HIV pandemic, medical brain drain and economic development in sub-Saharan Africa

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Background

- Over 25 million HIV positive individuals in sub-Saharan Africa
- WHO had the goal of providing ART to 3 million people in developing countries by 2005
- Approximately 100,000 are receiving ART in Africa
- Healthcare staff are necessary for treatment

Background issues

- The report by Physicians for Human Rights (2004) advocates greater resources for building up the healthcare infrastructure
- Emigration of nurses and doctors from countries such as Ethiopia, Ghana and South Africa compounds the problems
- OECD countries continue to attract healthcare staff from African countries

Background issues

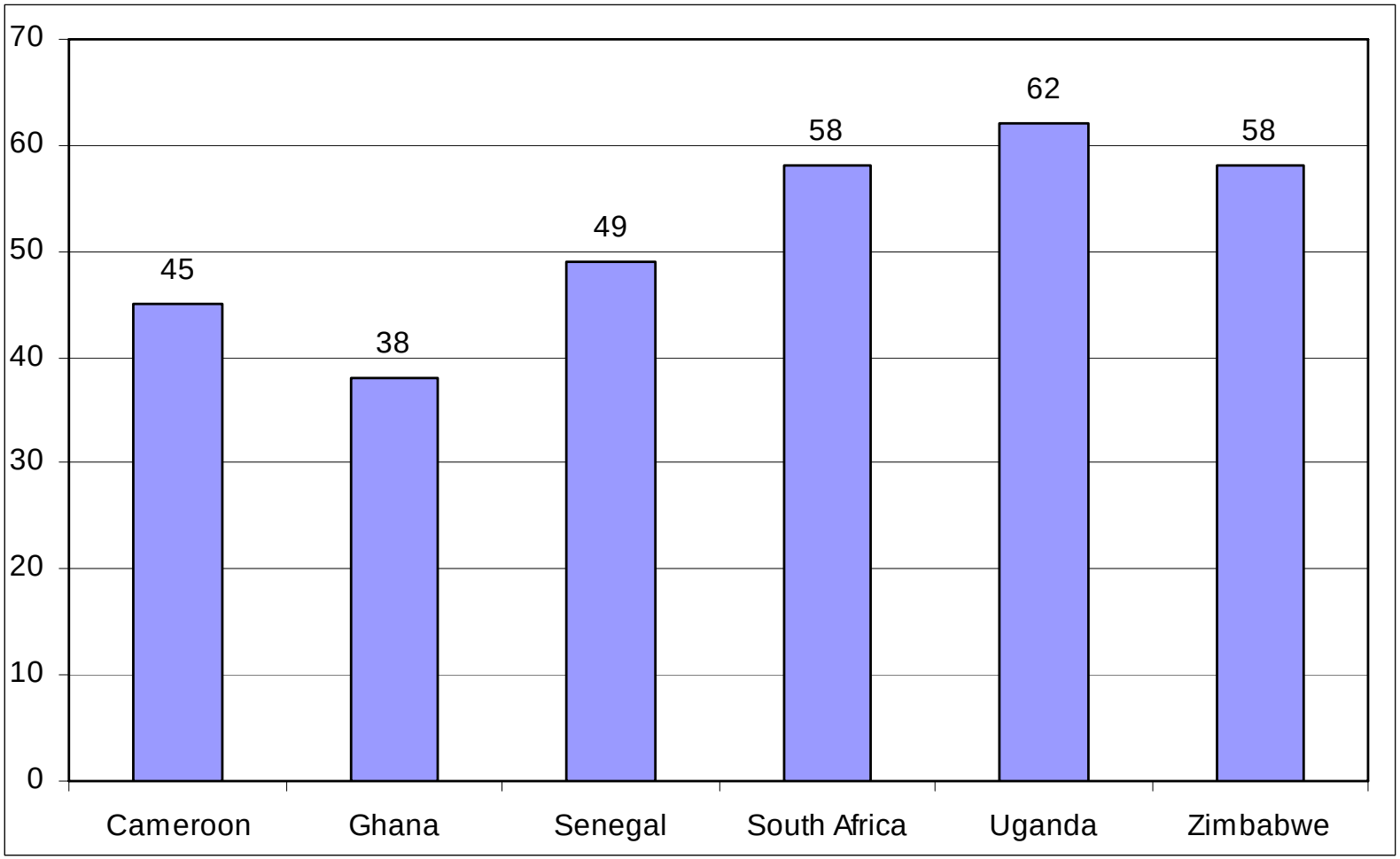
- Compensation should be based on the "opportunity costs" of producing doctors and nurses in developed rather than in developing countries
- Unlike commodities that are sold, healthcare staff from developing countries are paid their "market value" (Bhargava, 2005, JAIDS)

