations can be formed, thereby positively affecting the overall health and economic welfare of the target population. However, we wish to emphasize that the use of these models should be considered solely as a preliminary step and as a basis for problem conceptualization due to our defined scope and limitations. In the paper's conclusion, we provide discussion on potential future uses and next steps.

Conceptualization

The situation of HIV/AIDS and economic welfare facing young women, Malawians, and the world is alarming. Young women are becoming infected with HIV and are suffering from AIDS while struggling at the same time to fulfill their daily duties and responsibilities, construct identities, and form their lives. Conceptualizing the environment and variables impacting these issues is imperative in beginning to understand the disparities and assess effective policies that can succeed in changing the fate of Malawian women with HIV/AIDS.

Dominant discourses on the relationship between the AIDS epidemic and poverty focus on the role AIDS plays at various levels (i.e., individual, household, community, and national) in escalating poverty. Fewer debates assess the reverse trend, where poverty, and its underlying system of inequality, drives individual behavior and social relations to the point where it shapes the AIDS epidemic (Masanjala, 2007). The following problem conceptualization and modeling incorporate both schools of thought, and places gender at the heart of understanding the dynamic intersections of AIDS and poverty within Malawi. Four significant areas of conceptualization, analyzed below, are poverty and women in Malawi, HIV infection, economic welfare and productivity, and the potential impact of ART.

Poverty and Women

Malawian poverty is largely driven by the fact that 83% of economically active Malawians depend on the relatively unstable agricultural sector and its related activities for sustenance. The instability of Malawi's agricultural sector is impacted by frequent famines and droughts. Furthermore, this agricultural dependency is not shared equally across genders. Ninety-seven percent of rural women engage in subsistence farming, thus placing young girls and women at the greatest risk of poverty (Ngwira, Kamchedzera & Semu, 2003). Other factors

disproportionately affecting females are based on culture norms in which economic support for the family is sought through exploitation of young women. Girls are often removed from school earlier than boys to help supplement the family income (UNAIDS, 2004). Through their forced marriage to older men, their required support of the household, and/or their encouraged migration to urban areas or agricultural poles – such as plantations, markets, or fisheries – for employment, young women are disproportionately affected by family hardships. Ultimately, females have less access to education, training, and productive resources like land and credit; females also tend to have limited entitlements, earn lower wages, and are less likely to own land and benefit from government assistance or international aid (Ghosh & Kalipeni, 2005; Ngwira, Bota, & Loevinsohn, 2001). In short, unequal social relations within Malawi often break down across gender, where gender norms and prescribed roles play a critical role in the "inextricably intertwined" nature of African poverty and gender (Masanjala, 2007, p.1037).

HIV Infection

With very little education, no livelihood skills, and no assistance, young women often resort to selling their bodies for survival. According to Linda Semu – a scholar whose research entails the intertwined nature of social policies, development, and gender specifically within Malawi – young Malawian women are often forced or encouraged to seek out sexual relationships with older men in exchange for money or gifts (personal communication, November 08, 2007). This practice is often perpetuated by cultural practices where males are encouraged to engage in sexual behaviors identified as risky, such as relationships with multiple partners, especially those with younger partners, as young women are believed to be free from sexually transmitted infections (STIs). There are also beliefs that go so far as to imply that having sex with virgins is a cure for AIDS (L. Semu, personal communication, November 08, 2007).

Young females married to older men also suffer from similar gender inequalities and risky behavior. Within Malawian culture, men tend to dominate the relationship and women typically remain financially dependent. Females are increasingly vulnerable to abuse because they are seen as a source of labor or as chattel to be exchanged in marriage (Ngwira et al., 2001). In these marriages, women are often infected with HIV by spouses who engage in extramarital risky sexual practices while working in urban areas. Risk of HIV infection for these women is also increased through polygamous unions, which account for approximately 17% of marriages in Malawia (Ngwira et al., 2003). Additionally, without knowledge of and practice in condom negotiation, it is difficult for women to simply ask their husbands to use one. Asking alone can imply infidelity on the part of the woman and a lack of trust in her husband, both of which place her at greater risk of abuse and domination (Ghosh & Kalipeni, 2005).

Productivity

While in many western countries, the progression of HIV to AIDS may take a number of years, in impoverished countries, the disease progression occurs at a more rapid rate. There has been a significant decline in life expectancy of Malawians since the onset of the AIDS pandemic. Malawians' life expectancy has dropped from 56 years prior to the AIDS outbreak to 40-42 years of age (Mosam & Dlova, 2006; UDNP, 2005; World Health Organization 2005). An average Malawian woman is only expected to be healthy (what we equate in this paper with the ability to be productive) until 35 (Mosam & Dlova, 2006). This decrease in productivity and life span is exacerbated by the increased nutritional requirements for people living with HIV/AIDS (up to

50% greater for protein and 15% for energy), as malnutrition can lead to increased susceptibility to opportunistic infections: thereby furnishing a cycle of an increased need yet a decreased supply of appropriate nutrition (Ngwira, et al., 2001).

AIDS undermines Malawi's vitality and productivity. HIV/AIDS minimizes the capacity of individuals, organizations, communities, and nations and, as described earlier, is intricately intertwined with societal welfare. Young women with HIV/AIDS become unable to maintain, let alone improve, their standard of living, leaving their children in a cycle of poverty. AIDS creates thousands of orphans in the care of other family members or the government. AIDS deprives a country of essential human capital, crucial for economic development. And yet, as AIDS is part of a vicious cycle, without economic development, AIDS will continue to deplete the country's resources. Without resources and assistance, young women, and Malawi as a whole, will be forced to remain in this endless cycle of AIDS and poverty.

Antiretroviral Therapy

To break this endless cycle, policies to aid women with HIV/AIDS in Malawi must be created. Poverty reduction policies that address the target population's short-term priorities, including access to ART, are fundamental for Malawi's development. Highly active antiretroviral therapies (HAART) have been extremely successful in developed countries for many years; however, only recently have African countries benefited from the first generation of ART (Malawi Ministry of Health and Population, 2004). Senegal, Botswana, and Uganda are a few of the countries that have experienced successful ART policies. To effectively combat HIV/AIDS, it is imperative that Malawi, too, provide ART to all in need, especially females.

Problem Definition

Considering these facts, this paper analyzes the feedback mechanisms affecting Malawian women between the ages of 15–24, with an emphasis on those living with HIV/AIDS, thereby elucidating the interactions of various key factors and creating a roadmap for effective policy discourse and alternatives for poverty reduction amongst this target population. This paper focuses on the impact of ART on the health and economic welfare of these young females. The dynamic hypothesis is as follows: *ART is fundamental to increasing economic welfare of young, HIV/AIDS infected women in Malawi.*

Qualitative Modeling

The HIV/AIDS pandemic in Malawi is complex. To gain clarity in the midst of the many variables, we found it important to disaggregate the model into four critical sectors: HIV infection, risk of HIV transmission, economic welfare (productivity), and ART. By disaggregating the model, we were able to obtain a more in-depth perspective and greater clarity, allowing for the elaboration of essential feedback loops identified within and among the model sectors. Furthermore, at the early stages of modeling, we found it more important to attempt to capture as many aspects of behavior as possible, for fear that one larger qualitative model would be missing critical interactions.

Upon separation, each model sector was then linked to the others through key variables. In this way, we were able to better organize and interpret our extensive information. The models in their entirety help to illustrate the complexity and magnitude of this social problem.

For insight into the development of these models and sectors, see our supporting materials, which include preliminary modeling sketches and records of our modeling process. For an overview of all variables and their links to one another, Appendix A includes a full table defining the variables used in each of the four sectors of the overall qualitative model.

