Effects of the Human Immunodeficiency Virus (AIDS) epidemic on economic growth in Iran

Hossein Sharifi Renani[1], Nader Akhoondi[2], Naghmeh Honarvar[3], Morteza Mohammadi[4]

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1. Assistant Professor Department of Economics ,Khorasgan (Isfahan) Branch, Islamic Azad University, Isfahan, Iran
2. Graduate in Department of Economics, Isfahan University, Iran
3.**Correspondence to**: PhD Student, Young Research and Elite Club, Khorasgan (Isfahan) Branch, Islamic Azad University, Isfahan, Iran
Tel/Fax: +98 751 332758
Email: naghmeh_honarvar@yahoo.com
4. Graduate in Department of Economics, Khorasgan (Isfahan) Branch , Islamic Azad University, Isfahan, Iran

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Abstract

Consensus in the international community has grown over the past two years that Human Immunodeficiency Virus (AIDS) poses a threat to development, security, and economic growth. This paper uses Vector Error Correction Model(VECM) and Johansen cointegration analysis to estimate the effects of HIV on economic growth in Iran from 1990-2009. The results show that there is a long run cointegrating relationship between GDP per capita, total HIV mortality rates and the age dependency ratio. Result showed that an increase of 1% in total HIV morality rates will result in 1.6% decrease in GDP. The results also indicate that 1% increase in the age dependency ratio leads to 0.9% decrease in GDP. The empirical estimations for Iran from 1990-2009 show the effects appear to be greater when HIV morality rates fall in the whole population. However, the old age dependency ratio also has an important influence on the relationship when HIV is measured in the population, although the effect of changes in age dependency on GDP is considerably less than that of HIV. Education is now directly involved in the long run relationship between GDP and HIV. In plain sight, HIV/AIDS impacts negatively economic growth by reducing the labor force and potential output, but the main issue is to find out to what extent and how to correct the problem in the least costly and most effective way.

Keywords: AIDS, Economic Growth, Epidemy, Iran

Introduction

The evolving HIV epidemic can be considered as the most significant adverse health development in modern history. In many countries, it has reversed gains in life expectancy and related health indicators that had been achieved over many decades. However, the impacts of HIV/AIDS on key macroeconomic indicators, such as economic growth and income per capita, have been modest so far. The impact of the HIV/AIDS epidemic on the economy has been a concern since the beginning of the pandemic. Some believe that the HIV/AIDS epidemic is responsible for slowing the rate of growth of the gross national product of many heavily affected countries and that in some cases, GDP growth could decrease by more than 1 percentage point for every

10 per cent HIV prevalence. Others take the view that HIV/AIDS has had little impact on the macr oeconomy so far. It is difficult to estimate empirically the effect of HIV/AIDS on economic performance since so many factors other than HIV/AIDS affect economic growth. The countries most seriously affected by the epidemic are also faced with drought, war and other problems[1].

AIDS is an emerging disease which has become known as 'the plague of the century' [2]. Although HIV is on the downward trend in a number of countries, the general trend globally is upward [3-5], and it continues to challenge human communities with its health, social, economic, cultural, and political consequences. According to a WHO report, the prevalence rate of HIV/AIDS in Iran has risen from low to concentrated [6]. The prevalence in the overall population is below 1%; this rate, however, has surpassed 5% in some high-risk groups such as IDUs [7,8]. For effective management and planning on the prevention and control of HIV, it is crucial to attend to the number of people living with HIV (PLHIV) and to identify prime high-risk groups. As well as focusing on the HIV/AIDS epidemic in the country and its longitudinal patterns of changes [1,9-12]. The HIV/AIDS outbreak became a public health problem and then a matter of economic development; firstly, the rapid spread of the disease around the world and the lack of medical treatments slaughtered a relatively large portion of the global population, especially those located in low- and middle-income countries. Secondly, millions of dollars have been spent in reducing the deadly effect of the virus and in preventing the disease, discouraging other economic activities. Most of the gains from technological advance and the globalization process of the past half century have been lost to the HIV/AIDS epidemic, which now represents one of the greatest health challenges of the recent times: as of December 2006, almost 40 million people around the world were living with the virus and would eventually develop full blown AIDS; 4.3 million people were newly infected (half million of them were children under 15 years), and there is an estimation of 3 million AIDS related deaths (0.38 million are children under 15 years) during the same period [8].

