Finance and health: Evidence from macro panel data

Ficawoyi Donou-Adonsou
Department of Economics & Finance
Boler College of Business
John Carroll University
1 John Carroll Boulevard
University Heights, OH 44118
Tel.: 216 397 4970 / Fax: 216 397 1728
fdonouadonsou@jcu.edu

Abstract: This paper examines the relationship between health and financial development in Sub-Saharan Africa. The results using the fixed-effects and two-step generalized method of moments estimators indicate significant relationships between health and financial development. All health indicators, at the exception of out-of-pocket expenditure, are positively associated with financial development. The out-of-pocket health expenditure is negatively associated with financial development. Furthermore, we fit the model with an autoregressive distributed lag specification to allow rich dynamics in a way financial development adjusts to changes in health conditions. We then apply the pooled-mean group estimator. While the results indicate that a long-run relationship coexists between health and financial development, no strong evidence seems to appear in the short-run. Overall, the results suggest that good health increases total saving and fosters financial development, especially in the long-run.

Keywords: Health, Financial development, Fixed-effects, Pooled-mean group.
JEL: G21; I10; O16

1. Introduction

The relationship between the financial sector and the health sector has not been subject to any studies in the literature[1]. However, when we analyze the relationship between the real sector and monetary sector, there could be potential correlations between health and financial development as measured by the expansion of credit. One can easily conjecture that a healthy man, unlike the unhealthy one, can work, save, and contribute to widening the financial sector. In other words, the healthy worker supplies labor and gets paid. He uses his labor income to consume and save[2]. His savings go through the market for loanable funds to finance capital goods for firms – households can also borrow funds to buy new houses. Everything being the same, the larger the savings, the deeper the financial sector. Higher public and private spending on healthcare will provide the society with healthier and stronger workers who, through their savings, may contribute to deepening the financial system. This paper offers a novel insight into the relationship between health and the development of the financial system.

One aspect of the efficiency wage theories stipulates that healthy workers are more productive. In developing countries, poor nutrition is a common problem. Accordingly, paying higher wages allows workers to eat better, look healthier, and be more productive. Leibenstein (1957) highlights these linkages among wages, nutrition, and health in less-developed countries, allowing firms to get healthier with more productive workers. It is reasonable to assume that the healthy worker on a higher wage eats better, works, and saves more, compared to the unhealthy

[1] Grigoli et al. (2018) attempts to understand the relationship, but focus on the broad determinants for private saving. Their study includes public health expenditure, but they do not find any significant impact on private saving.
[2] The model does not include government.

worker on a lower wage. From this premise, the healthy worker participates in widening the financial system, unlike the unhealthy one.

Using the life-cycle models, Smith (1999) discusses the effect of health on wealth and argues that savings may fall as current health gets worse. Put simply, poor health reduces current period income or increases either consumption or out-of-pocket medical expenses. Following up on this argument, the unhealthy household simply dissaves. In the scenario the worker has no medical insurance which is supposed to cover his medical expenses, a sick worker would pay for the medical bills by himself. This is the case for many households in developing countries. The partial medical insurance coverage, best known as deductible, would have the same dissaving effect since the household co-pays for his medical bills. Even under the full coverage policy, the household ends up dissaving. That is, the insurance companies do not cover every single disease the household happens to get – a minor flu, for instance – and the household always has related costs that cannot be claimed – an appetite for a particular food, for instance, as it is the case for pregnant women. In any case, the household ends up dissaving, albeit the importance of dissaving varies across different policies and spells of illness. The implication for the loanable funds market is that the supply of loanable fund will shift to the left and investment will go down.

Viscusi and Evans (1990) use utility functions to analyze the effect of health on wealth. They model utility functions that depend on the health status, with the health status depending on income and the states of the world – the healthy state and the unhealthy state. Their results show that poor health reduces utility and the marginal utility of income. Put differently, at a given level of income, utility increases in healthy state and decreases in unhealthy state. The reduction in utility may imply that medical expenses lower household's wealth and hence the utility level.

Given that utility functions are subject to diminishing marginal utility, the decrease in marginal utility is higher with lower wealth induced by medical expenses. If so, the healthy household would accumulate wealth over time that would boost savings in the market for loanable funds assuming wealth goes through the financial system.