HIV Infection Sector: Qualitative Model Formulation and Evaluation

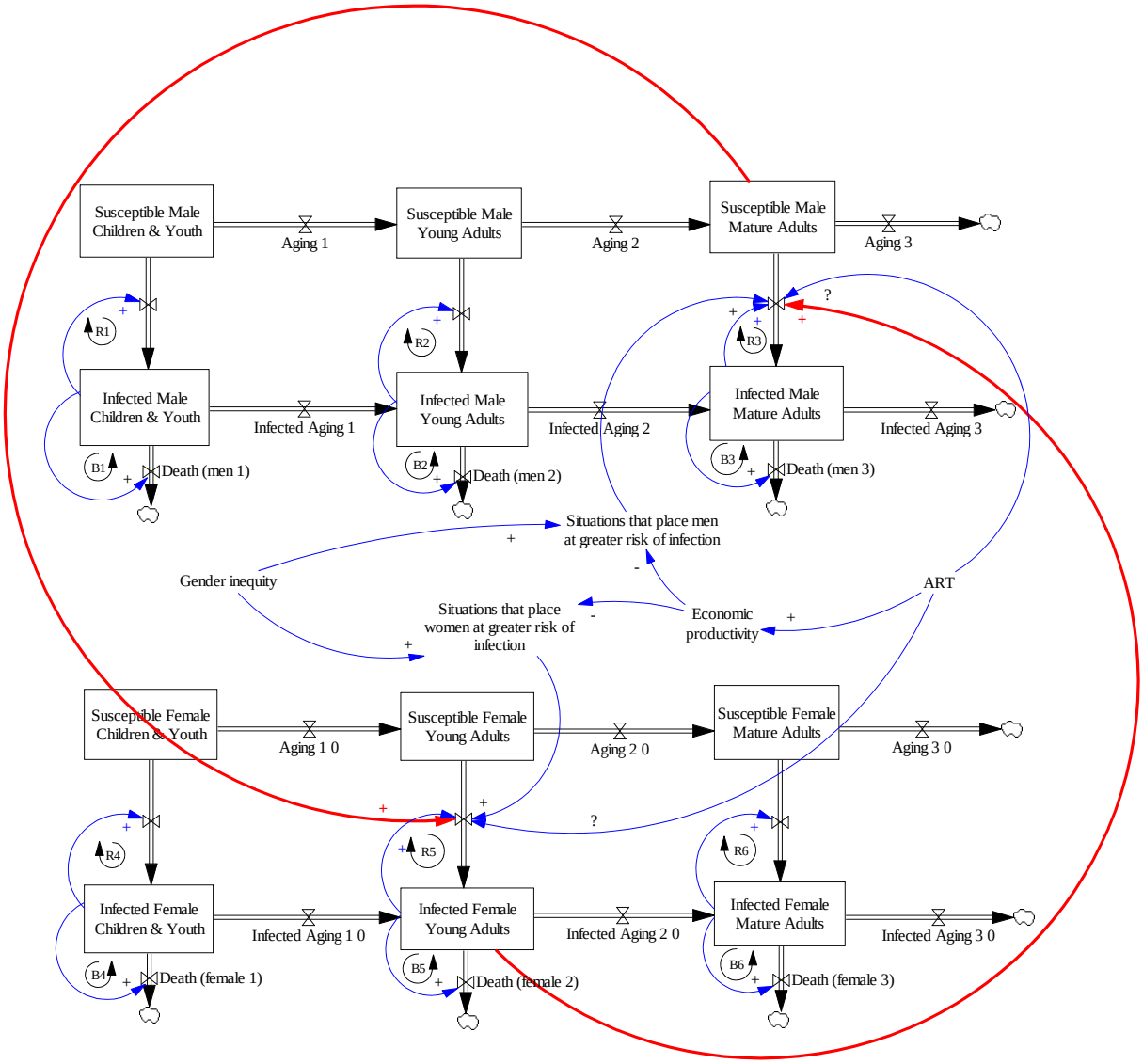

Figure 1: HIV Infection Substructure

While the HIV Infection sector[3] appears to be the most basic model, in reality it is the most complex, as each other qualitative model sector relates to a portion of the HIV Infection sector. The stock-flow structure is broken into susceptible and infected populations by sex and age group to capture cross-generational, heterosexual transmission. The six flows moving between susceptible populations to infected populations refer to the transmission of HIV. The bold arrows indicate the transmission of HIV from older men to younger women and vice versa,

[3] For larger visuals of each substructure, please see Appendix B-E.

offering in part an explanation for why women in the 15-24 age group are more likely to be infected than men. Aside from highlighting the impact of cross-generational sex, this sector includes the broader categories of the three additional qualitative sectors within its variables: *ART*, *economic productivity*, (i.e., economic welfare), and female/male risk of infection (*situations that place women/men at greater risk of infection*). The pervasiveness of *gender inequity* also plays an important role in impacting risk factors for transmission (as mentioned and supported by the Conceptualization section).

Six balancing feedback loops (B1-B6 in Figure 1) support the lethalness of HIV/AIDS, as each age group's death rate increases as infections increase. The infected population does not eventually die out, however, due to six counteracting reinforcing loops representing transmission (R1-R6 in Figure 1). In these reinforcing loops, the infected population hastens the transmission rate, which in turn leads to an increase in the infected population. While these reinforcing and balancing loops imitate in many ways the reality of HIV transmission and death, it is important to note that our system is unchecked by prevention strategies.

The HIV Infection sector highlights the role of cross-generational sex in transmitting the disease across varying age groups and the ability of gender interactions to affect disease transmission and risk. These areas become potential areas to delve into further when debating policies to effect change. However, as this model is preliminary, important next steps would include evaluating model refinement, questioning and reevaluating model boundaries and potential elements missing that may be essential to understanding the dynamics at play. These issues are discussed further in the Implications section.

With the aim of narrowing our scope to remain aligned with our dynamic hypothesis, we have purposefully excluded male-specific transmission, the impact of circumcision, men who have sex with men and women who have sex with women, higher female transmission rates, and prevention campaigns.

HIV Risk of Transmission Sector: Qualitative Model Formulation and Evaluation

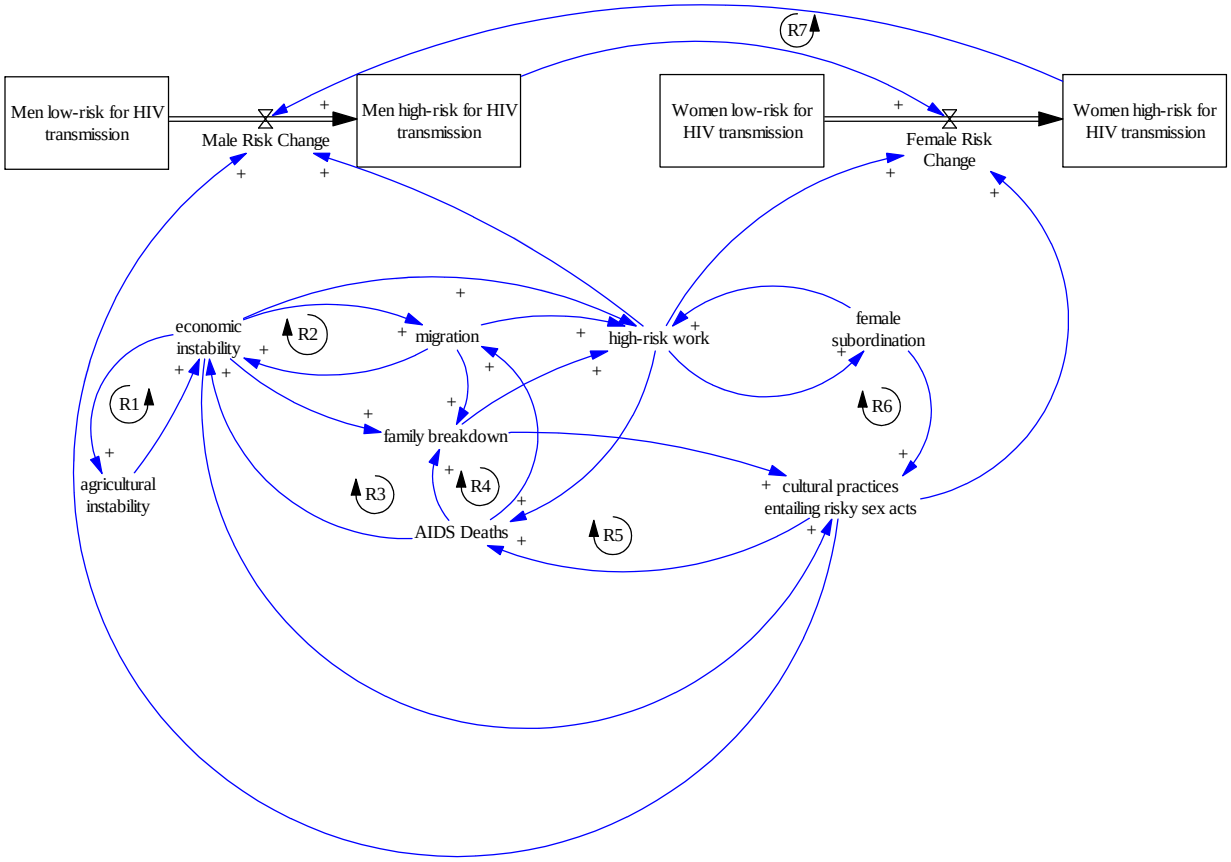

Figure 2: HIV Risk of Transmission Substructure

Why are there are a disproportionate number of Malawian women between the ages of 15-24 infected with HIV? The HIV Risk Model (see Figure 2) attempts to depict the unique reinforcing sexual behaviors that create this disproportionate dynamic. Understanding the epidemiology of the disease amongst this target population is integral to establishing a comprehensive model and eventually, effective policy interventions.