Barro in 1996, who derived a theoretical framework for the relationship between health and economic growth by extending the neoclassical growth model to incorporate health capital. Barro proposed that the output of goods, depends on physical capital, labour hours and two forms of human capital, worker schooling and education and the state of worker health, or health capital. A key feature of Barro's model is that it allows for two-way causation between health and economic growth. An increase in output, increases health capital because it increases the ability to invest, for example, in the purchase of medical treatment or in preventative measures such as exercise and nutrition. At the same time, better health can increase output both directly and indirectly. An improvement in the health of workers, directly raises output for any given level of physical capital and education. In addition, an improvement in health indirectly increases output because a longer life with less working time lost to illness raises the rate of return on past investments in human capital, that is, it reduces the depreciation rate of both forms of human capital. Consequently better health increases the incentive for further investments in both education and health. These indirect effects have important implications, particularly for higher income countries. They suggest firstly that the economic gains from improving health by reducing death and illness from communicable diseases such as HIV. Secondly, if the rates of return on investment in human capital increase as the economy grows, the ratios of education and health to physical capital and output should also increase, that is, education and health should become more important as income rises. The HIV/AIDS epidemic has targeted mainly adults and therefore impacted negatively human capital accumulation by reducing its productivity. The burden of any disease, or the loss of health capital, has had

a powerful influence on the economic activity of a country at different levels of income, especially when it affects the labor force [18].

There is plenty of evidence that the HIV/AIDS epidemic has deeply affected human kind during more than two decades. Since the emergence of new and powerful medical treatments, the rate of mortality has decreased drastically in some countries , diminishing the burden of the illness and the rate of depreciation of human capital. A higher level of health care have proven to take place at higher levels of income per capita, so more investment in health, and therefore in human capital, promotes economic growth and vice-versa. Industrialized countries seem to face most of the diseases, including the HIV/ AIDS pandemic, with relatively less adverse results and the loss of human capital has been offset by government supporting programs and a network of civilian institutions. Mean while middle- and low-income nations are struggling with the devastating impact of the illnesses that could be prevented or reduced by implementing cost-efficient plans [15].

Few studies done about the effects of AIDS on economic growth that are listed below:

Haghdoost and et al. 2011 estimate and project HIV/AIDS in Iran up to 2014. Based on the main scenario R2, the estimated prevalence of HIV infection among adults was 0.16% (0.08-1.03%) in 2009. It will slightly decrease to 0.15% (0.06-1.08%) in 2012. With respect to the number of infected people with HIV, the estimated number was 89,000 and 106,000 for 2009 and 2014 respectively. There were estimated to be approximately 7,000 new cases annually. The highest trend of HIV was estimated to be a shift from IDUs to FSWs, and the estimate is that new infected cases via unsafe sex will increase in the future, while over time, the trend with respect to transmission via unsafe injection will decrease [13].

Bonnel concluded from a cross-country study using African data, that HIV/AIDS on average reduced Africa's per capita growth rate by 0.7 percent points, which is substantial given an average growth rate in the sample of 0.4 percent per annum per capita. Furthermore, if the countries were also affected by malaria, the growth rate was lowered by a further 0.3 percent points. These results were obtained using a cross-section/cross-country growth equation estimated in a system with equations for policy variables and HIV. It would therefore seem that Bonnel's work using more recent and comprehensive data are sufficient to cast doubt upon Bloom and Mahal's earlier study [14]. Corrigan et al 2005 highlight generational linkages between health and education by arguing that the children of adults who drop out of the workforce due to ill-health, may enter the labour force prematurely, thereby forgoing their education to maintain the household's income [20].

Arndt use a multi-sector computable general equilibrium (CGE) model to examine the impact of HIV and AIDS on South African economic growth. Relative to a no AIDS scenario, they predict by 2010 annual aggregate gross domestic product (GDP) in South Africa would be 17% smaller in the presence of AIDS [19].

Sackey and Rarpala project Lesotho's GDP growth in 2010 would drop from 4.0% without AIDS to 2.4% with the disease, and in 2015 drop from 4.0% to 1.3% [20].

Bonnel specifies a macroeconomic model with more structural features of an economy than Over. Using a more complete data set covering the period 1990-97, Bonnel attempts toidentify the forces precipitated by the disease that would cause GDP per capita to decline. Hisresults suggest that relative to a no-AIDS case, over a twenty year period a typical sub Saharan country with a prevalence rate of 20% would realize a 67% drop in per capita GDP levels. He finds that a decline of this magnitude also lead to decline in the growth of per capita GDP [14].

The aim of this study was to evaluate the effects of HIV on economic growth in Iran. Because few studies done about the effects of AIDS on economic growth, either within the country or outside the country, the following are some of the researches.

This paper uses VECM and Johansen

cointegration analysis to examine the effects of HIV on GDP growth in Iran. The rest of the paper is organised as follows. Section 2 discusses about the data and methodology to be used in the estimations, while Section 3 the results of the estimations in more detail and section 4 provides some concluding comments.

2. Model, Data and Methodology

2.1 Model

The model for the econometric estimation is based on model of Barro(1996) that the system of equations estimated in the Johansen method is described as a vector error correction. The VECM system of equations is written as: [1]

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-1} + \mu + \Psi D_t + \varepsilon_t$$

where zt is the vector of variables,μ is a vector of constants, and Dt a vector of other deterministic variables such as a time trend.