Background issues

- High workload can create a “stressful” and risky environment for medical staff
- Low wages and poor medical facilities can encourage emigration of healthcare staff
- High HIV prevalence rates may lead to safety concerns for adolescent children of medical staff and encourage emigration

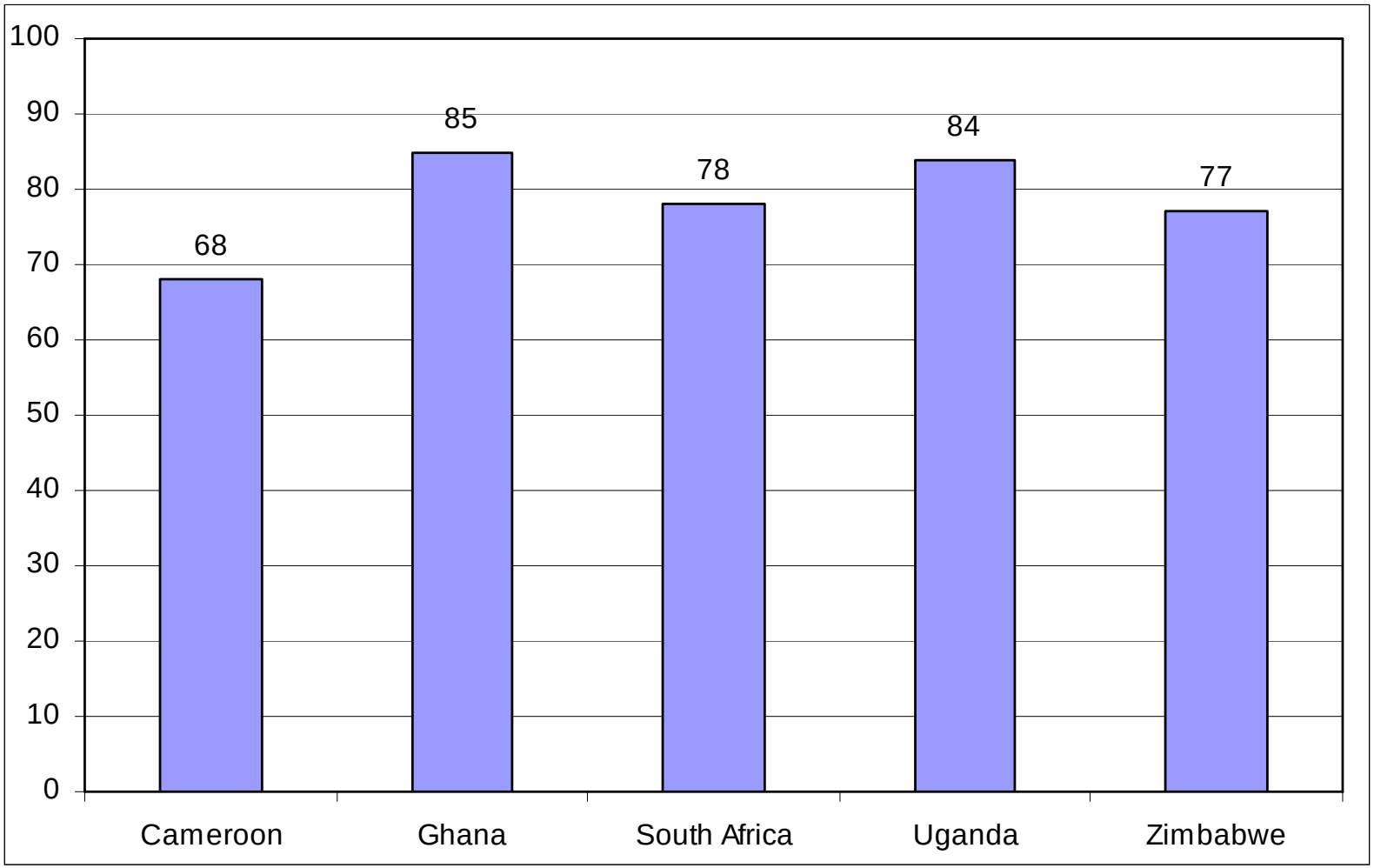
Background information

Percentages of staff "stressed" due to caring for HIV/AIDS patients in Cameroon, Ghana, Senegal, South Africa, Uganda and Zimbabwe: 45, 38 49, 58, 62, and 58. Source: Awases et al. (2003)