The HIV Risk Model includes four stocks derived from the HIV Infection Model. They include the following: *Men low risk for HIV Transmission, Men high-risk for HIV Transmission, Women low-risk for HIV Transmission,* and *Women high-risk for HIV Transmission*. These parallel stocks have parallel flows of *Male Risk Change* and *Female Risk Change*. The disaggregated genders are then connected through variables indicating the complex social, political, economic, and cultural behaviors prompting HIV transmission and infection.

According to research mentioned above, poverty dictates a certain type of migration pattern and sexual behavior that serves as a reinforcing tool for HIV infection. Agricultural instability, discussed earlier, is indicated by the variable *Natural Disasters* in the linked Economic Welfare sector (L. Semu, personal communication, November 08, 2007). This instability perpetuates economic instability, indicated by a reinforcing loop (R1 in Figure 2). For many Malawian families, economic stability has forced family members to migrate (represented by *migration* in Figure 2). Areas of higher economic stability and growth potential are generally located around *high-risk work* environments and within urban centers. It is in these locations, away from family, where young women are prone to engage in risky sexual behavior as a means

of survival (L. Semu, personal communication, November 08, 2007). For men between the ages of 29-34 who migrate to agricultural poles or urban centers, the cycle differs slightly. Older men tend to experience a *family breakdown* due to extended periods of time away from home, whereupon they engage in risky sexual behaviors with commercial sex workers. The more the family model deteriorates, the higher the increase in *high-risk work*. *Family breakdown* is also linked to *cultural practices entailing risky sex acts*, such as having multiple sexual partners, engaging in unprotected sex, and also engaging in certain sex acts that are harmful to women. These polygamous and risky cultural practices increase infections, *AIDS progression* (linked to Economic Welfare sector) and *AIDS Deaths*. *Family breakdown, cultural practices entailing risky sex acts,* and *AIDS Deaths* signify one large reinforcing loop, R5. Additionally, as mentioned earlier, *AIDS Deaths* contribute to further *family breakdown,* which links to increased *economic instability* and increased flow into *high-risk work* environments for other family members (this reinforcing loop in referenced by R3 and R4). It is important to note that all of these behaviors and variables link to *high-risk work,* which invariably feeds the flow of *Male Risk Change* into the *Men high-risk for HIV transmission* stock.

The *Men high-risk for HIV transmission* stock then affects women's HIV/AIDS status. In addition to going through the above mentioned variables earlier in life, females also come in contact with infected older men through yet another reinforcing cycle (R6) with *female subordination* being its significant variable. Culturally, women are oftentimes considered inferior. It is this practice of *female subordination* that forces young girls into the *high-risk work* environment described earlier. The link occurs in the opposite direction as well, where *high-risk work* environments perpetuate *female subordination*. Commercial sex workers in Malawi are often subjected to sexual and physical abuse (Ghosh & Kalipeni, 2005). In the greater scheme, the variable *female subordination* creates a reinforcing loop when linked with *cultural practices entailing risky sex acts*, *AIDS Deaths*, *family breakdown*, and *high-risk work*. Ultimately, the culmination of both *cultural practices* and *high-risk work* positively contributes to the flow of *Female Risk Change,* which creates an accumulation of the *Women high-risk for HIV transmission* stock. The contact rate and reinforcing loop between infected and high-risk women and men, R7, indicates that uninfected males often become infected by engaging in risky sexual behaviors with infected females and vice versa.

The HIV risk model is meant to demonstrate a significant trend found in the research. It includes many variables, but a key conclusion is that the economic and social environment perpetuates the contact rate between infected and uninfected individuals. Variables such as *economic instability*, *migration*, *high-risk work*, and *female subordination* are essential to understanding how low-risk males and females change risk categories. It is also important to note from our review of the literature that the flow of risk change for females occurs significantly earlier than for males, thus supporting the existing disproportionate infection rate between different age groups. A critique of the model may be its lack of balancing loops. Nevertheless, this lack of a systems check in fact agrees with much of the research, in that the flow of men and women from low-risk to high-risk categories for HIV transmission continues to increase. Despite this rising statistic, it is important to note again that prevention efforts are outside the model boundary. One can easily conclude this variable would have a significant balancing effect on the model. We chose not to include prevention because it was beyond our immediate scope. Most policy discussions would need to correct for this exclusion as prevention and treatment are so often inextricably intertwined.

Economic Welfare Sector: Qualitative Model Formulation and Evaluation

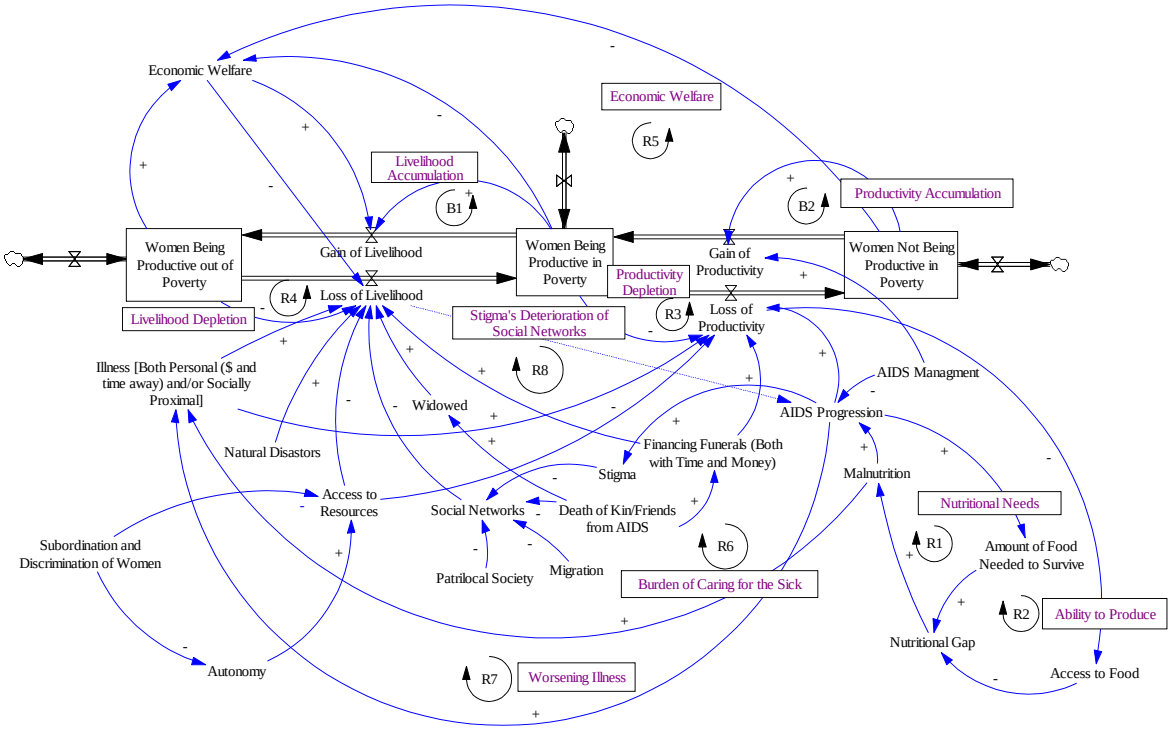

Figure 3: Economic Welfare Substructure

To better understand the impact of HIV/AIDS and ART on economic welfare for Malawian women, we developed a qualitative model of the stock-flow structure implicitly reflected by the research (see Figure 3). The structure demonstrates the flow of women through three different stocks, as they progress through the stages of economic welfare that we identified as the most important for our system: *Women Being Productive out of Poverty*, *Women Being Productive in Poverty*, and *Women Not Being Productive in Poverty*. For the purpose of this qualitative model, we defined poverty as living on less than $2/day (a conservative estimate at best). Also note that we emphasize the impact of illness on productivity by only considering those women whose economic welfare is threatened by HIV/AIDS. We chose not to include productivity of the healthy as well, to keep our model bounded to the specific population encompassed by our dynamic hypothesis. We also equate productivity for women out of poverty in crude terms with economic welfare, though there are certainly exogenous variables impacting economic welfare, but not productivity (e.g., livable wages, theories of development).

