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The effects of HIV mortality on saving and investment in Asia

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ABSTRACT

This paper examines the effects of HIV/AIDS mortality on saving and investment in Asia. Annual data for years 1990-2015 from 43 Asian countries. The empirical model also allows for potential gender differences in AIDS mortality to vary the effect on savings and investment. Our research shows that there are gender and wealth differences in how this disease affects the macro economy. An increase in the AIDS mortality rate of either gender reduces saving and investment in low-income countries. In regards to savings, an increase in male AIDS mortality is shown to increase savings. On the other hand, an increase in female AIDS mortality is expected to decrease savings. In terms of investment we find the opposite effects across genders: increasing male AIDS mortality causes decrease in investment (though not statistically significant) and increasing female AIDS mortality increases investment. For low-income countries, we find a negative relationship between AIDS mortality of either gender on saving or investment.

Contribution/ Originality
In recent years Asia has noted an increase in AIDS related death which is contrary to the global trend. Additionally, 70% of those living with HIV/AIDS in Asia are living in low income countries. As much recent research has focused on African countries, current study focuses on Asian country trends that are not only contrary to the global trend but may also reflect potential responses in other low income regions of the world. This study highlights the gender differences in how this disease affects the macro economy.

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1. INTRODUCTION

First identified in 1981, HIV/AIDS played a large role in hindering much of the progress in economic growth and development. Through the 1990s and early 2000s, it continued to grow as one of the major global health epidemics. Of most significance was its impact on the African continent, where "in the 10 hardest-hit countries of eastern and southern Africa, life expectancy declined from 55.0 years in 1990 to 48.9 years in 2006" (UNAIDS, 2017). Affecting the labor productivity of over 10% of the population in some countries, it surely has deterred economic growth. Globally, the disease affects the lives of over 36 million people directly, while also indirectly affecting their families (Hacker, 2004).

Many of those affected by HIV/AIDS in this study belong to six key populations: sex workers and their clients, gay men and men who have sex with other men, people who inject drugs, and transgender people (UNAIDS, 2017). In Asia, the start of sexual transmission of HIV in Thailand and Cambodia can be traced back to a small number of female sex workers who subsequently spread the disease (Rojanapithayakorn, 2006). Mentioned earlier, HIV/AIDS not only affects those directly infected; it also has large economic effects on the families of those affected (Hacker, 2004). Those directly infected tend to be of prime working age, and have already felt the negative effects of the disease on their work life by the time they seek treatment (Resch *et al.*, 2011). This loss of income is not typically of a temporary nature, as social pressures hinder many from getting tested at the first suspicion of infection.

Thankfully, much progress has been made since the disease reached its peak in the early 2000s. According to the World Health Organization (WHO, 2016), AIDS-related deaths in 2015 decreased 43% from 2003. Much of the reason for the success in the war on AIDS is the discovery and mobilization of Antiretroviral Therapy (ART). Through ART, foreign investment, information campaigns to reach those most at-risk, and various other methods, AIDS no longer demands the foreign direct investment into developing countries that it once did – and this scares the UN and WHO. Possessing US$19.5 billion in resources to be made available to middle and low-income countries to combat the virus in 2013, funding for this stagnated and slightly decreased to US$19.1 billion in 2016 (UNAIDS Factsheet, 2017). The WHO believes if investment continues to stagnate the world will inevitably see an increase in infection numbers again.

While eastern and southern Africa, the region most afflicted by the disease, has seen a drastic decrease in AIDS-related deaths, some countries of the Asian continent have seen an alarming increase in HIV infection that goes contrary to global trends. AIDS may no longer be seen as the global threat it was, but the Asia and Pacific region labeled by UNAIDS has seen an increase in the total number of people living with AIDS (2017). With 5.1 million people living with HIV in the region, UNAIDS reports show that 95% of new infections in the region are occurring in 10 countries (pg. 124). Further west, the annual number of new infections in Eastern Europe and Central Asia has skyrocketed to 60% (UNAIDS, 2017). While the region most well known for being hurt economically by HIV/AIDS has seen reduced prevalence, parts of Asia are struggling in the battle. What further hinders progress in these regions is the decline of foreign aid to fight HIV/AIDS that could be due to decreased attention paid to the disease as its macroeconomic prospects do not appear as bleak as it once did (Ashraf *et al* 2009; Young, 2005).

