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Further Results on the Macroeconomic Effects of AIDS: The Dualistic, Labor-Surplus Economy

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This article generalizes and extends the earlier analyses of Cuddington (1993) and Cuddington and Hancock (forthcoming) by incorporating the presence of under-employment and dual labor markets—considerations that seem particularly important when assessing the likely impact of AIDS *in many African countries. The dual-economy simulations of the economic impact of* AIDS *using Tanzanian data suggest that the macroeconomic consequences of the epidemic are of the same order of magnitude as those obtained using a single-sector, full-employment model: gross domestic product (*GDP*) is 15 to 25 percent smaller by 2010 than it would have been without* AIDS, *and per capita* GDP *is 0 to 10 percent smaller. The output loss from* AIDS *in the dual-economy framework is roughly the same as the output gain achievable through policies designed to increase labor market flexibility. The exercise is crude, but it suggests that meaningful efforts at economic reform in economies devastated by* AIDS *may at least ameliorate some of the negative economic effects of the epidemic, although they would certainly not offset its personal and social costs.*

Recent analyses by Cuddington (1993) and Cuddington and Hancock (forthcoming) have modeled the macroeconomic effects of the AIDS epidemic using a modified Solow (1956) growth model. This single-sector framework implicitly assumes that labor and capital are always efficiently allocated throughout the economy; there are no market failures or policy-induced distortions that lead to resource misallocation. Thus, these articles, in effect, model the impact of AIDS on the economy's potential growth path.

Although such models are useful for studying various channels through which AIDS affects the macroeconomy, their underlying assumptions are open to question when studying low-income developing countries in Sub-Saharan Africa. Tanzania, for example, arguably operates well below its full-capacity level, in spite of the rapid growth in employment and wage levels in the informal sector in recent years (Maliyamkono and Bagachwa 1990). Some have conjectured that the estimated impact of AIDS in Tanzania based on the single-sector, full-employment growth model in Cuddington (1993) is significantly overstated. They argue that workers

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who die from AIDS can easily be replaced by otherwise unemployed or underemployed workers, leaving total output relatively unaffected. In this situation the spread of AIDS may lead to a rise in per capita income.[1]

With these concerns in mind, this article generalizes the simple full-employment model to incorporate underemployment and dual labor markets. Section I shows that the macroeconomic impact of AIDS may, in principle, be larger or smaller than previously estimated once the possibility of unemployment is introduced into the single-sector growth framework. After developing the intuition behind this result, section II describes a somewhat more complicated dual-economy model. This model is then used in section III to reassess the macroeconomic effects of the AIDS epidemic in Tanzania. Like Cuddington (1993), these simulations use Bulatao's (1990) demographic simulations for AIDS and no-AIDS scenarios to assess the economic impact of the disease in relation to a no-AIDS counterfactual case. Section IV considers the impact of policies designed to speed labor market adjustment in economies where the AIDS epidemic is worsening. Section V concludes.

I. The Impact of AIDS in Full-Employment and Unemployment Models

This section develops some intuition regarding the direction and approximate magnitudes of the bias in results obtained from simple full-employment models (as in Cuddington 1993; Cuddington and Hancock 1992; and Over 1992) if the economy in question is, in fact, characterized by considerable underemployment. It argues that it is not whether the economy is at full employment that is critical; rather it is the extent to which the spread of AIDS causes capacity utilization to change. If AIDS reduces unemployment, the total loss in output is overestimated when the analyst makes the simplifying assumption of full employment. Conversely, if AIDS increases unemployment, the loss in output will be underestimated by the simple full-employment framework. In situations where the amount of unemployment or idle capacity is relatively unaffected by AIDS, the estimated output loss based on earlier full-employment models will be approximately correct. These three cases can be seen by comparing the impact of AIDS on GDP in a single-sector, full-employment model and an otherwise identical sticky-wage model with unemployment.

The Full-Employment Case

Recall from Cuddington (1993) that the spread of HIV/AIDS reduces effective labor supply:[2]

1. Cuddington (1993), in contrast, predicts that Tanzania's GDP by 2010 could be 15 to 25 percent smaller because of the AIDS epidemic and that per capita GDP might be 0 to 10 percent lower. The estimates for Malawi in Cuddington and Hancock (1992) are somewhat smaller, because its epidemic seems less severe up to this point.

2. Under the assumption that firms are aware of average age-based productivity differentials and make

$$E^s = \sum_{i=15}^{64} \rho_i L_i \tag{1}$$

where E^S is effective labor supply and L_i is the number of workers of age i. As in Cuddington (1993), ρ_i, the productivity coefficient for workers of age i, captures specific productivity differentials: $\rho_i = 0.8 + 0.02(i\text{-}15) - 0.0002(i\text{-}15)^2$. Note that E^S is defined slightly differently here than in Cuddington (1993). In the latter, E measured physical units of labor adjusted for age-specific and AIDS-related productivity differentials. Here E^S is the physical supply of labor adjusted for the non-AIDS-related, age-specific productivity differentials only. The impact of AIDS on average productivity is captured separately as shown in the production function (equation 2). The assumption—based on data availability—that z and a do not vary across age cohorts enables this simplification.[3] It has the pedagogic advantage that the presence of AIDS does not alter the units in which labor is measured, but instead is reflected in the shifts in effective labor demand and supplies outlined below.