The flows identify how women can move between the stocks in this section. The transition from being productive out of poverty to being productive, yet still in poverty is governed by a flow called *Loss of Livelihood*. While loss of livelihood actually represents a two-way flow, we chose to disaggregate it into two, clear, one-way flows (a loss and a gain of livelihood) to demonstrate factors that differentially affect the flow, depending on direction. Livelihood, for our purposes, is defined as the means of supporting an individual or family's existence. This definition, chosen in part to distinguish it from the *Loss of Productivity* flow, governs the transition from being productive while in poverty to not being productive and still in poverty. Generic, unnamed, two-way flows affecting each stock represent other means of

entering and exiting the system, unrelated to the key concepts of our model. These unnamed flows are necessary to help clarify the assertion that every woman will not have the capacity or ability to gain back her productivity (e.g., some women may die while in the nonproductive, poverty stock, and would then leave our system, never being able to join the productive, poverty stock).

The difference between livelihood and productivity, and how they are lost and gained, lies in the fact that livelihood is defined as a means of living and its corresponding activities and abilities. Productivity, on the other hand, is not only a measure of working or livelihood capacity, but also of any productive activity (e.g., school), regardless of age. In looking at the diagram, it is apparent that some variables affect both the livelihood *and* the productivity flows. We believe these variables to be the most important in the system, as they have the greatest potential impact on the economic welfare of our population.

The most important variable of this sector of our qualitative model is, of course, *Economic Welfare*. This is affected by the number of women in each of the three stocks, while the variable itself also affects the livelihood flows. The remaining variables strive to express key factors identified in the literature that may exacerbate or alleviate a woman's transition from one stock to the next.

The *Loss of Livelihood* flow is affected by the most variables. *Illness* represents not only personal illness, but also illness within a woman's family or social network. This inclusion shows how *AIDS Progression* in a community can impact an individual's economic welfare. As the culturally prescribed primary care givers, women bear the brunt of caring after the sick. Additionally, this extends beyond a woman's family unit, into caring for the community because of cultural expectations.

> The burdens of caring for the sick and for orphans are customarily spread within communities, benefiting households that are both better and less well off, but as prevalence rises, these burdens may overwhelm the ability or willingness of other households to further divide their economic entitlements. (Ngwira et al., 2001, p.16)

This relationship between *Illness* and *AIDS Progression* leads to the reinforcing loop, R6: "Burden of Caring for the Sick." While the loop may seem discontinuous when considering this particular sub-domain of our qualitative diagram, it connects to the HIV/AIDS Infection sector, linking *Women Being Productive in Poverty* and the variable *AIDS Progression*. When taking into account the other sectors, *AIDS Progression* is influenced by an *AIDS Infection*, ultimately the result of a transition of a woman from a low-risk to a high-risk environment, which is demonstrated in this particular sector when the woman enters the first poverty stock.

Reinforcing loop R7: "Worsening Illness" also affects *Illness*. This loop connects to the HIV/AIDS Infection sector similarly, influenced by the link between women in poverty and *AIDS Progression* as well. As malnutrition worsens, *Illness* increases as do the *Loss of Livelihood* and the *Loss of Productivity* rates. As *Illness* impacts both the livelihood ***and*** the productivity flows, it is a major factor influencing the economic welfare of the women in our system.

Two reinforcing loops, R1: "Nutritional Needs" and R2: "Ability to Produce" support existing data, showing that the faster a woman loses her productivity, *Access to Food* decreases. This could mean access as in a woman's ability to cultivate and preserve her food supply, or it

could also refer to her ability to gain an income with which to purchase necessary food. *Nutritional Gap* positively contributes to *Malnutrition*, which in turn, adds to *AIDS Progression*. The final causal link to complete this set of reinforcing loops is the connection from *AIDS Progression* to the *Amount of Food Needed to Survive*. It has been shown that people living with HIV/AIDS have increased nutritional requirements that can be as much as 50% greater than an otherwise healthy individual (Ngwira et al., 2001). Thus *AIDS Progression* contributes to a vicious cycle in which an individual who becomes sick can no longer produce the very sustenance needed to maintain her own viability, thus only worsening her fate as defined by her livelihood, her productivity, and her disease.

Access to Resources is another critical factor that needing to be managed from a policy standpoint, as it affects both the productivity and livelihood flows. It encompasses many other key variables that differentially affect this subset of the population in Malawi and is affected primarily by variables pertaining to gender inequality, as expanded upon earlier in the Conceptualization section. Additionally, even when a woman recognizes her disadvantaged status, she generally has little power herself to effect change or her future. The impact of gender inequity on access to resources is a critical area of interest and concern.

Social Networks is another contributor to the *Loss of Livelihood* rate. A breakdown of one's social network can threaten food security and livelihood because of a loss of charity and comfort from the community. As social networks collapse, so too does a person's social capital, and we see an increase in the rate of progression from economic well-being to the stock of being productive, yet impoverished (Masanjala, 2007). The *Social Networks* variable represents the community in which a woman lives, and the success of these networks is negatively affected by four fundamental factors. First, there is the *Patrilocal Society* organization variable, which displaces a woman from her family and friends to those of her husband once she is married (a cultural factor and an exogenous variable in this context). Secondly, *Migration* includes a woman who moves to another area, leaving her social network behind. The third and fourth variables, both stemming from the variable *AIDS Progression*, are *Death of Kin/Friends from AIDS*, which clearly deteriorates a social network as people pass away, and *Stigma*, which destroys an individual's social network by isolating her from her community. *Stigma* is part of another important reinforcing loop, R8: "Stigma's Deterioration of Social Networks," which illustrates how society's rejection of an individual worsens her economic welfare. By entering her into a vicious cycle, *Stigma* has an indirect effect on the rate at which productivity is lost. In order to envision this full loop, it is important to again consider the connection between this sector and the HIV/AIDS Infection sector, which elucidates the connection between *Loss of Livelihood* and *AIDS Progression*.

The final variables affecting a woman's *Loss of Livelihood* rate are *Natural Disasters*, *Financing Funerals,* and *Widowed. Financing Funerals*, incremented by *Death of Kin/Friends from AIDS* encompasses both the money spent on the culturally mandated, extravagant ceremonies, as well as the actual time spent attending the funerals of others. Time spent away from one's livelihood negatively affects the yield from that livelihood, but nonetheless is an important social practice. "Time spent at funerals, visiting the sick…is in a way a subscription to society and thus enables the family to claim benefits in time of hardship…it is checked in the society's register" (Ngwira et al., 2001, p.15).

Several small loops (R4, B1, R3, and B2) each demonstrate how the number of women in each stock will affect the flows into and out of those respective stocks. R4: "Livelihood Depletion" demonstrates that as more women transition into poverty, that rate of this transition

will increase because of community factors, such as those described by the *Social Networks* variable. B1: "Livelihood Accumulation" reflects the opposite phenomenon, where the rate of gaining livelihood increases as more women in poverty become productive. Loops R3: "Productivity Depletion" and B2: "Productivity Accumulation" are also opposites in this same way.

The last variable that requires consideration, and possibly the most important one in this sector, is *AIDS Management*. Although it appears exogenous when considering only this sector, it provides a vital link between the economic welfare diagram and the ART sector. *AIDS Management* is negatively linked to *AIDS Progression*, in that as management of the disease develops and grows, the progression of the disease is impeded. This also explains the link between *AIDS Progression* and the *Loss of Productivity* flow. *AIDS Progression* will always increase the rate at which a woman moves from productive to nonproductive; however, it is with the incorporation of a treatment regime such as ART that the unnecessarily high pace of this flow can be mitigated. *AIDS Management*'s importance has been stressed in our model by showing its effect not only on *AIDS Progression*, but also on the flow of women out of the nonproductive stock and back into the productive stock. Moving to the productive stock then gives women in our target population the hope of continuing their productivity and, one day, moving out of poverty altogether.