While much research has been compiled on the effects of HIV/AIDS on economic development on the African continent, we have yet to come across a similar paper considering the Asian continent. The WHO (2016) reports around 70% of those living with HIV live in middle-income countries – quite different from the population sampled in many studies focusing on HIV/AIDS in Africa. This research is of importance, as we hope it will lend itself to further knowledge of the macroeconomic effects of HIV and comparable diseases. We are not aware of any studies that have quantitatively estimated the macroeconomic effects of AIDS mortality on saving and investment in Asia. With micro-level panel data from a country with similar social practices in terms of response to adult

mortality, we believe there is reason to conclude the macro-level response found in Asia may apply to other regions of the world as well.

This paper examines the effects of HIV/AIDS mortality on saving and investment in Asian countries. We examine these effects while controlling for: per capita GDP, GDP, population growth, and literacy. Our model also allows for potential gender differences in AIDS mortality to vary the effect on savings and investment.

2. LITERATURE REVIEW

2.1. Gender and wealth differences in effects of adult mortality

AIDS mortality largely occurs in prime working-age people, there is also literature that illustrates gender and wealth differences in the effects of adult mortality on a household. Yamano and Jayn (2004) researched the effects of AIDS mortality on households in Kenya, Africa. Utilizing panel data from various parts of the country. The research found that male head of household mortality has significant negative economic effects on low-income families. Conversely, no statistically significant effects are found with the loss of a female head of household. In high-income families, the death of a male head of household leads to a reduction in the number of females in the home. Yamano and Jayne "found daughters getting married and leaving households, possibly for bride dowries, after a death of a male head" (pg. 112). This is an example of one method high-income families are able to use to financially ease their burden after the death of the primary breadwinner.

2.2. Effect on saving

The literature illustrates that savings decrease as a result of HIV infection in low-income families but increase in those of higher income families. When a person is infected with HIV, they oftentimes are of prime working age. Due to social marginalization of those with the disease, many will go an extended period of time with the symptoms of the disease affecting their work-life. Oftentimes, they will have seen a decrease in their wages before seeking diagnosis or treatment. Once undergoing treatment, Hacker (2004) finds savings likely to decrease as a result of the increased expenditure. Additionally, he finds "earned income in households affected by HIV/AIDS was 27% lower than those unaffected". This financial distress is found to be prevalent among those uninsured (Gustafsson-Wright *et al.* 2011). While the earnings of the infected individual decrease, those who begin to take on the role of caregiver to the infected individual also see their wages decrease. Children of those with HIV infection are also at a higher risk of malnutrition (Hacker, 2004), as a result of the loss of household income and increased expenditure in healthcare.

Savings are expected to increase in higher-income countries. When a vital breadwinner is diagnosed with the virus, the family, possessing greater disposable income than those in lower-income countries, is expected to save a greater proportion of its income to prepare for the potential loss of future income and increased medical expenses. While individuals of all income statuses face an increase in medical expenses when battling HIV/AIDS, Qiao (2012) finds that families living in growing economies are able to save more.

Yamano and Jayne (2004) also find the impact of adult mortality on household is related to household wealth. In higher-income families, it is found that when a male head of household dies, there is a decrease in the number of girls in the household. Their conclusion is that this is due to the girls getting married, so the mother can garner a bride price for her daughter(s). This bride price the mother receives could allow for an increase in savings. While their study takes place in Kenya, bride price and dowry are common practice in many Asian countries, and could be a potential avenue by which families losing a male head of household could assist in the loss of future wealth.

Further evidence is seen in Shang-Jin and Zhang's (2011) research stating that Chinese parents with a son are increasing their household savings to make their children more attractive in terms of the amount of bride price that could be paid out. They believe this "can potentially account for about half

the increase in the household savings rate during 1990-2007" (pg. 511). The evidence they find to support this assertion is savings by identical households with a son tend to be greater in regions with that possess a greater ratio of males to females.

While the microeconomic effects of HIV/AIDS are in general consensus, there have been contrasting findings as to the macroeconomic effects of HIV/AIDS on saving. In certain cultures, the cost of a proper burial is enough to tarnish the savings capabilities of a family. Steinberg *et al.* (2002) finds that funeral expenses are typically the equivalent of four months' salary. Hacker (2004) finds "over 30 percent of funeral costs were paid from household savings, and 40 percent from 'friends and family". Clearly, this decrease in savings is felt outside of the nuclear family. The increased mortality rate tears at the social fabric of the family. With the majority of those affected being of prime working age, more children are raised by a single parent; or, they end up orphaned. Overall, an aggregate decrease in savings is expected to lead to a decrease in investment; and, a slowing of economic growth.