Background information

Percentages of staff reporting higher salaries as a motivation for emigration in Cameroon, Ghana, South Africa, Uganda and Zimbabwe: 68, 85, 78, 84 and 77. Source: Awases et al. (2003)



Background and data issues

- Individual level studies provide insights into effects of nutritional status and sexually transmitted infections on HIV transmission
- Country-level data enable modeling the effects of HIV prevalence on emigration of physicians
- Medical brain drain can increase AIDS deaths and reduce life expectancy and economic growth

Data issues

- Longitudinal data (1990-2004) on emigration of physicians from sub-Saharan African countries to 16 major O.E.C.D. countries
- Emigrants defined according to country of qualification in Canada, France, New Zealand, Norway, U.K., and U.S.
- Emigrants defined by country of birth in Australia, Austria, Belgium, Denmark, Ireland and Sweden
- Emigrants defined by citizenship in Germany, Italy, Portugal and Switzerland

Data issues

- Recent longitudinal data on HIV prevalence rates and deaths due to AIDS from UNAIDS (2006)
- Socioeconomic variables from World Development Indicators 2005
- Additional data on wages from ILO and health expenditures from WHO
- 3-yearly averages at 5 time points 1990-2004 were constructed

Definitions

Medical

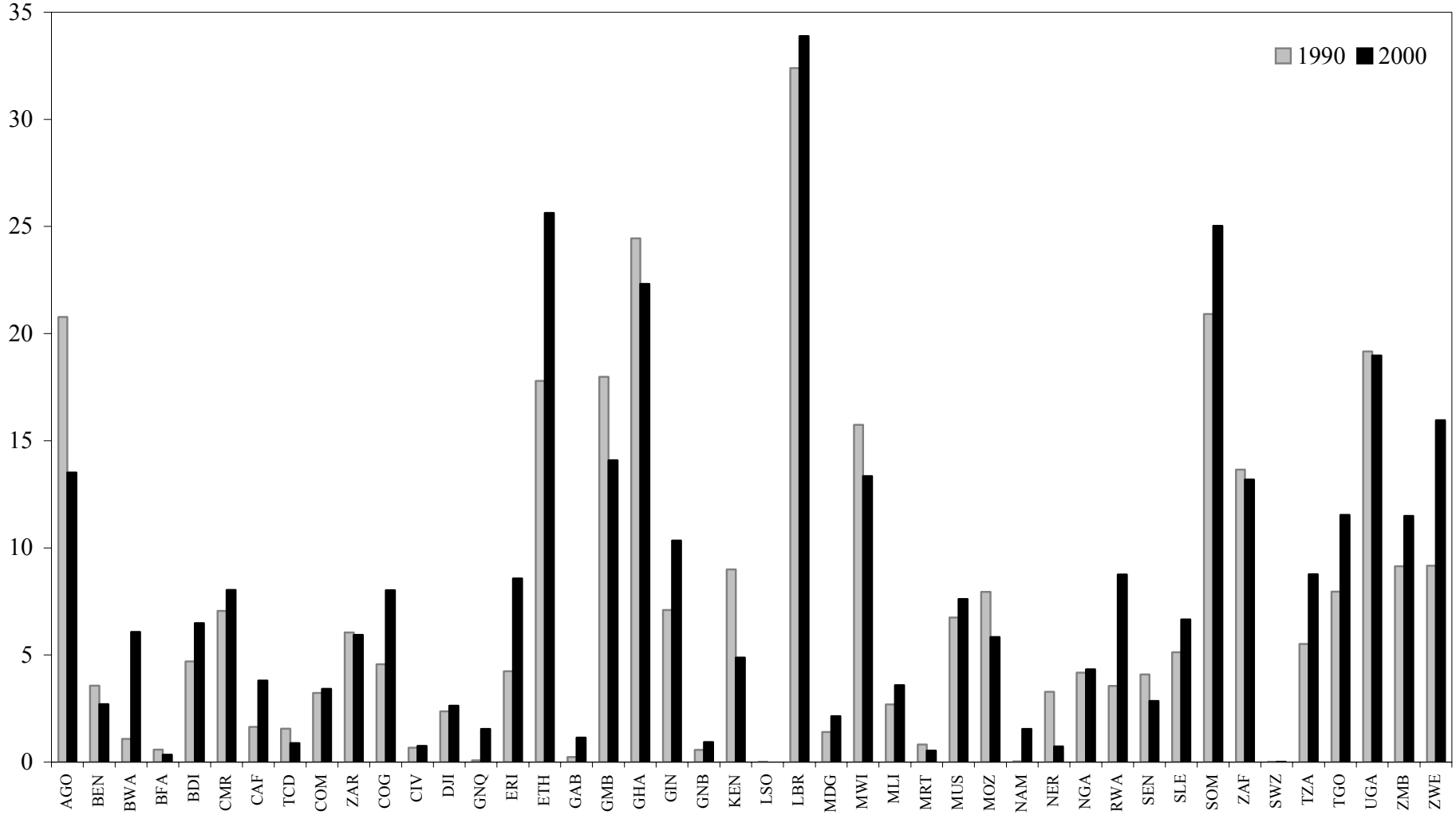
brian

drain:

$$m_{i,t} = \frac{M_{i,t}}{P_{i,t} + M_{i,t}}$$

(Equation 1)

Figure 1: Medical brain drain rates from sub-Saharan Africa in the years 1990 and 2000



Source: Authors' calculations.