The rise in mortality rates due to AIDS reduces the size of the labor force and tilts its composition toward younger (less-experienced) age cohorts. These factors shift the effective labor supply curve in figure 1 to the left (from E_0^S to E_1^S).[4]

On the labor-demand side, AIDS-related illness reduces labor productivity by increasing absences from work and reducing overall strength, stamina, and concentration. The adverse impact of active AIDS cases (not HIV-positive status, which is typically unknown) is reflected in the aggregate production function

$$Y = \alpha \gamma^t [(1 - za)E]^\beta K^{1-\beta}. \tag{2}$$

In equation 2, Y is GDP, E is effective labor demand, K is the capital stock, a is the proportion of the work force with active AIDS, and z is the fraction (or multiple) of worker productivity lost because of AIDS-related illness. γ^t is an exogenous time trend capturing technical progress. β is labor's share of total output and α is a constant chosen to ensure that the equality in equation 2 holds for the initial values of Y, E, and K.

Using equation 2 and assuming firms face a fixed real wage schedule in which relative wages correctly reflect age-specific productivity differentials but does not take into account workers' AIDS status,[5] effective labor demand is found to

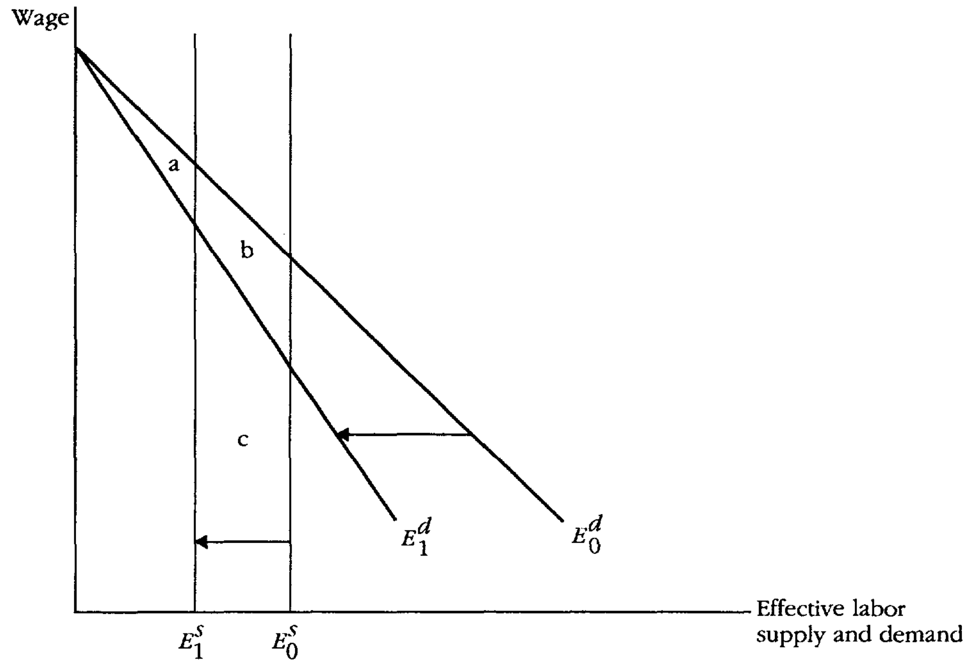
hiring or wage decisions based on this information—but not on the HIV or AIDS status of individual workers—it is legitimate in the analysis below to consider the quantity and sectoral allocation of "effective" rather than actual laborers.

3. As a referee correctly points out, this assumption simplifies the theoretical and simulation analysis considerably. If, for example, these parameters vary across cohorts but the sticky-wage structure reflects only non-AIDS-related productivity differences, then firms would first hire workers in the cohorts with low za values because they are expected to be more productive.

4. See Kambou, Devarajan, and Over (1992) for a computable general equilibrium model analyzing the implications of an AIDS-related reduction in the labor supply.

5. This makes firms indifferent to whether they hire young or older workers, thereby eliminating the need for firms to worry about which age or experience levels of workers to hire. This specification

Figure 1. *The Full-Employment Case*



be a function of the prevailing real wage, w; AIDS prevalence, a; and the capital stock, K:

$$(3) \qquad E = \phi K, \qquad \text{where } \phi \equiv [\alpha \gamma^t \beta (1 - za)^{\beta} / w]^{1/(1-\beta)}.$$

The negative relation between real wages and labor demand in the formal sector, other things equal, is shown by the E^d curve in figure 1. An increase in AIDS prevalence shifts the effective labor-demand curve inward (from E_0^d to E_1^d) as productivity declines.[6]

Clearly, real wages may rise or fall over time as a consequence of the AIDS epidemic relative to the no-AIDS counterfactual case. It depends on the relative magnitudes of the shifts in the labor supply and demand schedules. The loss in total output can be diagrammatically represented by the area $a + b + c$ in figure 1.