The increase in medical expenses due to poor health may be assimilated to unexpected income shocks, which would drain households' savings out of the financial system. Under the permanent income hypothesis framework, household savings increase if permanent income (the long-term average income) is expected to be less than the current income to smooth consumption over time. The implication of this hypothesis is that savings will go down following adverse income shocks such as an increase in medical expenses due to poor health, thereby making permanent income probably higher than the current income.

Evidence by Bronchetti (2012) suggests that only an increase in worker's compensation allows workers to enjoy the same consumption level after they become ill. Had compensation not increased to offset the drop of household consumption post sickness, workers' savings would probably go down or debt level would go up. In either case, private investment would suffer as a result. In the context of farm households, Kochar (1995) argues that there is a significant loss of wage income associated with illness, leading to informal borrowing and possibly to poverty. The author also argues that households are more vulnerable to health shocks than income shocks. At macro level, Grigoli et al (2018) survey consumption theories to investigate private saving determinants around the world. Several determinants are highlighted: income levels, current and future growth, inflation have positive impacts on private saving, while public saving, credit, dependency ration, and urbanization have negative impacts on private saving. Although public

health expenditure has a negative impact on private saving, its coefficient is not statistically significant.

There is an extensive macro literature on financial development, most of which is focused on growth (Beck et al., 2000; Levin et al., 2000; Donou-Adonsou and Sylwester, 2017). Other aspects focus on poverty (Donou-Adonsou and Sylwester, 2016), capital controls, legal systems and institutional quality (Chinn and Ito, 2009), trade openness (Gries et al., 2009), remittances (Aggarwal et al., 2011), inflation (Boyd et al., 2001), capital structure (Donou-Adonsou, 2014), or globalization (Mishkin, 2009). While financial development has been investigated in many respects, to the best of our knowledge, there is no macro study that has examined the relationship between financial development and health.

In this paper, we contribute to the existing literature by investigating the relationship between health and financial development. More specifically, we examine whether improvements in health conditions in Sub-Saharan African countries can help explain the expansion of the financial system. Based on the literature, we posit that countries with better health infrastructure are likely to exhibit stronger and healthier economies. Accordingly, those countries will save more, allowing their financial system to grow deeper. A lot of health-related studies are micro-related studies that connect household health and saving. This paper offers a macro perspective that relates health indicators to financial development indicators.

The results using the fixed-effects and generalized method of moments (GMM) estimators indicate significant relationships between health and financial development. All health indicators, at the exception of out-of-pocket expenditure, are positively associated with financial development. The out-of-pocket health expenditure is negatively associated with financial

development. Furthermore, we fit the model with an autoregressive distributed lag (ARDL) specification to allow rich dynamics in a way financial development adjusts to changes in health conditions. We then apply the pooled-mean group estimator. While the results indicate that a long-run relationship coexists between health and financial development, no strong evidence seems to appear in the short-run.

The rest of the paper is organized as follows. In Section 2, we present the data and describe the variables. Section 3 discusses the empirical model, while Sections 4, 5, and 6 present the fixed-effects, GMM, and pooled-mean group results, respectively. In Section 7, we conclude.

2. Data and descriptive statistics

This paper uses a panel encompassing 46 countries in Sub-Saharan African countries over the period 1995 to 2015. Variables used in this study come from the World Development Indicators database, the Global Financial Development database, the UNDP Human Development Reports Office, and the Worldwide Governance Indicators database (see appendix for more details).

Financial development indicators widely used in the finance-growth literature include private credit to GDP and market capitalization to GDP. While the former accounts for bank system development, the second accounts for equity market development. For instance, these two indicators have been used by Baltagi et al. (2009). According to Rajan and Zingales (2003), private credit measures how easy it is for any entrepreneur with a viable project to get funding from banks. Stock market capitalization is the stock market value of listed companies as a percentage of GDP. It proxies for the size of the stock market relative to the economy. The main

flaw, however, of this indicator is that prices in the stock market are subject to animal spirit and random walk, thus making dynamic modeling more challenging (Baltagi et al., 2009). Despite this flaw, market capitalization is widely used to measure stock market development. However, in the context of this study, there are a lot of missing data reported for market capitalization. In addition, countries in West Africa do not have individual stock markets, but instead one stock market (BRVM[3]), so market capitalization is reported only for Cote d'Ivoire, the headquarter of the BRVM. Therefore, besides private credit to GDP, we instead use liquid liabilities to GDP, which is a common measure of financial depth. Liquidity liabilities is equal to the sum of currency and demand and interest-bearing liabilities of banks and non-bank financial intermediaries divided by GDP. More details about these variables as well as data sources are provided in the appendix.