Country codes (ISO): AGO=Angola; BEN=Benin; BWA=Botswana; BFA=Burkina Faso; BDI=Burundi; CMR=Cameroon; CAF=Central Afr Rep; TCD=Chad; COM=Comoros; ZAR=Congo Dem Rep; COG=Congo Rep; CIV=Cote d'Ivoire; DJI=Djibouti; GNQ=Equat. Guinea; ERI=Eritrea; ETH=Ethiopia; GAB=Gabon; GMB=Gambia, The; GHA=Ghana; GIN=Guinea; GNB=Guinea-Bissau; KEN=Kenya; LSO=Lesotho; LBR=Liberia; MDG=Madagascar; MWI=Malawi; MLI=Mali; MRT=Mauritania; MUS=Mauritius; MOZ=Mozambique; NAM=Namibia; NER=Niger; NGA=Nigeria; RWA=Rwanda; SEN=Senegal; SLE=Sierra Leone; SOM=Somalia; ZAF=South Africa; SWZ=Swaziland; TZA=Tanzania; TGO=Togo; UGA=Uganda; ZMB=Zambia; ZWE=Zimbabwe

Empirical Models

$$(\text{Medical brain drain rate})_{i\,t} = a_0 + a_1 \ln(\text{Physicians Wage/USA ratio})_{it} + a_2 \ln(\text{School enrollment secondary})_{it} + a_3 \ln(\text{GDP})_{it} + a_4 \ln(\text{HIV prevalence rate})_{i\,t} + a_5 \ln(\text{Medical brain drain rate})_{i\,t-1} + u_{1i\,t} \qquad (i=1,...,N;\ t=2,,3,4,5)$$

(Equation 2)

HIV prevalence rate treated as an endogenous variable in random effects models: (Equation 3)

$$u_{1i\,t} = \delta_i + v_{i\,t}$$

Empirical models

- Possible “reverse causality” is tested i.e. if higher medical brain drain can increase HIV prevalence rates
- Difficult to model HIV prevalence rates at aggregate levels since they depend on levels of sexually transmitted infections, number of sex partners, migrant labor, etc

Empirical Models

(Equation 4)

$$(\text{Deaths due to AIDS})_{i\,t} = b_0 + b_1 \ln(\text{Population})_i + b_2 \ln(\text{Prop. labor force with secondary + tertiary education})_{it} + b_3 \ln(\text{GDP})_{it} + b_4 \ln(\text{HIV prevalence rate})_{i\,t} + b_5 \ln(\text{Medical brain drain rate})_{i\,t} + b_6 \ln(\text{Deaths due to AIDS})_{i\,t-1} + u_{2i\,t} \qquad (i=1,...,N;\ t=2,,3,4,5)$$

Medical brain drain and HIV prevalence rates treated as endogenous variables ; Specification 2 interacts medical brain drain and HIV prevalence rates