On the other hand, a rise in AIDS-mortality lends itself to a greater allocation of resources to the lessening population; thus, increasing income per capita. With the increase in income per capita, it would be expected to find savings positively correlated. Young (2005) finds consumption possibilities increasing in his simulation of the effects of AIDS on the South African economy. Hacker (2004) states "the macroeconomic literature suggests that the adverse impacts of HIV/AIDS on productivity and savings are at least partly reversed by an increase in the capital-labor ratio, as productive assets are shared among fewer people".

2.3. Effect on investment

In regions where HIV is of high prevalence, people are less likely to make investment in human capital. One prevalent example of human capital investment impacted by HIV is schooling. Using data from previous literature, Fortson (2011) finds that a region possessing a population of which 10% is HIV+ should reduce education by 0.5 years. While HIV has been shown to have a large impact on orphans, she finds this decrease in schooling impacts non-orphans as well.

Adult mortality can also result in asset losses, as their children or spouses do not receive their proper endowed assets due to methods of disinheritance, such as land grabbing (Beegle *et al.*, 2008) or property ownership laws that are gender-bias (Agarwal, 1995). In addition, Chapoto *et al.* (2011) finds widows' struggling to hold on to their land – especially if they were relatively wealthy.

While the microeconomic effects of AIDS mortality on investment are well explained, the literature is inconclusive at the macroeconomic level. Negatively, decreasing the productivity of the labor force will discourage foreign investment from multinational firms who may otherwise be intrigued by the low cost of production in a developing country. On the other hand, companies that have already invested in an area affected by high HIV incidence may further invest in health education programs and other social benefits to decrease the impact of the disease on their labor inputs for the future. The increased cost of investing in the labor force affected by the disease may work better in their profit-maximization efforts than searching for labor and capital inputs in another nation. The rise of ART further makes this an attractive option, as Rosen *et al.* (2014) finds persons on ART "significantly reduced reported difficulties in performing a job". The scientific advancement, primarily seen through ART, allows for HIV to no longer be the "death sentence" it was seen as throughout the 1980s and 90s. Nowadays, it is possible to suppress the viral load of infected individuals to such low levels that the risk of transmission is greatly reduced (UNAIDS, 2017).

2.4. Effect of literacy

There is no clear, direct, causal relationship between literacy and economic growth. With some encouraging it for centuries as a "springboard" to prosperity and growth, some have dubbed this "the literacy myth". Graff (2010) states, "the assumed link between literacy and economic success is one of the cornerstones of western modernization theories, and the last century and a half witnessed what we may call the globalization of the literacy myth" (pg. 17). Further, he asserts, "literacy's power and

influence were seldom independent of other determining and mediating factors" (pg. 18). On the contrary, much literature makes connections between literacy, numeracy, and labor market outcomes (Vignoles *et al.*, 2011; A'Hearn *et al.*, 2009; Becker and Woessmann, 2009).

2.5. Relationship between saving and investment

The relationship between saving and investment is the topic of ongoing research. In one of the most noted papers in this area, Feldstein and Horioka (1980) find strong correlation between national saving and investment in industrialized countries. Their primary assertion is: "if portfolio preferences and institutional rigidities impede the flow of long-term capital among countries, increases in domestic saving will be reflected primarily in additional domestic investment" (pg. 328). Further, Zeira (1987) states that, while standard open economy models find investment independent of domestic savings, much empirical work finds strong correlation between the two in both OECD countries and least-developed countries (pg. 265).

2.6. Population growth and savings

Birdsall (1988); Dasgupta (1995); and Dreze *et al.* (1995) apply the theory of consumer behavior to explain family size decisions in which children have been treated as consumption good, so that family's demand for children relative to other goods becomes a rational economic response. The economic theory of fertility has gained strong support in diverse developing countries. According to this theory, rapid population growth forces families to consume what otherwise would be savings. It is argued that resources otherwise available for productive purposes are diverted to satisfy the consumption needs hence adversely affected the national saving rate.

Contrarily, it has been argued that East Asia benefited in the recent past from demographic shifts in which the relative size of the age groups that produce and save the most has been increasing. This would explain why East Asian countries' economic performance and savings have been enhanced Bloom and Williamson (1998) and Behrman *et al.* (1999).

2.7. Population growth and investment

Bayles (2000) states that economic development depends upon investment. When investment resources are scarce, rapid population growth retards investment needed for higher future consumption. Jhingan (2007) states that population growth retards capital formation. As population increase, per capita available income decline, resulting in low savings and consequently in the level of investment.

Afzal (2009) argues that rapid population growth, in Asia is problematic for the economy because it contributes to lower investment growth and diminishes the saving rate. Further, Schultz (1987), found that population growth does affect investment and expenditure on human capital particularly on education and health.