The Sticky-Wage, Labor-Surplus Economy Case

Now consider an economy that has a sticky wage (above the market-clearing level) and hence some unemployment, but produces the same amount of output

assumes that the pay of workers depends on their age, a proxy for experience, but is not reduced if they become sick with AIDS. Note that, by assumption, there is no immediate direct effect of a change in AIDS prevalence on the sticky real wage. AIDS prevalence, however, does affect the long-run equilibrium wage and hence the evolution of wages over time through equation 6.

6. In Cuddington (1993) labor demand is also reduced over time to the extent that AIDS-related increases in medical expenditures reduce saving and hence available capital stock.

in the no-AIDS scenario as the economy in figure 1. In this second economy, shown in figure 2, the sticky wage, $\bar{w}$, limits labor demand to E_0^d. Unemployment initially equals $U = E_0^S - E_0^d$. As AIDS strikes the economy, labor supply and labor demand again shift inward, as they did in the full-employment case. Given the sticky wage, the fall in employment is determined by the amount of the fall in labor demand (being the short side of the market). The resulting output loss is shown by the area $d + e + f$ in figure 2.

Comparing the relative sizes of areas c and f (given that $a + b = d + e$) in figures 1 and 2, the output loss caused by AIDS can, in principle, be greater or smaller in the labor-surplus economy than it would have been in a full-employment economy. It depends on the relative magnitude of the employment effects in the two scenarios.[7] In figure 1, the change in employment equals $\Delta E^s = E_1^S - E_0^S$. In figure 2, it equals $\Delta E^d = E_1^d - E_0^d$.

The same comparison can be expressed in terms of the change in unemployment in the labor-surplus case, which equals $\Delta U = \Delta E^s - \Delta E^d$. If the reduction in E^s ($\Delta E^s < 0$) is greater than the reduction in employment ($\Delta E^d < 0$) in the labor-surplus case, unemployment falls. But in this case the estimated loss in output in the full-employment model overstates that estimated in the actual economy where labor surplus prevails. The converse also holds: if the spread of AIDS leads to an increase in unemployment, it must be true that the simple full-employment framework underestimates actual output losses. This is the result stated at the beginning of this section.

II. The Dual-Economy Model

This section describes how the single-sector model can be extended to a dual-economy framework. In this context, laborers who are not hired by formal sector firms are not completely unemployed but rather find lower-productivity employment ("underemployment") in the informal sector. This leaves the basic intuition above intact, but provides a somewhat richer model for simulation in sections III and IV.

Production and Labor Allocation

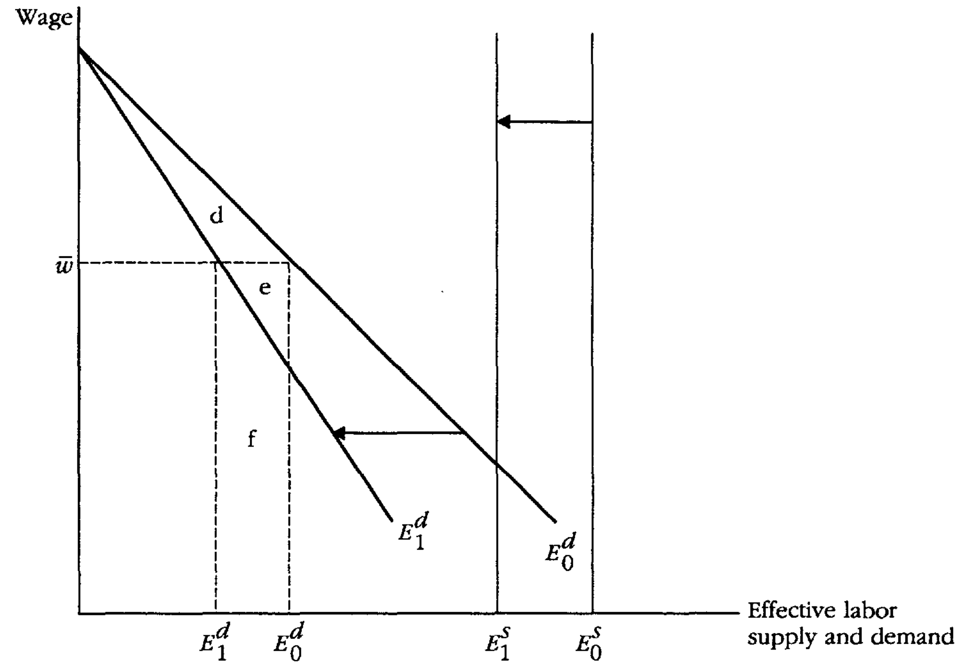
The economy is divided into a formal and an informal sector.[8,9] The production functions are analogous to equation 1, with subscripts F and I denoting the

7. The introductory section of this article conjectured that the macroeconomic consequences of AIDS may be overstated by models that ignore the presence of "labor surplus" in the economy. That scenario implicitly ignores the impact of AIDS on labor demand. If labor demand and hence output were, in fact, unaffected by the AIDS epidemic, then per capita income would rise because of its negative effect on labor supply.