The primary insights gained from this sector are symbolized by the reinforcing loop R5: "Economic Welfare." This loop demonstrates the heart of our model, in that as a woman's *Economic Welfare* increases, the rate of *Loss of Livelihood*, the number of women in the productive yet impoverished stock, and the number of women who become nonproductive altogether all decrease, thereby increasing *Economic Welfare*. To enter this reinforcing loop is necessary according to this preliminary model, and to strengthen it is paramount. Model testing and refinement would be essential before determining if introducing ART as a means to manage HIV/AIDS is the most effective strengthening measure.

Another important insight gained from this preliminary model is not only the pervasiveness of gender inequity across the various sectors, but its existence at key leverage points, highlighting its crucial role throughout the entire process and the need to infuse gender inequity into prevention, treatment, and policy conversations.

Antiretroviral Therapy Sector: Qualitative Model Formulation and Evaluation

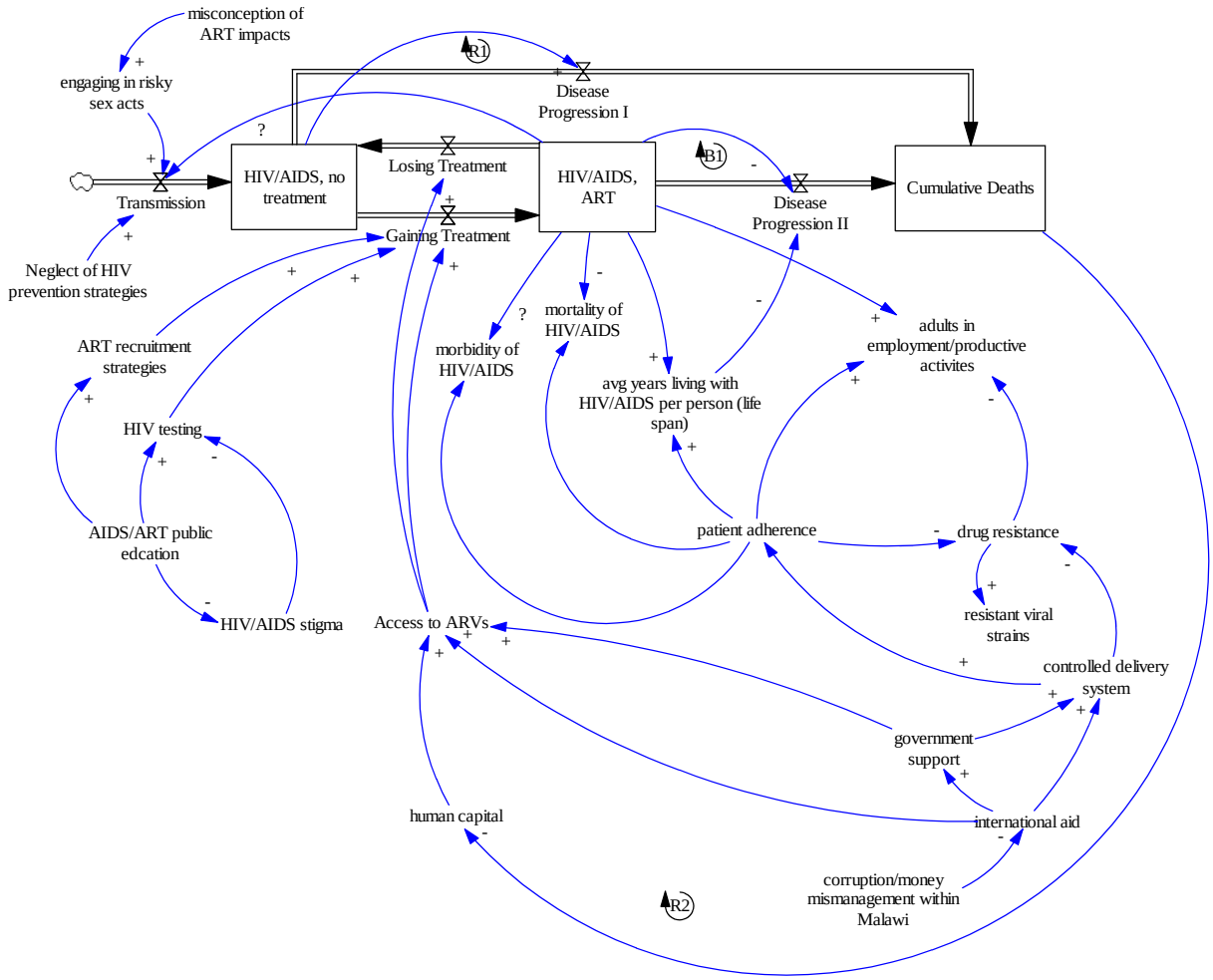

Figure 4: Antiretroviral Therapy Substructure

The primary intent of creating an ART qualitative stock-flow diagram is to capture the overall dynamics at play when ART is involved: those things that encourage and prevent treatment with antiretrovirals (ARVs), the effects of receiving ART on the disease progression and on people's lives, and potential ways to lose treatment. The entirety of this sector is broadly represented by the variable *ART* within the HIV Infection sector. After an extensive literature review and several iterations of variable disaggregation and aggregation, we crafted the ART model in Figure 4. As we are mostly interested in the movement of people with HIV/AIDS who are not receiving treatment to those who are receiving treatment (and back again), as well as AIDS progression, our stock-flow system mirrors this focus. The chosen variables range from smaller, observable measurements, such as *patient adherence*, to aggregate variables, such as *access to ARVs* (which includes financial considerations, the capacity of the health sector, equity of distribution, etc…).

Three feedback loops are apparent: R1: "Increasing Disease Progression," B1: "Decreasing Disease Progression," and R2: "Human Resources." As we are assuming ART to be the only treatment for HIV/AIDS in this model, the logical balancing loop to help prevent and/or slow deaths from AIDS involves ART and its ability to extend lives. The "Increasing Disease

Progression" reinforcing loop speeds AIDS progression and increases cumulative deaths while the second reinforcing loop demonstrates that the greater the human capital (due to fewer deaths as a result of ART), the greater the access to ART and the greater the number of those who become treated. Feedback mechanisms involving other sectors involve the livelihood and productivity flows from the Economic Welfare sector (as mentioned in the previous section) and the impact of AIDS deaths in the HIV Risk sector, though these are ripe areas for further growth and development.

A complicating factor in the creation of this model is that the impact of ART on transmission and morbidity is currently under debate. It is also an area where further model refinement and development may help shed light on the short- and long-term effects of ART. Although ART extends lives and may therefore increase chances of contact with an infected individual, ART also reduces the infectivity of a person (Rehle & Shisana, 2005). The impact of ART on the disease reproduction rate (as in a typical SIR model including disease duration and infectivity) is unknown. For this reason, we have included links between ART and transmission and morbidity with unknown polarities. However, modeling the link between ART and HIV transmission could greatly expand our knowledge and expectations of this gray area.

As gender inequity has played a critical role throughout other model sectors, its absence from the ART substructure becomes increasingly apparent. While we were not able to assess the role of gender inequity, it is an important area for future development. Other forms of discrimination are also likely to be of importance in describing and assessing access to ART. Aside from gender inequity (which *might* not play a significant role with access to ART due to the role antenatal clinics play in their distribution), class, ethnic group, religious, and geographical discrimination would be additional variables to consider, especially in the policy arena or in monitoring and evaluating ART programs. Another limitation of our current ART substructure to take into account is our decision to exclude, given the scope of our project, national economic well-being, the presence of and economic complexities surrounding generic ARVs, differences between HAART and ART, and alternative treatments. Including any one of these variables, let alone all, could alter what constitutes effective measures delineated by our current model.

From our preliminary structure, it is clear that ART can have an impact on extending life and productivity (and thus, economic well-being). However, due to an apparent lack of literature emphasizing the relationship between ART and economic well-being, the relationship could stand to be flushed out further as well, particularly with evidence-based data. Despite these limitations, what is apparent from this early stage of the model and from existing literature is the number of multifaceted factors affecting whether or not a woman in Malawi will be able to receive ART. The ability to take ARVs is a precarious one, teetering on an individual, societal, and global level.