2.8. Per capita income and savings

Aghevli *et al.* (1990) noted that net national savings rate and economic growth has positive relationship. Also, Mojtahed and Karami (2003) showed the influence of economic growth and per capita income on saving rates is positive. Uremadu (2007) found that GDP growth, per capita income, quasi-money, and coefficient of debt payments have a positive effect on savings. Additionally, the rate of GDP growth, inflation rate, current-account conditions, and trading terms have a positive impact on national savings.

Farhan and Akram (2011) identified the short-term and long-term relationships between income level and savings behavior in Pakistan, in association with inflation and the age dependency ratio, using co-integration and error correction model for the period 1985-2009. It is noted that in the short-term and long-term income levels there is a significant and positive relationship with the savings behavior in Pakistan. Prema and Kunal (2001), discussed the determinants of private saving in the economic development process in light of India's experience during 1954 to 1998. Econometric evidence shows

the actual interest rate, growth and level of per capita income, the expansion of banking facilities, and the inflation rate had statistically significant positive effects on domestic savings.

The literature also shows a negative relationship between GDP per capita and savings. Bebezuk and Musalem (2006), based on a sample of 48 developed and developing countries over the period 1980-2004 using panel data techniques, conclude that dependency rates in old age and urbanization rates has negative correlation with savings.

2.9. Per capita income and investment

The literature presents an ambiguous relationship between per capita income and investment. Pahlavani *et al*. (2006) and Chang (2010) concluded that economic growth may stimulate domestic capital accumulation. Adhikary (2011) theorizes that the linkage between capital formation and economic growth tends to be positive. On the other hand, Adekunle and Aderemi (2012) found a negative relationship between the rate of growth of per capital GDP rate of and investment.

3. EMPIRICAL MODELS

We focus on the effects of per-capita income, gross capital formation (investment), literacy rate, population growth, female and male HIV mortality rates on saving and investment in low income and high income Asian countries. Our data set covers annual data from the year 1990 to the year 2015, inclusive. With country-level panel data on 43 Asian countries over 26 years, we have a total of 1,161 observations. Due to lack of data, the remaining five Asian countries were not included in this study. All data measuring our variables was collected from the World Bank's World Development Economic Indicators (WDI, 2016) database. This database collects the most dependable data for the indicators relevant to our study. As with any country-level data, questions will arise as to its accuracy in measurement-particularly in our utilization of male and female AIDS mortality. While there is notable variance in the estimate of the mean value for each country and year, there is no more reliable source of data available than that presented by UNAIDS via the World Bank World Development Economic Indicators. No statistical data regarding the subject of male and female AIDS mortality is better collected, funded and supported than the effort of the United Nations and its joint partners. In short, to search for better data at this moment for the purposes of this research would mean to halt the research altogether.

3.1. Fixed effects model

We estimate the following fixed-effects, one-way error component regression models on a panel for all Asian countries over a 26 year span[1]:

$$Saving_{it} = \beta_i + \beta_1 lngdpp_{i,t-2} + \beta_2 mm_{i,t-1} + \beta_3 Fm_{i,t-1} + \beta_4 Pg_{i,t-1} + \beta_5 Lit_{i,t-1} + \varepsilon_{it} \quad \ldots\ldots (1)$$

$$\varepsilon_{it} = \upsilon_i + \mu_{it} \quad \ldots\ldots (2)$$

$$\beta_i = \beta_0 + \beta_6 Z_i \quad \ldots\ldots (3)$$

$$Inv_{it} = \alpha_i + \alpha_1 lngdpp_{i,t-2} + \alpha_2 mm_{i,t-1} + \alpha_3 Fm_{i,t-1} + \alpha_4 Pg_{i,t-1} + \alpha_5 Lit_{i,t-1} + \mathcal{E}_{it} \quad \ldots\ldots (4)$$

$$\mathcal{E}_{it} = \nu_i + \mho_{it} \quad \ldots\ldots (5)$$

$$\alpha_i = \alpha_0 + \alpha_6 £_i \quad \ldots\ldots (6)$$

In the regressions above, $Saving_{it}$ measures gross domestic savings (% of GDP) for country *i*. Finally,Inv_i measures Gross capital formation (% of GDP) for country *i*. $lngdpp_{i,t-2}$ is the natural logarithm of per-capita income for country *i* lagged 2 years. $mm_{i,t-1}$ is the percentage of males

[1] List of countries appendix table 4.

mortality due to HIV infection for country *i* lagged one year, $Fm_{i,t-1}$ is the percentage of females mortality due to HIV infection for country *i* lagged one year. The annual population growth rate is denoted by $Pg_{i,t-1}$ for country *i* lagged one year. $Lit_{i,t-1}$is the percentage of the population ages 15 and above who can read and write a short simple statement on their everyday life for country *i* lagged one year.