8. This is the most basic of dual economies. The voluminous literature on dual-economy models presents many more complicated variants. See the survey by Ranis (1988) and references therein.

9. Over (1992) has developed a dual-sector model that introduces the possibility of higher AIDS prevalence among highly productive, well-educated members of society. His model does not, however, consider the possibility of underemployment and wage adjustment, which play a central role in the present analysis.

Figure 2. The Labor-Surplus Case



respective sectors, formal and informal, as needed. The informal sector is assumed to be much more labor-intensive than the formal sector (that is, $\beta_I > \beta_F$).

Wages in the formal sector (with appropriate allowance for nonwage benefits) are assumed to lie considerably above those prevailing in the informal sector, and workers prefer formal sector employment if available. Thus, formal sector employment is determined by a sectoral labor-demand function analogous to equation 3:

(4) $$E_F = \phi_F K_F, \qquad \text{where } \phi_F \equiv [\alpha_F \gamma_F^t \beta_F (1 - z_F a)^{\beta_F}/w]^{1/(1-\beta_F)}.$$

Workers who are unable to secure employment in the formal sector turn to informal sector work, such as urban service activities or smallholder agriculture.

Rather than adopting the assumption of profit-maximizing behavior to determine wages in the informal sector, the sector's total income (from labor and capital) is assumed to be divided among all informal sector workers with appropriate allowance for age-related productivity differences. Therefore, each (effective) laborer receives her or his average (rather than marginal) revenue product:

(5) $$y_I \equiv Y_I/E_I = \alpha_I \gamma_I^t (1-z_I a)^{\beta_I} (K_I/E_I)^{1-\beta_I}$$

where y_I is the average revenue product in the informal sector and informal sector employment equals $E_I \equiv E^S - E_F$. This specification reflects the fact that a large fraction of informal production occurs through family enterprises (including smallholder farming, and small business in the informal urban sector) in which family members share household output (see Ranis 1988: 80–82, on "organizational dualism").

Although the formal sector wage is sticky in the short run, it adjusts gradually toward the market-clearing level w^* over time according to the following partial adjustment mechanism:

$$w_t = \min\,[w_{t-1} + \lambda(w_t^* - w_{t-1}), w_t^*] \tag{6}$$

where w_t is the wage at time t and λ is the speed of labor market adjustment. The minimum restriction in equation 6 guarantees that, during the adjustment toward full employment where dualism in the labor market ultimately disappears, workers are never forced to work in the formal sector at wages below the "reservation" income available in the informal sector.

Sources and Allocation of Saving

The manner in which the AIDS epidemic affects domestic capital accumulation is captured, as in Cuddington (1993), by specifying the proportion (or multiple), x, of AIDS-related medical costs that were paid for by reducing national saving rather than current nonmedical consumption. Formal sector saving and available foreign funds $[s^*(Y_F + Y_I)]$ are allocated to investment in the relatively capital-intensive formal sector (equation 7).[10] To reflect the segmented nature of capital markets in developing countries in the present two-sector context, it is assumed that informal sector capital formation, given by equation 8, is limited by the amount of saving that can be generated in the informal sector itself.[11]

$$\Delta K_F = s_F Y_F + s^*(Y_F + Y_I) - x_F(H_F + \omega H_I) - \delta_F K_F(t-1) \tag{7}$$

$$\Delta K_I = s_I Y_I - x_I(1 - \omega) H_I - \delta_I K_I(t-1) \tag{8}$$

where s is the saving rate, Y is sectoral output, H is AIDS-related health care costs, δ is the depreciation rate on capital, and subscripts F and I denote formal and informal sector households, respectively.[12]

Given the huge costs associated with AIDS patient care (in relation to per capita income, say), it seems likely that informal sector households stricken by AIDS will receive some form of assistance from the formal sector through the health care system. If increased medical expenses are not paid entirely from patients' savings, which is extremely likely in a socialized medical system like Tanzania's, then part of the cost will be reflected in reduced saving by the formal sector as

10. We make the neutral assumption that foreign capital inflows stay constant at their historical ratio to domestic GDP (s^*) under both the no-AIDS and AIDS scenarios. As these flows have been primarily foreign aid and concessional loans from official institutions, debt-servicing payments have been ignored.