Empirical Models

(Equation 5)

$$(\text{GDP growth rate})_{i\,t} = c_0 + c_1 \ln(\text{Prop. labor force with secondary + tertiary education})_{it-1}$$
$$+ c_2 \ln(\text{Investment/GDP})_{it-1} + c_3 \ln(\text{Imports/GDP})_{it-1} + c_4 \ln(\text{Export/GDP})_{i\,t-1}$$
$$+ c_5 \ln(\text{Population})_{i\,t-1} + c_6 \ln(\text{Life expectancy})_{i\,t-1} + c_7 \ln(\text{GDP})_{i\,t-1}$$
$$+ u_{3i\,t} \qquad (i=1,...,N;\ t=,2,3,4,5)$$

Life expectancy and GDP levels treated as endogenous variables in the models for aggregate and per capita GDP growth rates

Econometric issues

- Treatment of endogeneity in dynamic models estimated using 4 time observations
- Random effects are assumed to be correlated with explanatory variables such as HIV prevalence rates in the models for medical brain drain, life expectancy and adult deaths due to AIDS
- More general endogeneity pattern in static models for GDP growth rates
- Issues of aggregate GDP growth rate versus per capita GDP growth rate

Equations

$$y_{i\,t} = \sum_{j=1}^{m} z_{i\,j}\,\gamma_j + \sum_{j=1}^{n_1} x_{1ij\,t}\,\beta_j + \sum_{j=n_1+1}^{n} x_{2ijt}\,\beta_j + u_{it} \qquad (5)$$

We can write a reduced form equation for the fully endogenous variables X_2 as:

$$X_{2it} = \sum_{j=1}^{T} F_{tj}\,X_{1ij} + F^{*}_{t}\,Z_i + U_{2it} \qquad (6),$$

where F_{tj} (t=1,..., T; j=1,...,T) and F^{*}_{t} (t=1,...,T) are, respectively, $n_2 x n_1$ and $n_2 x m$ matrices

of reduced form coefficients; U_{2it} is the $n_2 x 1$ vector of errors.

$$x_{2ijt} = \lambda_j\,\delta_i + x^{*}_{2ijt} \qquad (7)$$

$$x^{+}_{2ijt} = x_{2ijt} - \bar{x}_{2ij} \quad (t=2,...,T;\ j=n_1+1,...,n;\ i=1,...,N) \qquad (8),$$

where

$$\bar{x}_{2ij} = \sum_{t=1}^{T} x_{2ijt}/T \quad (j=n_1+1,...n;\ i=1,...,N) \qquad (9),$$

TABLE 1. ***Sample means and standard deviations of selected variables for sub-Saharan countries at 3-year intervals for the period 1991-2004***

Year :	1991		1994		1997	
Variable :	Mean	SD	Mean	SD	Mean	SD
HIV prevalence, %	2.98	3.72	5.037	5.592	6.594	7.047
No. of AIDS Deaths	3960.82	7777.64	10253.64	16672.51	19713.29	28002.43
No. Physicians/1000	0.153	0.241	0.153	0.219	0.158	0.235
Physicians emigrating	151.35	528.16	169.10	586.36	188.77	650.39
Medical brain drain	0.094	0.113	0.096	0.115	0.097	0.113
Life expectancy, years	50.79	8.21	50.13	8.28	49.36	7.75
GDP per capita, 2000$	752.84	1134.56	749.14	1179.60	818.13	1292.17
GDP pc growth rate,%	1.670	1.547	1.950	2.125	4.176	8.232

TABLE 1. ***Sample means and standard deviations of selected variables for sub-Saharan countries at 3-year intervals for the period 1991-2004***

Year :		2000		2003
Variable :	Mean	SD	Mean	SD
HIV prevalence, %	7.073	7.907	7.073	7.907
No. of AIDS Deaths	30245.11	40974.4	30245.11	40974.4
No. Physicians/1000	0.160	0.239	0.160	0.239
Physicians emigrating	211.26	687.94	211.26	687.94
Medical brain drain	0.103	0.113	0.103	0.113
Life expectancy, years	48.59	7.88	48.59	7.88
GDP per capita, 2000$	876.92	1400.12	876.92	1400.12
GDP pc growth rate,%	2.810	2.864	2.810	2.864

TABLE 1. ***Sample means and standard deviations of selected variables for sub-Saharan countries at 3-year intervals for the period 1991-2004***