Discussion

Caveats and Limitations

Modeling the intersection of HIV/AIDS infection and transmission, economic welfare, and ART is a daunting task, incorporating numerous aspects of our target population's lives and numerous frameworks of thought. As such, we would like to emphasize that while we find our current model useful in conceptualizing the issue and understanding critical aspects, our model is in its preliminary stage. This model is not intended to provide an answer key to policies that

would solve the public health and development problems facing Malawi today, nor, however, is it intended to remain static. While the current model is clear, informative, and helpful, additional steps are needed to strengthen its usefulness and capacity to better inform policy discussions and decisions. As a "living model," several iterations are necessary, not just to move the model beyond its preliminary stages, but also to keep pace with the latest aspects of the AIDS epidemic, treatment, HIV transmission, poverty, and gender inequities throughout Malawi and the world. Addressing the limitations of the current model would be one important step toward improving its potential use.

Many limitations of our model are listed throughout the text, but we believe the model boundaries significantly constrain the model from broader use and application. Several key elements to the epidemic are excluded, such as:

- prevention strategies and programs, and their impact,
- treatment measures other than ART,
- additional modes of HIV transmission (men who have sex with men (MSM), women who have sex with women (WSW), mother-to-child transmission, injecting drug users (IDUs), etc…,
- biologically-driven differences in transmission rates due to gender, circumcision, vaginal vs. anal penetration, and
- macroeconomic policies affecting social and economic development, the dynamics of international aid and national debt, and market globalization.

Our model is also bounded by time and is not equipped to look at issues of long-term sustainability. This issue is especially relevant when looking at the costs of ARVs, since, for most of those in Africa living with HIV, treatment (and thus, life) "depends on the state's capacity to provide free or subsidized ART" (Masanjala, 2007, p. 1036).

However, given our defined project scope, we feel it is appropriate to demarcate our boundaries in such a way. For our general purpose of problem conceptualization, we do not believe that these exclusions jeopardize our model integrity. Indeed, to incorporate each level of analysis, framework of thought, and all related arenas would weaken the final product. Future versions or additions to this model most certainly could and *should* integrate these missing elements, though with conscious forethought to the goal of the model rather than as a tribute to the mega-scope of these overarching issues.

Dowsett (2003) argues, somewhat like we do, that alongside gender, other structural and social forces such as global inequality, poverty, mass migration, and cultural transitions due to globalization are essential in understanding the growing HIV pandemic. Yet Dowsett points out how sexuality as a social structure (rather than as a study of individual behaviors) generally becomes subsumed under the umbrella thinking of gender. To do so neglects the breadth of the issue and the social determinants of HIV risk and vulnerability. This neglect leads not only to a failure in understanding the epidemic, but also to a failure in intervention. Thus, we strongly suggest that broader applications of the model should incorporate not just gender, but structural conceptualizations of sexuality as well.

Implications

Overall, we found from the literature and our different model sectors, that *Access to ARVs* is fundamental to restoring and augmenting a woman's productivity and economic welfare. Therefore, our preliminary suggestions for increasing the economic welfare of this population

include breaking down the barriers to ART availability, first on a national scale, then reassessing how this affects access on an individual level. Modeling this dynamic further and in more detail, perhaps with a quantitative model, would hopefully help in assessing the accuracy of our preliminary findings. Through refinement of our qualitative model and joining the global debate on HIV/AIDS and economic development, we hope to, in the long-term, inform discussion on potential changes in social policy and test the presence of flawed mental models.

Since these model structures are in their preliminary stage, their avenues for future use are extremely broad. Any number of individuals or groups may be interested in refining the structures and entering into discussions on the relationships and feedback mechanisms involved. These interested parties may include the Malawian government, private not-for-profit agencies, funders, researchers, experts in system dynamics and/or experts in topics such as health and social development, those involved with health policies, and ARV supply chain distributors and logistic planners. Perhaps most importantly, interested parties to include in additional model iterations and discussions should include Malawians themselves, specifically the affected populations: young women, people living with HIV/AIDS, AIDS organization workers, and medical staff.

Private non-governmental organizations (NGOs) may be local or international and work in fields as diverse as health, the economy, youth, women's health, and social development. Non-Malawian government offices and regionally-based NGOs could be interested in using this model foundation to help identify both similarities and differences between countries and regions. Similarly, funding sources may be local or international, large or small, just as research institutions might also be. The broad audiences potentially interested in furthering these model structures speak not only to the number of directions future model work may take, but also to the intertwined, overarching, and highly applicable issues discussed throughout our paper.

Just as this paper's audience is broad, so too are the potential directions for application. One obvious extension would be the development of a quantitative model by system dynamics experts so the goal of influencing policy discussions could be more easily reached. With a working quantitative model, simulations could predict outcomes, key leverage points in the model, and effective areas of change. Furthermore, a quantitative model could help address many of the limitations in our qualitative model by simulating long-term effects, assessing sustainable practices and cost issues, and highlighting potential pitfalls.

As another application, the qualitative model might be refined on the ground based on real-life experiences. In this case, understanding key policy levers and simulating changes would not be the end goal. Learning, discussion, group consensus, and community investment would be. Such applications are especially useful when applying Western thought across cultures and when working within a context rife with historical and current-day imperialist thought and policies. The non-linear thinking characteristic of system dynamics may indeed be a great strength in working across cultures and groups.

In furthering discussion on the topic, the above-mentioned parties can work together to gain a better understanding of the epidemic, and could potentially craft effective and sustainable policy strategies to control the AIDS epidemic and aid vulnerable populations in Malawi. This paper can also be used toward gaining a clear understanding of areas of need, as well as areas of limited research and data.

Ultimately, we hope that this paper will help in the search to find answers (and in the search to discover appropriate questions) to complex social problems, such as women with HIV/AIDS in Malawi, and jumpstart the critical discussions necessary to tackling such

interwoven, multifaceted social problems. This paper may also help test and illustrate the long reach that gender inequity has, with consequences not just for women, but for nations as a whole. It is our hope that long-term implications for social policy include increased empowerment for this vulnerable age group. Once levels of healthy productivity are attained, women with HIV/AIDS can then begin striving for long-term goals, such as poverty-reduction strategies including asset building and micro-financing. Increased productivity of women living with AIDS leads to increased economic welfare for a large percentage of the population, which ultimately translates into increased economic welfare for the country as a whole. However, it deserves reiteration, that such long-term goals simply cannot be attained until women are able also to reach their short-term priorities.

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Appendix A: Qualitative Variables

	Variable	Definition	Links to Other Sectors (*Sector*: linked variable(s))
HIV/AIDS Infection Sector	*ART*	The degree to which antiretroviral therapy is present or absent.	*Antiretroviral Therapy*: HIV/AIDS, ART stock.
	Economic productivity	Economic welfare and the ability to produce goods and services for market exchange.	*Economic Welfare*: economic welfare
	Gender inequity	Aggregate variable combining women's subordination and oppression with women's resulting lack of empowerment and agency.	*Economic Welfare*: cultural subordination of women, discrimination based on gender, and patrilocal society *HIV/AIDS Risk*: female subordination
	Situations that place men at greater risk of HIV infection	Aggregate variable combining societal pressures (cultural & economic) that increase a man's chance of becoming infected with HIV/AIDS.	*HIV/AIDS Risk:* encompasses the entire male stock/flow progression.
	Situations that place women at greater risk of HIV infection	Aggregate variable combining societal pressures (cultural & economic) that increase a woman's chance of becoming infected with HIV/AIDS.	*HIV/AIDS Risk:* encompasses the entire female stock/flow progression.