The first group of terms on the right hand side of equation [1], up to and including Δz_{t-k+1}, represents the short run lagged effects of differences in the variables in z on each variable in the system. The next term, Πz_{t-1}, is the error correction term (ECT) that represents the long run cointegrating relationships between the levels of the variables in z. If there are n variables in the vector of variables z_t, there are (n – 1) potential cointegrating relationships between them. The number of cointegrating relationships is determined by the rank (r) of the matrix of long run coefficients Π. If a cointegrating relationship exists between the variables, Πcan be factorised into $\Pi = \alpha\beta'$, where β' is the coefficients on the individual variables in the long run cointegrating relationship and α is the coefficient on the ECT itself [21].

The econometric estimationis based on the model developed by Barro. The model for econometric estimation is based on the log form as followed: [2]

$$\text{h}\ GDP_t = \beta_0 + \beta_1 \text{h}\ k_t + \beta_2 \text{h}\ EDU_t + \beta_3 \text{h}\ HIVTOT_t + \beta_4 DEP + \varepsilon_t$$

The that matrix of variables is determine by the following: [3]

$$Y_t = [GDP \quad K \quad EDU \; HIVTOT \quad DEP]$$

GDP: Gross Domestic Product

K: Physical Capital. Data on the stock of physical capital is not available for the period estimated here. In neoclassical growth models of closed economies, the steady state level of capital per effective worker is dependent on the domestic savings rate. But in open economies like that of Iran, the level of investment may be higher because of the potential for the use of foreign savings. For this reason, the ratio of investment to GDP (INV) is often used as a proxy measure of capital formation in empirical estimations of growth models [18].

EDU: School enrollment, primary

HIV TOT: Prevalence of HIV, total or HIV morality. DEP: Old Age Dependency Ratio, that is the ratio of the population aged 65 and over the working age population (15-64 years). and εtis an i.i.d error term.

All data variables are taken from the website of the Central Bank of Iran and the World Bank and WDI.This article is an original research article and all estimates are done by the JmulTi software.

Results

Stationarity testing of the variables was performed using Augmented Dickey-Fuller (ADF) tests. The log forms of all five variables, GDP per capita, HIV mortality rates for the total population (HIVTOT), education (EDU), investment rate (INV) and old age dependency (DEP) were non-stationary but their first differences were found to be stationary. It is therefore appropriate to use cointegration analysis to estimate the relationships between the variables.

The Johansen cointegration method was chosen for this section to determine the number of long term relationship between variables. Table 1 shows the results of the Johansen Test for long run relationship between the variables. Result show that there is one long run or cointegration relationship between the variables in the model.

None of the variables have any significant short run effects in the equation for GDP, which is consistent with the long run nature of the model of economic growth. As in the long run relationship, there are significant

Table 1 *Rank Test for number of cointegrating vectors*

Null	Eigenvalues	Trace Statistic	Critical values (95%)
Estimation with HIV Mortality Rate of Total Population (HIVTOT)			
r = 0	0.40	111.0*	97.2
r = 1	0.28	70.0	70.3
r = 2	0.21	41.4	47.6
r = 3	0.14	23.1	29.7
r = 4	0.12	11.0	17.9

* Denotes significance at 5%.

short run effects between HIV morality and the age dependency ratio.

The coefficients of the VECM in Table 2 show that an increase in both HIV morality rates and in the dependency ratio will lead to a long run decrease in GDP, but HIV has a much bigger impact. If HIV morality rates in the population were to rise by 1%, GDP will fall by 1.6% in the long run, but 1% increase in the dependency ratio will reduce GDP by only 0.9% in the long run. The relative size of these effects implies that reducing disease and mortality from HIV disease can have significant benefits for economic growth even in an economy with an aging population.

Table 2 *ECMs from estimation with HIV Mortality Rate of Total Population (HIVTOT)*

		dGDP	dHIVTOT	dDEP	dINV	dEDU
Short run variables	$dGPC_{t-1}$	0.002 (0.017)	0.208* (4.198)	0.022 (1.571)	0.225** (1.90)	0.035 (-0.839)
	$dHIVTOT_{t-1}$	0.198 (1.287)	-0.283* (-3.592)	-0.036** (-1.655)	0.025 (0.138)	0.048 (0.758)
	$dDEP_{t-1}$	-0.751 (-1.432)	0.764* (2.848)	0.871* (11.808)	0.587 (0.943)	-0.407** (-1.887)
	$dINV_{t-1}$	-0.002 (-0.026)	-0.032 (-0.796)	-0.016 (-1.455)	0.270* (2.900)	0.040 (1.217)
	$dEDU_{t-1}$	-0.027 (-0.141)	0.018 (0.187)	0.010 (0.390)	0.139 (0.626)	0.655* (8.359)
Long run variables	α	-0.162* (-2.686)	-0.202* (-6.559)	0.000	0.000	0.000
	ECT[1]: GDP	1.000	1.000			
	HIVTOT	1.605* (6.387)	1.605* (6.387)			
	DEP	0.912* (6.510)	0.912* (6.510)			

* Denotes significance at 5%.