We lag all independent variables to reflect the notion that it takes time for impacts to be realized.[2] It is not expected that our explanatory variables will directly affect the dependent variable in the same time period; so, after utilizing the AIC and BIC options in STATA, we find the recommended two-year lag for GDP per capita, gross domestic saving (Saving), gross capital formation (investment), and the one-year lag for male and female AIDS mortality, annual population growth rate, and literacy. Z_i and $\pounds_i$ represents unobserved characteristics and β_0 , β_7 , α_0, and α_7 are coefficients. In this one-way error model, υ_i and ν_i denote the time-invariant and unobservable country-specific effects, and μ_{it} and $\mho_{it}$ denotes the remainder disturbance with mean zero and variance-covariance $\sigma^2{}_{\nu} I_{nt}$.

The primary econometric issue we hope to address in our model is that of endogeneity. Our control variables are all factors we believe to be endogenous to AIDS mortality; including them gives us a precise estimate. In addition, we expect there to be country-level, time-constant factors that are correlated with our explanatory variables. As a result, we decided to utilize a fixed-effects model in our estimation. This creates a proper estimation scenario by which our idiosyncratic error term is not correlated with our explanatory variables. As a result, our fixed-effects estimation should be unbiased and precise. Another econometric concern would be that of serial correlation in the idiosyncratic error term. Any issue of heteroskedasticity will be found by using the Cook-Weisberg and White tests.

4. RESULTS

As shown in Table 1a and Table 1b, all coefficients associated with the regressors have the expected signs and are statistically significant (except population growth in table 1a). We follow the Baltagi (2001) procedure for testing the joint significance of fixed-effects, and find significant fixed-effects at better than 1%. This demonstrates the appropriateness of our application and all our regressions. While one may expect heterogeneity to be an issue in our whole sample regression, running the Cook-Weisberg and White test both tell us confidently that we cannot reject the null hypothesis of homoskedasticity. Our results in Table 1a suggest that any increase in male and female mortality has a negative impact on saving, with both statistically significant at the 10% level. The decrease in savings as a result of increased AIDS mortality by either gender is something we would expect. Again, the majority of those affected by HIV are of prime working age, and we would expect the average family in Asia to struggle to recover from this loss.

Additionally, an increase in male AIDS mortality has a less negative effect on saving than female AIDS mortality. A 10% increase in male AIDS mortality should lead to ~ .04% decrease in saving; but, if there is a 10% increase in female AIDS mortality, savings should decrease by ~ 1.08%. This suggests gender differences in macroeconomic effects of AIDS mortality, following the micro-level results found in Yamano and Jayne's (2004) research.

Looking at our other explanatory variables, we see a positive relationship between population growth and saving; but it is not statistically significant. In terms of the effect of literacy, we see a positive relationship between literacy and saving when savings is regressed on the entire sample. The coefficient for literacy is statistically significant at the 5% level. Lastly, the savings-investment relationship shows a 1% increase in investment increases saving by ~0.5%. The coefficient on investment is statistically significant at the 5% level.

[2] Both AIC and BIC appropriate mentioned number of lags

Table 1b shows that an increase in the mortality of either gender as a result of AIDS should decrease investment. Our coefficient for both gender's mortality as a result of AIDS is significant at the 10% level. While we found a noticeable spread in the coefficients of male and female AIDS mortality when saving was our dependent variable (-0.004 vs. -0.108), we find much less of a spread with investment as our dependent variable. In this case, a 10% increase in male AIDS mortality should decrease investment by ~0.48%; a 10% increase in female AIDS mortality should decrease investment by ~0.37%. This finding is consistent with the literature, as HIV/AIDS leaves fewer resources available for investment (Hacker, 2004).

Further analysis of our whole-sample regression of investment, there is a negative relationship between GDP per capita and investment. The coefficient on GDP per capita is significant at the 1% level. This follows the global trend of decreasing investment as a share of GDP over the relevant time period (World Bank). There is also a negative relationship between investment and rate of population growth, which is significant at the 1% level. We also see that a 1% increase in the literacy rate is expected to decease investment by ~0.15%. This negative relationship can be explained by Graff's (2010) "literacy myth." The coefficient on literacy is significant at the 5% level. The savings-investment correlation in this model shows a 1% increase in saving is expected to increase investment by ~0.36%. The coefficient on saving is statistically significant at the 1% level.