11. The presence of this capital market imperfection, or the dualistic labor market (where informal employment is not based on marginal productivity), implies that the present model will not generate the same results as the simple single-sector model in Cuddington (1993) even when instantaneous wage adjustment is assumed.

12. The simulations also include AIDS-related medical expenditures for children, allocated across the formal and informal sectors in the same proportions as AIDS cases in the adult population.

well as the informal sector. This is captured by the parameter ω in equations 7 and 8.

Adjustment Dynamics

Without AIDS, adjustment to long-run equilibrium has three aspects: the evolution in the size and composition of the labor force from Bulatao's (1990)

Table 1. *Macroeconomic Indicators in the AIDS Scenario with Slow Wage Adjustment*

AIDS cost met from reduced saving, x (fraction of annual AIDS-related medical costs)	*Indicator*	*Labor productivity lost per AIDS case, z (fraction of workyear lost)* 0.0	0.5	1.0	1.5	2.0
0.0	GDP in 2010 (millions of 1980 Tanzanian shillings)	94,378	92,711	91,042	89,378	87,715
	Average growth rate of GDP, 1985–2010 (percent)	3.5	3.5	3.4	3.3	3.2
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.31	2.27	2.23	2.19	2.14
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.9	0.8	0.7	0.7	0.6
	Saving rate in 2010 (share of GDP)	0.14	0.14	0.14	0.14	0.14
0.5	GDP in 2010 (millions of 1980 Tanzanian shillings)	91,579	89,940	88,304	86,671	85,040
	Average growth rate of GDP, 1985–2010 (percent)	3.4	3.3	3.3	3.2	3.1
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.24	2.20	2.16	2.12	2.08
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.8	0.7	0.6	0.5	0.5
	Saving rate in 2010 (share of GDP)	0.12	0.12	0.12	0.12	0.12
1.0	GDP in 2010 (millions of 1980 Tanzanian shillings)	88,715	87,108	85,504	83,903	82,308
	Average growth rate of GDP, 1985–2010 (percent)	3.3	3.2	3.1	3.1	3.0
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.17	2.13	2.09	2.05	2.01
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.6	0.6	0.5	0.4	0.3
	Saving rate in 2010 (share of GDP)	0.11	0.11	0.10	0.10	0.10
1.5	GDP in 2010 (millions of 1980 Tanzanian shillings)	85,785	84,211	82,640	81,075	79,514
	Average growth rate of GDP, 1985–2010 (percent)	3.1	3.1	3.0	2.9	2.8
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.10	2.06	2.02	1.98	1.94
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.5	0.4	0.4	0.3	0.2
	Saving rate in 2010 (share of GDP)	0.09	0.09	0.08	0.08	0.08

Table 1. *(continued)*

AIDS cost met from reduced saving, x (fraction of annual AIDS-related medical costs)	Indicator	Labor productivity lost per AIDS case, z (fraction of workyear lost) 0.0	0.5	1.0	1.5	2.0
2.0	GDP in 2010 (millions of 1980 Tanzanian shillings)	82,784	81,243	79,709	78,179	76,655
	Average growth rate of GDP, 1985–2010 (percent)	3.0	2.9	2.8	2.8	2.7
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.02	1.99	1.95	1.91	1.87
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.4	0.3	0.2	0.1	0.1
	Saving rate in 2010 (share of GDP)	0.07	0.07	0.06	0.06	0.06

Note: The following assumptions underlie the AIDS scenario:

Value	*Parameter*
15,652	Formal sector output level in 1985 (Y_F85) (millions of 1980 Tanzanian shillings)
23,479	Informal sector output level in 1985 (Y_I85) (millions of 1980 Tanzanian shillings)
2,131	Formal sector labor force in 1985 (L_F85)
5	Capital-output ratio in formal sector, 1985 (K_F/Y_F)
1.5	Capital-output ratio in informal sector, 1985 (K_I/Y_I)
0.6	Labor's share of output in formal sector (β_F)
0.8	Labor's share of output in informal sector (β_I)
1.003	Formal sector productivity growth rate (γ_F)
1	Informal sector productivity growth rate (γ_I)
0.05	Formal sector depreciation rate (θ_F)
0.05	Informal sector depreciation rate (θ_I)
0.16	Initial saving rate in formal sector (s_F)
0.08	Initial saving rate in informal sector (s_I)
0.10	Rate of capital inflow (s)
3.23	Yearly medical cost per adult AIDS case (m_a) (thousands of 1980 Tanzanian shillings)
2.47	Yearly medical cost per child AIDS case (m_c) (thousands of 1980 Tanzanian shillings)
0.8	Percentage of informal sector AIDS costs paid by formal sector (ω)

Source: Author's calculations.