** Denotes significance at 10%.

[1] ECT is normalised on GDP

Conclusion

The objective of this paper was to examine empirically the impact of HIV prevalence on economic growth. The pronounced impact of HIV/AIDS prevalence on health capital/infant mortality, and hence on incomes, suggests that the epidemic may now be entering a stage where the loss of life is starting to impact appreciably upon both social and economic interactions[1].

The theoretical model of economic growth derived from Barro proposes that HIV can affect GDP per capita both directly, and indirectly, by decreasing incentives for

investment in human and physical capital, and that higher GDP per capita will tend to lower HIV mortality rates [18] . The empirical estimations for Iran from 1990-2009 show the effects appear to be greater when HIV morality rates fall in the whole population. However, the old age dependency ratio also has an important influence on the relationship when HIV is measured in the population, although the effect of changes in age dependency on GDP is considerably less than that of HIV.

Education is now directly involved in the long run relationship between GDP and HIV. In this model, a rise in HIV morality rates has a very similar long run impact on GDP to a similar sized fall in education participation. In addition, changes in both GDP and HIV morality rates that affect the long run relationship will also affect education and investment indirectly.

If the effects of HIV on economic growth found here for Iran apply more widely, there are serious implications for growth and development in all countries. More research is need to estimate the economic impact of HIV in a broader range of countries, and to examine the effects of other communicable diseases that are likely to have major impacts on global economic growth in the future.

A number of researchers in others countries have argued that analyses of the epidemic's macroeconomic effects tend to give an overly sanguine assessment of the eventual economic impact of the epidemic because they fail to take account of effects on human capital and social capital that will become

increasingly prominent as time goes on. According to Bell, Devarajan and Gersbach, "not only does AIDS destroy existing human capital, but by killing mostly young adults, it also weakens the mechanism through which knowledge and abilities are transmitted from one generation to the next; for the children of AIDS victims will be left without one or both parents to love, raise and educate them". Nevertheless, these results produce useful additional information and indicate that the macroeconomic affects of the HIV/AIDS epidemic are substantial. In some countries for example Iran, where HIV is health problems, the level of the marginal impacts of HIV prevalence on income per capita are of orders of magnitude that suggest a substantial proportion of the apparently poor economic performance of many of these economies over the past 10 to 20 years can be attributable to the HIV epidemic; a characteristic that has been omitted from many macroeconometric studies that have sought to explain economic performance in many developing countries [6]. Moreover the marginal effects are sufficiently large to suggest that they threaten macroeconomic stability, which is generally most fragile in the poorer countries that are also those most prone to catastrophic escalations of the epidemic. If the legitimate aspirations of the inhabitants of these countries are to be achieved and poverty reduction strategies, and similar policies, in these countries are to be realized, the maintenance of macroeconomic stability is likely to be a prerequisite. All of which indicates that over and above the humanitarian case for supporting health care provision and services in countries suffering from the HIV/AIDS pandemic, there is a strong case for providing more general economic support.

In conclusion, this study finds that the HIV/AIDS epidemic involves not only devastating human and social costs, but also large economic costs. The broad policy implications that have arisen from this emerging literature are supported by our results. These policy implications include (i) that in countries considered at particular risk of increased HIV prevalence in the future, from a purely economic cost-benefit perspective, devotion of substantial preventative resources is justified to avoid large long-run economic damage, and (ii) for those countries already in the midst of a severe epidemic, not only should resources be devoted to tackling the epidemics spread and improving the quality and productivity of life for HIV sufferers, they should also be directed to maintaining participation in and quality of the education system that in turn would prevent a breakdown

in the transmission of human capital across generations. Limitation of this study was faced restrictions on data access.

there is a need for research that provides a greater understanding of the mechanisms by which sustained epidemics impact upon economic performance such as level of economic growth that it is the most important economic variable in any countries.

The results also indicate the need for further explorations of how the epidemic impacts upon economic relationships, so as to direct policy makers' attention to the economic implications of AIDS Such a research agenda will necessitate the development of forward looking models that provide insights into how, inter alia, the large numbers of AIDS orphans will impact upon the accumulation of education capital.

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Contributions

Study design: HShR, NA, NH, MM

Data collection and analysis: HShR, NA, NH, MM

Manuscript preparation: HShR, NA, NH, MM

Conflict of Interest

"The authors declare that they have no competing interests."

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