Now regressing saving on our high-income sample as defined by the World Bank (Table 2a), we see further evidence of gender differences in the effects of adult mortality. For our high income countries, there exists the generally-expected negative relationship between female AIDS mortality and savings; but, there is a positive relationship between male AIDS mortality and savings. Both are significant at the 10% level, and the p-value of $llnhivmm$ is 0.073. Similar to our whole sample regression, there is a positive relationship between GDP per capita and saving. The coefficient on GDP per capita is significant at just above the 5% level (p-value: 0.052). Rate of population growth also has a positive relationship with savings. The coefficient on population growth is significant at the 1% level. In looking at the effects of literacy on investment, we see that a 1% increase in the literacy rate in high-income Asian countries is expected to lead to a ~1.32% increase in the savings rate. This rather large effect of literacy on gross domestic saving may be a result of under-specification. There may be an endogeneity issue with the literacy variable in this regression that is giving it such a high elasticity. That being said, it is significant at the 5% level. The savings-investment correlation is negative in our high-income Asian countries sample, and it is statistically significant at the 5% level. Our six explanatory variables are jointly significant at the 1% level; and, as expected with our findings from our regressions on the entire sample, the Cook-Weisberg and White tests tell us that we cannot reject the hypothesis of homoskedasticity.

The positive correlation between male AIDS mortality and saving for high-income Asian countries is the most interesting finding in our analysis. With micro-level data from a country with similar cultural responses to HIV supporting this relationship (Yamano and Jayne, 2004), we believe this serves as to further demonstrate that there are gender and wealth differences in the effects of HIV/AIDS on the macroeconomy. By dividing their sample into two groups depending on the initial asset levels of the household, similar to our high and low income groups as defined by the World Bank, Yamano and Jayne found "negative impacts on the net value of crop production, assets, and off-farm income only in the case of male head-of-household mortality among relatively poor households" (pg. 115).

Looking at our high-income sample regression with investment as the dependent variable, we see GDP per capita positively correlated with investment and statistically significant at the at the 1% level. In terms of gender mortality as a result of AIDS, an increase in male mortality is expected to decrease investment, but our result is not statistically significant. This is the only coefficient we have for gender mortality as a result of AIDS that is not statistically significant at generally respectable level. In terms of female AIDS mortality in low-income countries, our data shows a 1% increase in female AIDS mortality in low-income Asian countries increasing investment by ~ 0.06%. This result is statistically significant at the 10% level. Literacy is showing a large effect on investment with a result that has a

p-value of 0.015. With such a major statement, a 1% increase in literacy should increase investment by 4% in low-income Asian countries, it is imperative to look deeper into the data for an explanation as to why such a significant result is being found. Rate of population growth is shown to be very statistically insignificant (p-value: 0.854). In terms of the saving-investment correlation, we again find a negative relationship between the two for the high-income sample. These explanatory variables are jointly significant at just above the 1% level. Again, the Cook-Weisberg and White tests tell us that heteroskedasticity is not a concern.

Now, focusing on saving and our low-income sample (Table 3a), we see that an increase of either gender mortality as a result of AIDS decreases savings. Similar to our analysis on all the countries in our sample, we see a notable spread in the result between genders. While both have negative coefficients, a 10% increase in male mortality as a result of AIDS is expected to decrease savings by roughly 1.4%. On the other hand, a 10% increase in female mortality as a result of AIDS should decrease savings by .4%. This roughly one percentage-point difference between the effects on each gender could be due to the generally increased financial pain that comes to a low-income household as a result of losing the male head of household (Yamano and Jayne, 2004).

Further, Table 3a shows a negative relationship between GDP per capita and saving that is significant at the 10% level. Rate of population growth appears as a statistically insignificant effect. The relationship between literacy and savings in low-income Asian countries is positive and statistically significant at the 5% level. Unlike our high-income sample, there is a strong positive correlation between savings and investment. Our regression shows a 1% increase in investment in low-income Asian countries should increase saving by roughly 1.17%; this result is statistically significant at the 5% level. The Cook-Weisberg test and White test show us that heteroskedasticity is not a concern. While all our variables except for rate of population growth have been statistically significant, they are not jointly significant in this estimation (p-value: 0.27).