Table 2. *Macroeconomic Indicators in the No-AIDS Scenario with Slow Wage Adjustment*

Indicator	*Value*
GDP in 2010 (millions of 1980 Tanzanian shillings)	106,428
Average growth rate of GDP, 1985–2010 (percent)	4.0
Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.23
Average per capita growth rate of GDP, 1985–2010 (percent)	0.8
Saving rate in 2010 (share of GDP)	0.14

Note: The parameter values in table 1 also apply here, except that $m_c = m_a = 0$.
Source: Tanzania (1981) and World Bank (1990); author's calculations.

demographic simulation model, capital accumulation in each sector, and wage adjustment and its consequences for the sectoral allocation of labor.

With the introduction of AIDS, rising AIDS prevalence (captured in the time path for a) and the resulting changes in the structure of the labor force (from Bulatao 1990) must also be considered. These considerations drive the simulations below.

III. Simulations Using the Dual-Economy Model

This section summarizes simulation results for the AIDS and no-AIDS scenarios for a dual-economy model of the Tanzanian economy with underemployment resulting from slow wage adjustment ($\lambda = 0.05$ in equation 6). Without an empirical estimate of the wage adjustment parameter, a low value is chosen so that the dualistic structure is an enduring feature of the economy over the forecast horizon (2010) and forecasted economic growth in the 1990s is in the range predicted by the World Bank (1989). In the no-AIDS case, Tanzanian real GDP growth rate accelerates from roughly 3.4 percent in 1990 to 4.6 percent by 2010. Per capita GDP in thousands of 1980 Tanzania shillings rises from 1.85 in 1985 to 2.23 by 2010, as output growth outstrips population growth. The share of the labor force employed in the formal sector rises continuously from 20 percent in 1985 to almost 60 percent by 2010 as a result of capital accumulation and the gradual fall in the sticky wage in the formal sector (from 4.4 to 3.4) toward its long-run equilibrium level. The long-run equilibrium wage in the formal sector remains virtually unchanged at 3.0 during the period. (See Cuddington 1992 for details on the behavior of various macro variables in the no-AIDS and AIDS cases.)

The basic simulation methodology parallels Cuddington (1993). The demographic input for the AIDS and no-AIDS scenarios is again taken from Bulatao (1990). Table 1 shows the key parameter assumptions used in the simulation exercises (Cuddington 1992). The values chosen lead to aggregate parameters roughly equal to those in the earlier one-sector analysis (Cuddington 1993). For example, the share of labor in total cost in the formal and informal sectors, respectively, is assumed to be 0.6 and 0.8 and the share of capital 0.4 and 0.2. The weighted-average share of labor for the economy is roughly 0.7 (as before). The initial (1985) capital-output ratio is 5 in the formal sector and 1.5 in the formal sector, which implies an economywide capital-output ratio of 3 (as before). Eighty percent of the medical care costs incurred by workers in the informal sector are assumed to be paid for by reductions in formal sector saving ($\omega = 0.8$); unfortunately, there is at present no empirical information on this point.

As in the earlier single-sector framework, the macroeconomic effects of AIDS depend importantly on the assumed values for the saving and productivity loss parameters (x and z). Table 1, which corresponds to table 1 in Cuddington (1993), summarizes the effects on future GDP and GDP per capita under different x and z assumptions for the AIDS scenarios. Table 2 shows the baseline no-AIDS case with which these scenarios should be compared.

Comparison of the two tables shows that the negative impact of AIDS on GDP in constant 1980 Tanzania shillings in 2010 ranges from 11 percent (T Sh94.4 billion compared with T Sh106.4 billion in the no-AIDS scenario in table 2) to 28 percent (T Sh76.7 billion compared with T Sh106.4 billion),[13] depending on the parameter assumptions. The impact of AIDS on per capita income ranges from a rise of 3.6 percent (from T Sh2.23 thousand in the no-AIDS scenario to T Sh2.31 thousand) when x and z are both 0, to a decline of 16.1 percent (from T Sh2.23 thousand with no AIDS to T Sh1.87 thousand) in the extreme case when x and z are both 2.

Examination of the time paths for individual variables suggests an explanation for the large GDP loss caused by the epidemic.[14] The share of employment and output that comes from the high-productivity formal sector is lower in the various AIDS scenarios than in the no-AIDS case. Given the high sticky wage, the number of formal sector jobs falls as AIDS cuts into labor productivity and the rate of capital formation. Both factors tend to shift the labor-demand schedule of the formal sector to the left over time in relation to the no-AIDS case (but not necessarily in absolute terms), forcing more workers back into lower-income employment in the informal sector. This mechanism is highlighted in section I, except that AIDS leads to greater underemployment in the dual-economy model rather than to unemployment as it did in the single-sector framework.