Year :	1991		1994		1997	
Variable :	Mean	SD	Mean	SD	Mean	SD
Population (‘000)	11536	16747	12511	18310	13515	19799
Literacy rate, %	50.76	19.73	53.73	19.72	56.76	19.62
School enroll prim, %	58.11	25.01	60.20	25.41	61.00	23.31
School enroll sec., %	19.11	15.95	20.64	17.34	22.06	18.22
Prop (sec+tert) educat	0.132	0.102	0.148	0.117	0.160	0.126
Govt HealExp/GDP,%	4.315	1.314	4.679	1.416	4.835	1.747
Physicians wages/USA	0.124	0.133	0.104	0.110	0.098	0.106
Investment/GDP, %	18.98	9.67	20.93	11.19	21.77	13.64
Import/GDP, %	38.98	21.74	43.16	22.41	44.13	27.14
Export/GDP, %	25.88	17.63	28.92	17.36	30.90	20.58

TABLE 1. ***Sample means and standard deviations of selected variables for sub-Saharan countries at 3-year intervals for the period 1991-2004***

Year :	2000		2003	
Variable :	Mean	SD	Mean	SD
Population (‘000)	14539	21223	15581	22692
Literacy rate, %	59.70	19.46	62.57	19.21
School enroll prim, %	62.57	20.98	67.00	19.71
School enroll sec., %	23.91	18.72	25.58	18.62
Prop (sec+tert) educat	0.170	0.129	0.180	0.137
Govt HealExp/GDP,%	4.872	1.786	4.981	1.747
Physicians wages/USA	0.082	0.072	0.083	0.074
Investment/GDP, %	21.36	13.57	20.04	13.45
Import/GDP, %	45.29	28.28	45.88	28.27
Export/GDP, %	32.38	22.43	33.00	22.22

TABLE 2. ***Maximum likelihood estimates from dynamic random effects models for 3-yearly medical brain drain rates of physicians from sub-Saharan African countries explained by socioeconomic variables and HIV prevalence rates for the period 1991-2004***

	Dependent variable: Medical brain drain rate					
Explanatory variables:	Specification 1		Specification 2		Specification 3 [2]	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Constant	-0.420*	0.138	-0.633*	0.173	-0.431*	0.141
Ln (Physicians wages/USA ratio)	-0.035*	0.019	-0.049*	0.052	-0.034*	0.019
Ln (% School enrollment secondary)	0.116*	0.044	0.171*	0.037	0.122*	0.022
Ln (GDP per capita)	-0.034	0.032	-0.051*	0.021	-0.036*	0.009
Ln (HIV prevalence)	0.078*	0.017	0.070*	0.017	0.071*	0.020
Lagged dependent variable	0.934*	0.025	0.890*	0.022	0.930*	0.017
(Between/within) variance ratio	-		0.104	0.076	-	
Within variance	-		0.049		-	
2 x (maximized log-likelihood function)	522.22		479.90		579.37	
Chi-square test for random effects decomposition (12 d.f.)	-		42.32*		-	
Chi-square test for exogeneity of HIV prevalence rate (5 d.f.)	-		-		11.38*	

Results for medical brain drain

- Higher wages in African countries predict significantly lower medical brain drain
- Higher HIV prevalence increases medical brain drain (SR elasticity=0.08; LR elasticity =1)
- Exogeneity of HIV prevalence was rejected by a likelihood ratio test
- A model for “reverse causality” showed no effect of medical brain drain on HIV prevalence rate

TABLE 3. ***Maximum likelihood estimates from dynamic random effects models for the number of adult deaths due to AIDS in sub-Saharan African countries at 3-yearly intervals explained by socioeconomic variables and HIV prevalence and medical brain drain rates for the period 1991-2004***

Dependent variable: Number of adult deaths due to AIDS				
Explanatory variables:	Specification 1 [2]		Specification 2[2]	
	Coefficient	SE	Coefficient	SE
Constant	-2.833*	0.422	-41212*	0.165
Ln (Population)	0.450*	0.017	0.480*	0.006
Ln (Prop. with second+tert education)	-0.045	0.027	-0.005	0.026
Ln (GDP per capita)	-0.014	0.025	-0.072*	0.025
Ln (HIV prevalence)	0.542*	0.039	0.778*	0.038
ln (Medical brain drain rate)	0.095*	0.019	-0.059*	0.023
ln (Medical brain drain) x ln (HIV prevalence)	-		0.049*	0.008
Lagged dependent variable	0.510*	0.012	0.498*	0.001
2 x (maximized log-likelihood function)	1243.35		1258.20	
Chi-square test for exogeneity of medical brain drain and HIV prevalence rates (10 d.f.)	104.03*		116.63*	