Looking at investment and our low-income sample (Table 3b), an increase in the mortality of either gender as a result of AIDS is expected to have very similar negative effects on investment. The results for both genders are significant at the 10% level, and say that a 10% increase in mortality of either gender is expected is expected to decrease investment by roughly .5%. Our coefficient for GDP per capita is negative, but statistically insignificant. Once again, rate of population growth in our low-income sample does not have a statistically significant effect. Literacy and investment show a positive relationship in our low-income sample, with statistical significance at the 10% level. The saving-investment correlation remains positive with investment now the dependent variable; but, the magnitude is reduced from that shown in Table 3a with savings as the dependent variable. In this case, saving is statistically significant at the 1% level. In this estimation, our explanatory variables are jointly significant at the 10% level (p-value: 0.0620). We can see that our explanatory variables do not explain the low-income sample as well as the high-income sample or the whole sample. In terms of heteroskedasticity, the Cook-Weisberg and White tests tell us that this is not an issue.

5. CONCLUSION

In evaluating the effects of AIDS mortality on saving and investment in Asian countries, our research shows that there are gender and wealth differences in how this disease affects the macro economy. While an increase in the AIDS mortality rate of either gender reduce saving and investment in low-income countries, we find gender differences on the effects of AIDS for high-income countries. In regards to savings, an increase in male AIDS mortality is shown to increase savings. On the other hand, an increase in female AIDS mortality is expected to decrease savings. In terms of investment we find the opposite effects across genders: increasing male AIDS mortality causes decrease in investment (though not statistically significant) and increasing female AIDS mortality increases investment. Further research is necessary to thoroughly understand the causes for gender differences in AIDS mortality on investment. Some potential explanations for gender differences in savings

include: precautionary savings as a result of the loss of a breadwinner; gender differences in savings behavior; the societal pressures of dowry/bride price encouraging savings (Yamano and Jayne, 2004).

For low-income countries, we see an increase in mortality of either gender as a result of AIDS reduces both saving and investment. With our variables not jointly significant at less than 1% for our low-income sample, we desire to further research for variables that may better the story of factors affecting low-income countries.

5.1. Future implications

Much work and room for advancement is left in the humanitarian fight against AIDS, and it will be interesting to see the economic implications. ART is a landmark discovery, and its increased availability has been one of the greatest factors in decreasing HIV incidence. That being said, "17 of the 37 million people living with HIV at the end of 2014 did not know their HIV status and 22 million were not accessing antiretroviral therapy" (WHO, 2016). The WHO (2016) openly admits "the initiation of antiretroviral therapy for everyone living with HIV would require an unprecedented effort from countries and partners." In their annual report (WHO, 2016), they assert "investments in HIV will need to grow to US$ 31 900 million in 2020 and US$ 29 300 million in 2030 if long-term control of the epidemic is to be achieved" (pg. 17).

Fear, or lack of knowledge, of diagnosis also remains a severe issue with HIV. Of people living with HIV in India who inject drugs, a known at-risk group, only 41% know their status; and, only 52% of those that know are on treatment (UNAIDS, 2017). This lack of knowledge of diagnosis and participating in ART is due to negative societal pressures and stigma associated with those who test positive for HIV. Much work is being done to alter and remove the stigma rendered on those who test positive, as it has been show to increase participation in this life-altering treatment. "Research in Jakarta, Indonesia, has shown that people with strong social support were 2.5 times more likely to adhere to treatment regimens over a three-month period compared to people who had less social support" (UNAIDS, 2017). Another avenue of improving diagnosis is increasing the use and prevalence of HIV self-testing, which "has the potential to meet key populations not secure in getting testing done in a public facility" (UNAIDS, 2017).

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Appendix

Table 1a: Whole sample regression: dependent variable – saving

(1) Independent variables	(2) Coefficients	(3) P-Values	(4) T-Statistics
l2lngdpp	0.334	0.026**	2.29
llnhivmm	-0.004	0.085*	-2.18
Llnhivfm	-0.107	0.093*	-1.93
Llnpop	0.169	0.346	0.95
Llnlity	0.444	0.034**	2.63
llninv	0.500	0.013**	2.54
constant	-3.169	0.246	-1.18

Adj. R^2 =0.3635
P-Value = 0.0004
Cook-Weisberg test for heteroskedasticity Prob > chi2 = 0.5445
White's test for Ho: homoskedasticity Prob > chi2 = 0.1939
*indicates significance at 10%
**indicates significance at 5%
***indicates significance at 1%.