IV. The AIDS Epidemic with More Rapid Labor Market Adjustment

Using the framework above, this section considers the effects of gradually increasing the speed of labor market adjustment from 0.05 to 0.55 (by increments of 0.10 every five-year period until 2010). This exercise serves two purposes. First, it provides a sensitivity analysis on the wage adjustment parameter used in section III, a key parameter for which there is no empirical estimate. Second, the results may be interpreted as showing, in an admittedly crude way, the possible benefits of implementing labor market adjustment policies that would moderate the negative economic effects of AIDS.

Tables 3 and 4 show various AIDS scenarios and the no-AIDS case, respectively, with the gradual acceleration in wage adjustment. Not surprisingly, comparing the no-AIDS scenarios in tables 2 and 4 shows that there is more rapid growth in total and per capita GDP when the speed of labor market adjustment is increased: GDP rises from T Sh39 billion in 1985 to T Sh117 billion in 2010 in table 4 (compared with T Sh106 billion in table 2).

Table 3 shows the economic consequences of the AIDS epidemic with accelerated wage adjustment for a range of values for x and z. The case when x and z are both 0.5 is reflected in the second column and second block of rows (shaded) in table 3. Comparing this scenario with the corresponding block in table 1

13. A billion is 1,000 million.

14. See Cuddington (1992; table 1) for the details on the time paths of various macro variables in the case when x and z are both 0.5.

Table 3. *Macroeconomic Indicators in the AIDS Scenario with Accelerating Wage Adjustment*

AIDS cost met from reduced saving, x (fraction of annual AIDS-related medical costs)	*Indicator*	*Labor productivity lost per AIDS case, z (fraction of workyear lost)* 0.0	0.5	1.0	1.5	2.0
0.0	GDP in 2010 (millions of 1980 Tanzanian shillings)	102,081	100,797	99,509	98,216	96,922
	Average growth rate of GDP, 1985–2010 (percent)	3.8	3.8	3.7	3.7	3.6
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.50	2.46	2.43	2.40	2.37
	Average per capita growth rate of GDP, 1985–2010 (percent)	1.2	1.2	1.1	1.0	1.0
	Saving rate in 2010 (share of GDP)	0.15	0.15	0.15	0.15	0.15
0.5	GDP in 2010 (millions of 1980 Tanzanian shillings)	99,828	**98,559**	97,282	96,002	94,719
	Average growth rate of GDP, 1985–2010 (percent)	3.7	**3.7**	3.6	3.6	3.5
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.44	**2.41**	2.38	2.35	2.32
	Average per capita growth rate of GDP, 1985–2010 (percent)	1.1	**1.1**	1.0	1.0	0.9
	Saving rate in 2010 (share of GDP)	0.14	**0.14**	0.14	0.14	0.14
1.0	GDP in 2010 (millions of 1980 Tanzanian shillings)	97,492	96,230	94,969	93,698	92,424
	Average growth rate of GDP, 1985–2010 (percent)	3.7	3.6	3.5	3.5	3.4
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.38	2.35	2.32	2.29	2.26
	Average per capita growth rate of GDP, 1985–2010 (percent)	1.0	1.0	0.9	0.9	0.8
	Saving rate in 2010 (share of GDP)	0.12	0.12	0.12	0.12	0.12
1.5	GDP in 2010 (millions of 1980 Tanzanian shillings)	95,060	93,809	92,554	91,294	90,032
	Average growth rate of GDP, 1985–2010 (percent)	3.6	3.5	3.4	3.4	3.3
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.32	2.29	2.26	2.23	2.20
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.9	0.9	0.8	0.8	0.7
	Saving rate in 2010 (share of GDP)	0.11	0.11	0.10	0.10	0.10

Table 3. *(continued)*

AIDS cost met from reduced saving, x (fraction of annual AIDS-related medical costs)	Indicator	Labor productivity lost per AIDS case, z (fraction of workyear lost)				
		0.0	0.5	1.0	1.5	2.0
2.0	GDP in 2010 (millions of 1980 mTanzanian shillings)	92,516	91,275	90,030	88,779	87,517
	Average growth rate of GDP, 1985–2010 (percent)	3.4	3.4	3.3	3.3	3.2
	Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.26	2.23	2.20	2.17	2.14
	Average per capita growth rate of GDP, 1985–2010 (percent)	0.8	0.8	0.7	0.6	0.6
	Saving rate in 2010 (share of GDP)	0.09	0.09	0.09	0.09	0.09

Note: The assumptions underlying the calculations in the AIDS scenario are the same as those for table 1, except for the wage adjustment parameter (λ), which rises from 0.05 to 0.55 in increments of 0.10 every five years from 1985 to 2010.
Source: Author's calculations.