For the health indicators, we use health index, total health expenditure (%GDP), public health expenditure (%GDP), private health expenditure (%GDP), out-of-pocket health expenditure (% of total expenditure on health), and per capita health expenditure ($ PPP, constant 2011). Health index data is provided by the UNDP Human Development Reports. These indicators proxy for health infrastructure in each country. The definitions and sources of these variables are found in the appendix.

The control variables include income, employment, corruption, trade openness, inflation, and rule of law. In the following section, we discuss these variables and provide more details in the appendix.

[3] Bourse Régionale des Valeurs Mobilières.

Table 1: Summary statistics

Variable	N	Mean	Std Dev	Min	Max
credit (Domestic credit, %GDP)	920	18.84	22.93	0	160.13
liquid (Liquid liabilities, %GDP)	854	29.35	21.54	3.29	137.73
health index	450	0.55	0.11	0.28	0.85
h.exp.total (Total health expenditure, %GDP)	912	5.44	2.12	1.45	14.39
h.exp.pub (Public health expenditure, %GDP)	912	2.45	1.26	0.05	9.09
h.exp.pri (Private health expenditure, %GDP)	912	2.99	1.68	0.18	11.06
h.oop.exp (Out of pocket health expenditure, % Total health expenditure)	912	39.33	18.83	1.99	80.91
h.exp.pc (Per capita health expenditure $PPP, 2011)	912	174.34	220.06	5.94	1768.68
income (Per capita GDP, constant 2010)	956	2104.70	3399.75	115.44	25732.68
inflation (% consumer price index)	890	50.15	835.82	-35.84	24411.03
rule of law (Index between 0 and 100)	920	29.47	20.79	0	83.25
corruption (Index between 0 and 100)	919	32.08	22.52	0	85.85
trade (Openness to trade, %GDP)	895	77.63	49.73	14.77	531.74
employment (Labor force participation rate, % 15+)	900	70.99	10.87	48.40	89.60

3. The empirical model

Using a permanent income model of savings in a micro setting, Paxson (1992) provides an empirical model that relates household savings to their permanent income, transitory income, and current income. The model defines a linear relationship between savings and the three types of income. However, as Paxson (1992) argues, permanent income and transitory income are unobservable which makes the estimation more difficult in terms of how to measure these two types of income. To circumvent this issue, micro studies sometimes instrument for permanent income only if suitable instruments are available. Other studies usually omit the transitory income from the saving equation. Estimating the propensity to save out of permanent income and transitory income is beyond the scope of this paper. In this study, we use a similar model that

relates financial development – proxied by savings – to current income and health status[4]. We then augment the model with some macroeconomic control variables found in the financial development literature. The model is given by:

$$FinDev_{it} = \alpha_0 + \beta_i + \theta_t + \alpha_1 FinDev_{it-1} + \alpha_2 Health_{it} + \alpha_3 Income_{it} + \alpha_4 Inflation_{it} +$$

$$\alpha_5 RuleOfLaw_{it} + \alpha_6 Corruption_{it} + \alpha_7 Trade_{it} + \alpha_8 Employment_{it} + \varepsilon_{it} \quad (1)$$

where *FinDev* denotes financial development indicator, *Health* is health indicator, β_i represents country-specific effects, θ_t represents the time effects, and ε_{it} the random error which captures the unobservable components of the financial development. In our specific case, both permanent and transitory incomes will be reflected in the error term. The fixed-effects model specification allows us to control for the unobserved heterogeneity such as differences in geography across countries that may be correlated with the error term. It also allows us to control for systemic risk or country risk faced by the financial system within a country. The inclusion of the time dummies allows us to control for possible time-specific exogenous shocks – common shocks such as fluctuations in international prices.