	Variable	Definition	Links to Other Sectors (*Sector*: linked variable(s))
HIV/AIDS Risk Sector	*Agricultural instability*	The inability of individuals, families, and groups to rely on agriculture for their own subsistence and for market exchange.	*Economic Welfare*: connected to a portion of natural disasters
	AIDS deaths	The number of deaths as a result of AIDS.	*Economic Welfare*: AIDS Progression & death of kin/friends from AIDS
	Cultural practices entailing risky sex acts	Includes wife inheritance, polygamy, acceptance and encouragement of extramarital affairs, dry sex, difficulty in condom negotiation, etc…	N/A
	Economic instability	The inability for individuals, families, and groups to rely on the economy and market.	*Economic Welfare*: economic welfare
	Family breakdown	The weakening and removal of ties that bond families together physically and psychologically.	*Economic Welfare*: social networks
	Female subordination	Objectification of women and instances that reproduce the sense that women are "worth less than" men.	*Economic Welfare*: cultural subordination of women, discrimination based on gender, and patrilocal society
	High-risk work	Where employment places people at greater risk of becoming infected with HIV and of transmitting the disease to others. Includes sex work, truck drivers, plant workers, and other mobile work groups whose movement between physical areas helps spread the disease.	N/A
	Migration	Moving away from home or work area (to an urban setting or another country). Change in geographic setting.	*Economic Welfare*: migration

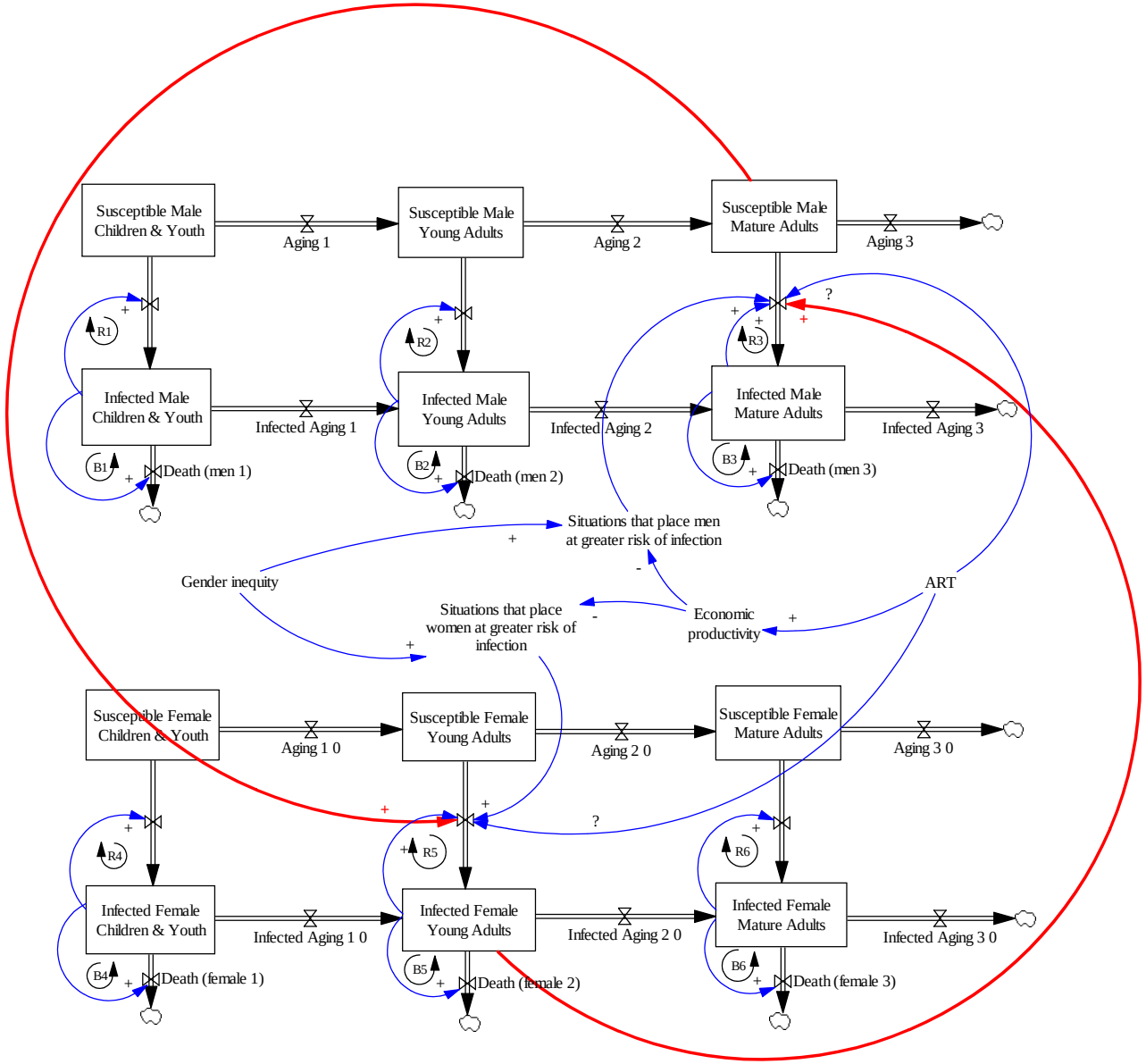
	Variable	Definition	Links to Other Sectors (*Sector*: linked variable(s))
Economic Welfare	*Access to food*	A woman's own ability to cultivate and preserve her food supply, or a woman's ability to gain an income with which to purchase food.	N/A
	Access to resources	Aggregate variable including those factors that affect a person's ability attain the resources needed to succeed.	N/A
	AIDS progression	Variable describing the nature of the progression of AIDS.	*HIV/AIDS Risk*: Infected Female Young Adults (implicitly an HIV infection)
	AIDS management	Variable describing the management of an individual's AIDS with ART.	*ART:* Stock of people with AIDS on ART
	Amount of food needed to survive	The amount of food necessary for a woman to survive.	N/A
	Autonomy	A woman's control over her own life.	N/A
	Subordination and Discrimination of women	Abstract variable describing the difficulties a woman in Malawi faces today, solely based on her gender, because of traditional cultural beliefs. Would include schooling, inequitable distribution of wages, lack of or blocked entitlements and resources, etc…	N/A
	Death of kin/friends from AIDS	Number of deaths from AIDS in a woman's social network.	N/A
	Discrimination based on gender	Abstract variable describing the difficulties a woman in Malawi faces today solely based on her gender because of an individual's set of beliefs regarding gender.	N/A
	Economic welfare	A woman's economic well being.	N/A

	Financing funerals	Both the money spent on culturally mandated, extravagant funerals, as well as the actual time spent attending the funerals of others.	N/A
	Illness	Both personal illness, as well as illness in a woman's family or social network.	N/A
	Malnutrition	State of lacking the necessary nutrition to maintain a woman's own health.	N/A
	Migration	Moving away from home or work area (to an urban setting or another country). Change in geographic setting.	N/A
	Natural disasters	Weather patterns that disrupt a woman's livelihood.	N/A
	Nutritional gap	The difference between the amount of food a woman needs to survive and the amount of food to which she has access.	N/A
	Patrilocal society	Residence after marriage in association with the husband's kin.	N/A
	Social Networks	The web of interconnected people in which a woman works and lives based on different relationships.	N/A
	Stigma	Level of taboo and mistreatment of those infected with and affected by HIV/AIDS.	N/A
	Widowed	The death of a husband.	N/A