Results for adult deaths due to AIDS

- Medical brain drain predicts significantly higher adult deaths due to AIDS (SR elasticity =0.1; LR=elasticity 0.2)
- Medical brain drain and HIV prevalence treated as endogenous variables
- Coefficient of interaction between medical brain drain and HIV prevalence significant- difficult to estimate thresholds with only few observations

TABLE 4. ***Maximum likelihood estimates from dynamic random effects models for life expectancy in sub-Saharan African countries at 3-yearly intervals explained by socioeconomic variables and HIV prevalence and medical brain drain rates for the period 1991-2004***

Dependent variable: Life expectancy				
Explanatory variables:	Specification 1[2]		Specification 2[2]	
	Coefficient	SE	Coefficient	SE
Constant	1.117*	0.005	1.012*	0.004
ln (% Government health expenditure/GDP)	0.040*	0.003	0.029*	0.003
ln (% School enrollment primary)	0.022*	0.009	0.022*	0.002
ln (GDP)	0.001	0.007	0.009*	0.004
ln (HIV prevalence)	-0.027*	0.003	-0.026*	0.004
ln (Medical brain drain rate)	-0.005	0.003	-	
ln (Physicians in home country)	-		-.0001	0.003
ln (Physicians abroad)	-		0.0001	0.002
Lagged dependent variable	0.662*	0.002	0.700*	0.001
2 x (maximized log-likelihood function)	1558.80		1588.15	
Chi-square test for exogeneity of medical brain drain rate or physicians abroad (5 d.f.)	16.64*		24.46*	

Results for life expectancy

- Health expenditures predict higher life expectancy in the countries
- SR elasticity of life expectancy (w.r.t. HIV prevalence) =0.02; LR elasticity =0.07
- Medical brain drain rate is not significant
- Physicians in home country and abroad in Specification 2 are not significant predictors

TABLE 5. ***Efficient estimates from static random effects models for aggregate and per capita GDP growth rates at3-year intervals in sub-Saharan African countries explained by socioeconomic variables and life expectancy***

	Dependent variable: GDP growth rates			
Explanatory variables :	Aggregate GDP growth rates		Per capita GDP growth rates	
	Coefficient	SE	Coefficient	SE
Constant	-0.332	0.210	-0.165	0.127
Ln (Proportion with second+tert education) $_{-1}$	-0.003	0.008	-0.002	0.006
ln (Investment/GDP)$_{-3}$	0.025*	0.012	0.023*	0.010
ln (Imports/GDP) $_{-3}$	0.003	0.018	0.006	0.012
ln (Export/GDP) $_{-3}$	-0.002	0.013	-0.011	0.011
ln (Population) $_{-3}$	0.013	0.008	-	
ln (Life expectancy) $_{-3}$	0.081*	0.037	0.025	0.034
ln (GDP) $_{-3}$	-0.011	0.010	0.003	0.010
Chi-square test for exogeneity of life expectancy and GDP levels (24 d.f.)	45.90*		63.86*	
Chi-square test for special form of exogeneity of life expectancy and GDP levels (8 d.f.)	2.38		3.11	

Results for GDP growth rates

- High internal variation in 3-yearly GDP growth rates
- Specification for aggregate GDP growth rates is preferred over per capita growth rates
- Investment/GDP ratio and life expectancy are the only significant predictors
- Exogeneity of life expectancy and GDP levels is rejected
- Longer time frame than 15 years is necessary

Conclusions

- Higher HIV prevalence can increase the emigration of physicians- greater resources should be devoted to increasing salaries and improving working conditions
- Higher medical brain drain predicted greater number of adult deaths due to AIDS
- Life expectancy was shortened by HIV prevalence but emigration of physicians did not significantly reduce life expectancy- a longer time frame is necessary to assess these effects

Conclusions

- GDP growth rates at 3-yearly intervals were significantly predicted by investment and life expectancy
- Although medical brain drain did not significantly predict lower GDP growth rates, it is likely to affect life expectancy and hence economic growth in the long run.
- It is important to discourage medical brain drain especially as anti-retroviral treatment becomes widely available
- HIV infected workers in industry can be cared for by firms while poor in rural areas need public programs
- Global Fund can facilitate compensation for medical brain drain