Table 4. *Macroeconomic Indicators in the No-AIDS Scenario with Accelerating Wage Adjustment*

Indicator	Value
GDP in 2010 (millions of 1980 Tanzanian shillings)	117,126
Average growth rate of GDP, 1985–2010 (percent)	4.4
Per capita GDP in 2010 (thousands of 1980 Tanzanian shillings)	2.46
Average per capita growth rate of GDP, 1985–2010 (percent)	1.1
Saving rate in 2010 (share of GDP)	0.15

Note: The parameter values in table 3 also apply here, except that $m_c = m_a = 0$.
Source: Tanzania (1981) and World Bank (1990); author's calculations.

produces a crude estimate of the benefits of improved labor market efficiency. By 2010, GDP is roughly T Sh98.6 billion in table 3, compared with T Sh89.9 billion in the slow-wage-adjustment case in table 1. As a result per capita income is also considerably higher (T Sh2.41 thousand compared with T Sh2.20 thousand by 2010).

The general conclusion suggested by comparing the low-wage-adjustment cases (tables 1 and 2) and the accelerating-wage-adjustment cases (tables 3 and 4) is that, in a highly distorted economy, the benefits of policies that improve the efficiency of resource allocation may well be of the same order of magnitude as the economic costs of the AIDS epidemic. Furthermore, the percentage difference between the no-AIDS and AIDS scenarios appears to be roughly the same whether one assumes slow or accelerating wage adjustment.

One interpretation of the above findings is that more flexible labor markets are beneficial with or without AIDS. However, AIDS-ridden economies are less able to afford the income losses that resource misallocation invariably entails. Therefore, labor market adjustment policies can play a potentially important role in offsetting the economic losses due to AIDS. These findings provide some justification for the emphasis in World Bank (1992) on the need to maintain and strengthen Tanzania's economic reform program to reduce the macroeconomic effects of the AIDS epidemic. The report, however, emphasized the *fiscal* burden of AIDS-related medical expenditures. Without rapid growth, this burden could not be covered by expected tax revenues.

V. Conclusion

The estimated economic impact of AIDS using the dual-economy model for Tanzania developed here suggests that the aggregate size of the economy will be 15 to 25 percent smaller by 2010 than it would have been without AIDS. The negative impact on per capita GDP by that time is expected to be 0 to 10 percent. Although these estimated macroeconomic consequences for Tanzania turn out to be roughly of the same order of magnitude as those obtained from a single-sector, full-employment model in Cuddington (1993), they could, in principle, be larger or smaller for reasons outlined in section I.

The dual-economy simulations also suggest that more rapid labor market adjustment could yield considerable real income gains. Interestingly, the output loss from AIDS in the present dual-economy framework is roughly similar in size to the output gain from policies designed to increase the speed of labor market adjustment. The exercise is crude, but nonetheless encouraging: labor market adjustment policies in economies devastated by AIDS may play a potentially important role in at least ameliorating some of the negative economic effects of the epidemic, although they would certainly not offset the devastating personal and social costs. Further research analyzing possible policy actions for coping with the disease—whether at the health-sector or macroeconomic level—is urgently needed.

References

The word "processed" describes informally reproduced that may not be commonly available through library systems.

Bulatao, Rudolfo. 1990. "The Demographic Impact of AIDS in Tanzania." World Bank, Population, Health, and Nutrition Department. Washington, D.C. Processed.

Cuddington, John T. 1992. "The Macroeconomic Impact of AIDS in a Dualistic, Labor-Surplus Economy with an Application to Tanzania." Working Paper 92-12. Georgetown University, Economics Department, Washington, D.C. Processed.

———. 1993. "Modelling the Macroeconomic Effects of AIDS with an Application to Tanzania." *The World Bank Economic Review*. 7(2, May):173–89.

Cuddington, John T., and John Hancock. Forthcoming. "Assessing the Impact of AIDS on the Growth Path of the Malawian Economy." *Journal of Development Economics*.

Kambou, Gerard, Shantayanan Devarajan, and Mead Over. 1992. "The Economic Impact of AIDS in an African Country: Simulations with a Computable General Equilibrium Model of Cameroon," *Journal of African Economies* 1(1):109–30.

Maliyamkono, T. L., and M. S. D. Bagachwa. 1990. *The Second Economy in Tanzania*. Athens, Ohio: Ohio University Press.

Over, Mead. 1992. "The Macroeconomic Impact of AIDS in Sub-Saharan Africa." Technical Working Paper 3. World Bank, Africa Technical Department, Washington, D.C. Processed.

Ranis, Gustav. 1988. "Analytics of Development: Dualism." In Hollis Chenery and T. N. Srinivasan, eds., *Handbook of Development Economics*. Vol. 1. Amsterdam: North-Holland.

Solow, R. M. 1956. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70 (February):65–94.

Tanzania, Bureau of Statistics. 1981. *National Income Accounts of Tanzania, 1966–80*. Dar es Salaam.

World Bank. 1989. *Sub-Saharan Africa: From Crisis to Sustainable Growth*. Washington, D.C.

———. 1990. *World Tables*. Baltimore, Md.: Johns Hopkins University Press.

———. 1992. *Tanzania: AIDS Assessment and Planning*. Washington, D.C.