Table 1b: Whole sample regression: dependent variable – investment

(1) Independent variables	(2) Coefficients	(3) P-Values	(4) T-Statistics
l2lngdpp	-0.107	0.080***	-1.79
llnhivmm	-0.048	0.085***	-1.95
Llnhivfm	-0.037	0.094***	-1.88
Llnpop	-0.230	0.044*	-2.07
Llnlity	-0.148	0.032**	-2.34
llnsave	0.355	0.000*	4.39
constant	3.975	0.016**	2.49

Adj. R^2 =0.3692
P-Value = 0.0008
Cook-Weisberg test for heteroskedasticity Prob > chi2 = 0.6001
White's test for Ho: homoskedasticity Prob > chi2 = 0.1877
*indicates significance at 1%
**indicates significance at 5%
***indicates significance at 10%.

Table 2a: High-income sample regression: dependent variable – saving

(1) Independent variables	(2) Coefficients	(3) P-Values	(4) T-Statistics
l2lngdpp	0.464	0.052***	2.06
llnhivmm	0.039	0.073***	1.97
Llnhivfm	-0.043	0.093***	-1.94
Llnpop	0.369	0.009*	2.88
Llnlity	1.316	0.028**	2.35
llninv	-0.078	0.049**	-2.19
constant	5.392	0.754	0.32

Adj. R^2 =0.4905
P-Value = 0.0064
Cook-Weisberg test for heteroskedasticity Prob > chi2 = 0.5044
White's test for Ho: homoskedasticity Prob > chi2 = 0.1907

*indicates significance at 1%
**indicates significance at 5%
***indicates significance at 10%.

Table 2b: High-income sample regression: dependent variable – investment

(1) Independent variables	(2) Coefficients	(3) P-Values	(4) T-Statistics
l2lngdpp	0.628	0.003*	3.32
llnhivmm	-0.058	0.167	-1.43
Llnhivfm	0.064	0.082***	1.88
Llnpop	-0.018	0.854	-0.19
Llnlity	4.023	0.015**	2.62
llnsave	-0.168	0.043**	-2.15
constant	16.451	0.022**	2.47

Adj. R^2 =0.4686
P-Value = 0.0121
Cook-Weisberg test for heteroskedasticity Prob > chi2 = 0.5510
White's test for Ho: homoskedasticity Prob > chi2 = 0.1812
*indicates significance at 1%
**indicates significance at 5%
***indicates significance at 10%.

Table 3a: Low-income sample regression: dependent variable – saving

(1) Independent variables	(2) Coefficients	(3) P-Values	(4) T-Statistics
l2lngdpp	-0.520	0.070***	-1.93
llnhivmm	-0.138	0.081***	-1.81
llnhivfm	-0.039	0.020**	-2.36
llnpop	-0.197	0.769	-0.30
llnlity	0.550	0.018**	2.45
llninv	1.169	0.041**	2.16
constant	1.274	0.813	0.24

Adj. R^2 =0.2860
P-Value = 0.2684
Cook-Weisberg test for heteroskedasticity Prob > chi2 = 0.6553
White's test for Ho: homoskedasticity Prob > chi2 = 0.2004
*indicates significance at 1%
**indicates significance at 5%
***indicates significance at 10%.

Table 3b: Low-income sample regression: dependent variable – investment

(1) Independent variables	(2) Coefficients	(3) P-Values	(4) T-Statistics
l2lngdpp	-0.365	0.109	-1.68
llnhivmm	-0.052	0.097***	-1.74
Llnhivfm	-0.050	0.081***	-1.86
Llnpop	-0.179	0.663	-0.44
Llnlity	0.204	0.094***	1.76
llnsave	0.397	0.009*	2.89
constant	4.333	0.163	1.45

Adj. R^2 =0.401
P-Value = 0.0620
Cook-Weisberg test for heteroskedasticity Prob > chi2 = 0.4998

White's test for Ho: homoskedasticity Prob > chi2 = 0.1962
*indicates significance at 1%
**indicates significance at 5%
***indicates significance at 10%.

Table 4: Countries by income

High Income	Low Income
Azerbaijan	Afghanistan
Bahrain	Armenia
China	Azerbaijan
Iran	Bangladesh
Iraq	Bhutan
Israel	Brunei
Japan	Cambodia
Jordan	India
Kazakhstan	Indonesia
Kuwait	Kyrgyz Republic
Lebanon	Maldives
Malaysia	Mongolia
Oman	Nepal
Qatar	Pakistan
Republic of Korea	Philippines
Saudi Arabia	Sri Lanka
Singapore	Syrian Arab Republic
Taiwan	Tajikistan
Thailand	Uzbekistan
Turkey	Vietnam
Turkmenistan	Yemen, Rep
United Arab Emirates	