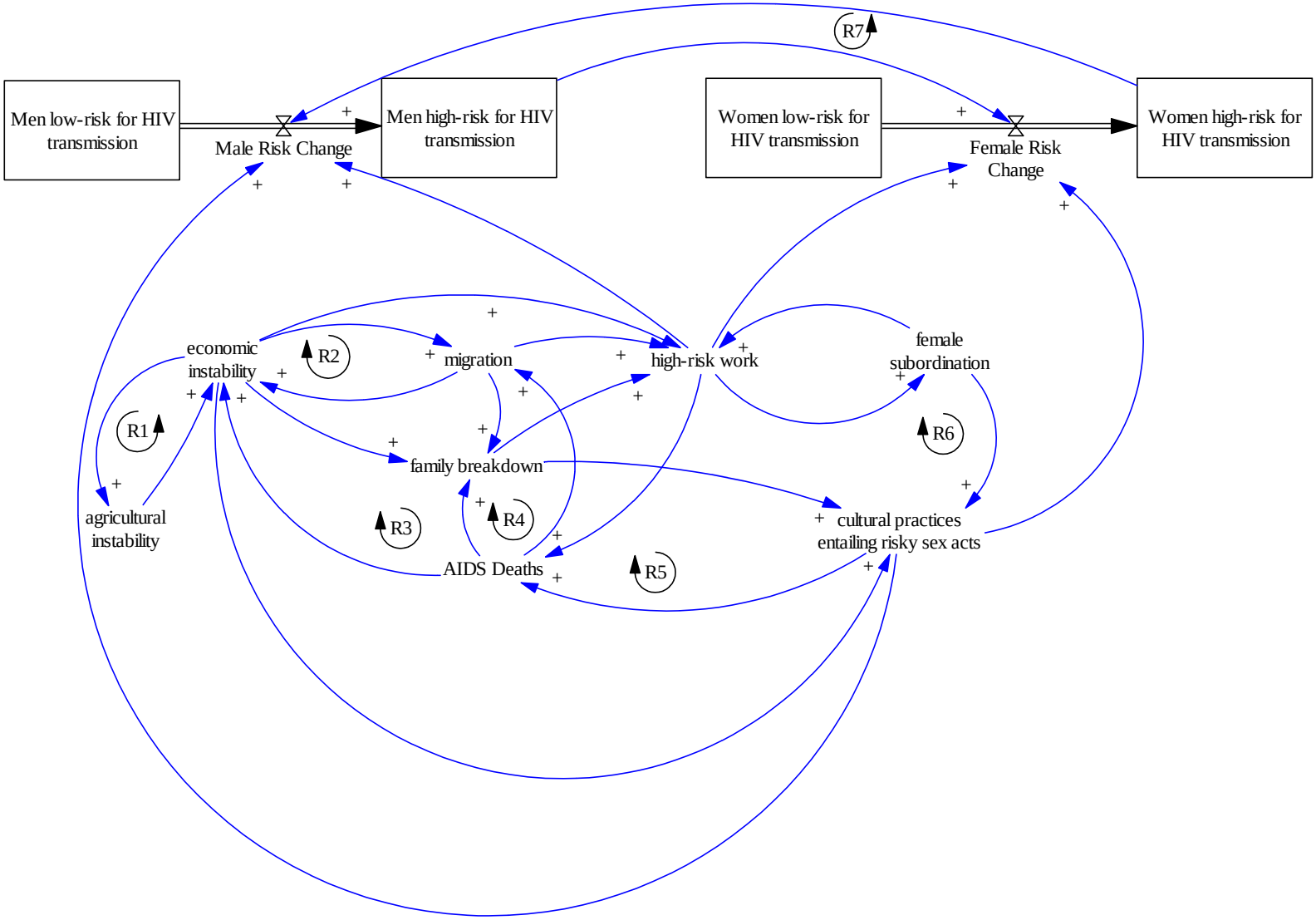
	Variable	Definition	Links to Other Sectors (*Sector*: linked variable(s))
Antiretroviral Therapy Sector	*Access to ARVs*	Aggregate variable including those factors that affect a person's ability to receive treatment: affordability of treatment, financial constraints, access to health care, & equitable distribution of resources.	*Economic Welfare*: access to resources
	Adult in employment and productive activities	Number of adults able to return to previous employment or productive activities after receiving treatment for AIDS.	*Economic Welfare*: gain of livelihood flow
	AIDS/ART public education	Raising awareness about the presence and effects of AIDS and ART.	N/A
	ART recruitment strategies	Manner of creating patient demand and knowledge.	N/A
	Average years living with HIV/AIDS per person	Average life span for one person living with HIV/AIDS.	N/A
	Controlled delivery system	Refers to Malawi's National ARV Treatment Guidelines, a public health approach to delivering ARVs. Includes: regular drug distribution, regular procurement, drug security, patient management, monitoring and evaluation, and drug availability.	N/A
	Corruption/money management within Malawi	Absence of fraud or the degree of fraud present within government and agencies.	N/A
	Drug resistance	Drugs inability to effectively treat disease due to misuse or resistant strains.	N/A
	Engaging in risky sex acts	Includes sex without protection & sexual practices that increase risk of transmission.	N/A
	Government support	The government of Malawi's support in fighting AIDS, distributing ARVs, and cooperation with international donors.	N/A
	HIV/AIDS stigma	Level of taboo and mistreatment of those infected with and affected by HIV/AIDS.	*Economic Welfare*: stigma

Variable	Definition	Links to Other Sectors (*Sector*: linked variable(s))
HIV testing	Number of people receiving VCT (voluntary counseling and testing)	N/A
Human capital	Human resources available for use.	N/A
International aid	Financial, scientific, and programmatic support from outside Malawi.	N/A
Misconception of ART impacts	Belief that taking ART reduces a person's viral load and consequently that using protection during sex is not necessary.	N/A
Morbidity of HIV/AIDS	The number of HIV/AIDS incidences.	N/A
Mortality of HIV/AIDS	The number of HIV/AIDS deaths.	*Economic Welfare*: death of kin/family from AIDS *HIV/AIDS Risk*: AIDS deaths
Neglect of HIV prevention strategies	Overdue attention to ART at the cost of prevention work.	N/A
Patient adherence	Patient's ability to follow ARV regime.	N/A
Resistant viral strains	Ability for disease to develop resistance to prescribed ARVs and other drugs.	N/A

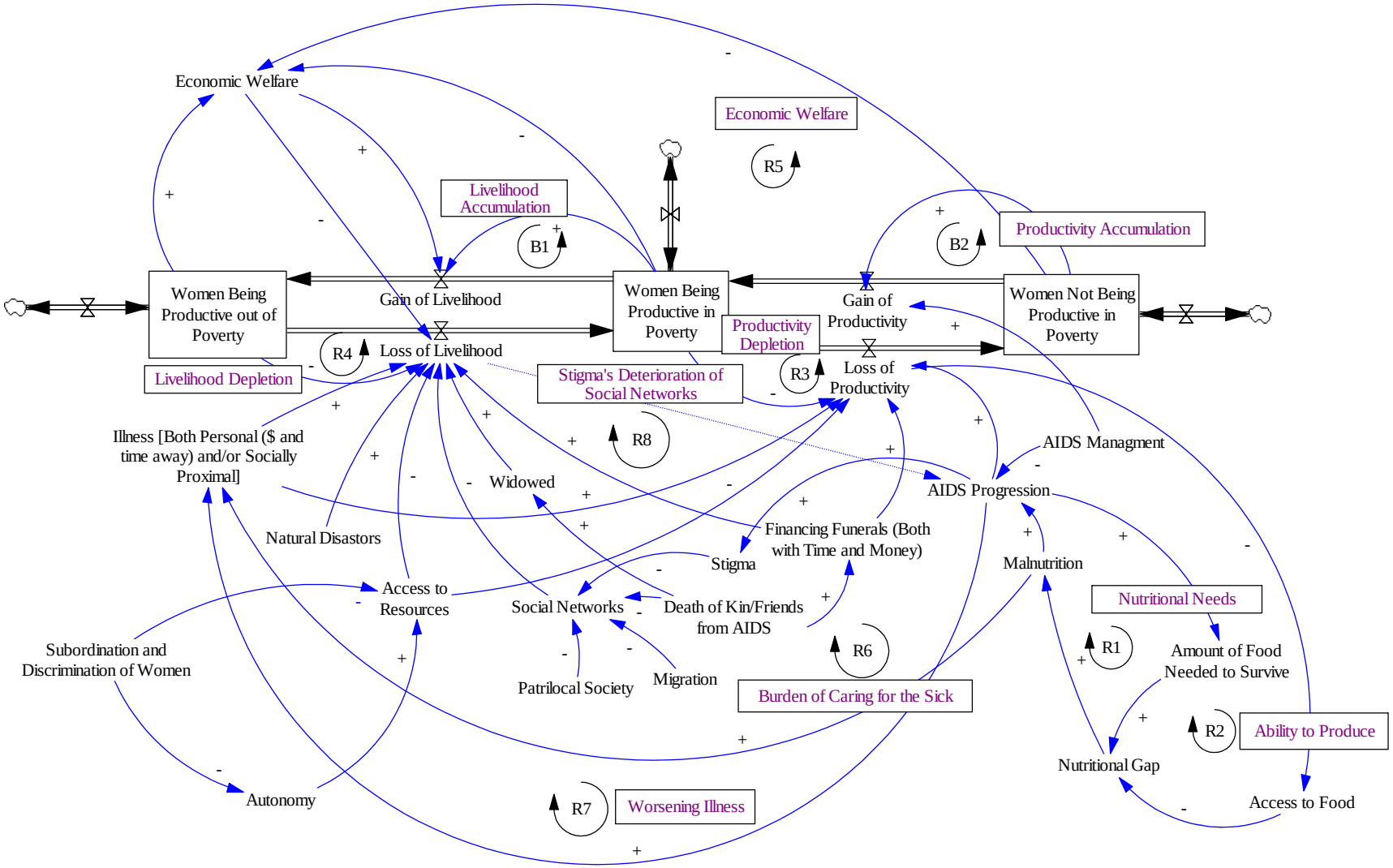
Appendix B: HIV Infection Sector



Appendix C: HIV Risk of Transmission Sector



Appendix D: Economic Welfare Sector



Appendix E: Antiretroviral Therapy Sector