Based on the theories provided above, better health is expected to positively influence financial development, that is $\alpha_2 > 0$. Likewise, poor health is expected to have a negative effect on financial development ($\alpha_2 < 0$). At the exception of the out-of-pocket health expenditure, any other health indicator is expected to be positively correlated with each one of the financial development indicators. Better health (more spending on health care) begets healthier workers

[4] We recall that the Paxson's (1992) micro model specification also included household demographic characteristics, such as age, household size, or gender. Given the macro nature of this study, these household demographic characteristics are dropped from the model. Instead, we include employment as an indicator of household labor participation. It is important to mention that Paxson (1992) discussed the importance of health variable in the model. However, the non-availability of household health data prevented such inclusion into his model.

according to the efficiency wage theories. The more they work, the more they can save and contribute to widening the financial system, unlike the unhealthy workers. The unhealthy workers will spend more on health. As a result, their deductible (out-of-pocket expenditure) will be higher, which means, ceteris paribus, less saving for the financial system.

The finance-growth literature highlights a bi-directional causality between finance and growth. As such, we expect income to have a positive effect on financial development. However, from a micro perspective, the effect on income (the variance of income to be more precise) on savings is ambiguous and depends on the utility function specified (Paxson, 1992). Rule of law and trade openness are expected to increase financial development, while inflation and corruption are expected to decrease it. The finance-growth literature contends that countries with strong institutions will be able to enforce contracts banks sign, thereby contributing to deepening their financial system. Rajan and Zingales (2003) suggest that trade openness is necessary for financial sector development and Baltagi et al. (2009) provide evidence corroborating this positive relationship between trade openness and financial development. Inflation, on the other hand, reduces the purchasing power and increases the demand for money households want to hold. In doing so, they will save less. Boyd et al. (2001) find a negative relationship between financial development and inflation. Likewise, corruption makes less competitive the financial sector, thereby reducing funds allocated to private investment. According to Mishkin (2009), when corrupt officials demand bribes, they reduce the incentives for entrepreneurs to make investments. As for employment, it is expected that more workers may imply more savings. However, if those workers have a lot of dependents, then it is reasonable to assume that savings will not increase with employment.

4. The fixed-effects estimates

We estimate equation (1) using the fixed-effects OLS with heteroscedastic robust standard errors. The results are reported in Table 2. All the six indicators without and with controls have the expected signs. Only private health expenditure does not appear at all to be statistically significant across the different models. Health index has a significant effect on domestic credit. A one-percentage point increase in health index increases domestic credit by between 13.41 and 17.10 percentage points, while a one-percentage point increase in the out-of-pocket health expenditure decreases domestic credit by between 0.06 and 0.07 percentage points. In addition, public health expenditure, unlike private health expenditure, has a significant effect on domestic credit.

In Table 3, we estimate the same equation using liquid liabilities as the dependent variable. The impacts of the health indicators on liquid liabilities are very similar to those on domestic credit.

Putting Tables 2 and 3 together, we can conclude that, while good health, proxied by health expenditure or infrastructure, fosters financial development, poor health, proxied by out-of-pocket expenditure, drains saving out of the financial system and impedes financial development. Also, from the fixed effects estimates, we can conclude that public health expenditure is more conducive to financial development than private health expenditure.

Table 2: The fixed-effects estimates: Dependent variable is domestic credit

	1	2	3	4	5	6
L.credit	0.785***	0.778***	0.771***	0.738***	0.773***	0.735***
	(0.087)	(0.098)	(0.099)	(0.113)	(0.098)	(0.113)
health index	17.100***	13.407**				
	(4.294)	(5.255)				
h.exp.total			0.334**	0.231		
			(0.131)	(0.143)		
h.exp.pub					0.488***	0.458**
					(0.145)	(0.194)
income		0.000		0.001*		0.001*
		(0.000)		(0.000)		(0.000)
inflation		-0.024**		-0.002		-0.002
		(0.009)		(0.001)		(0.001)
rule of law		-0.039*		0.025		0.020
		(0.022)		(0.026)		(0.025)
corruption		0.031		-0.000		0.004
		(0.021)		(0.016)		(0.016)
trade		0.014		0.028*		0.030*
		(0.013)		(0.016)		(0.016)
employment		0.170***		-0.095		-0.095
		(0.061)		(0.206)		(0.206)
Constant	-4.371**	-15.958***	2.906*	6.487	3.484**	6.629
	(1.736)	(4.911)	(1.491)	(14.778)	(1.590)	(14.790)
Obs	429	384	825	716	825	716
R2	0.661	0.675	0.592	0.587	0.592	0.588

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 2: The fixed-effects estimates: Dependent variable is domestic credit (continued)

	7	8	9	10	11	12
L.credit	0.778***	0.744***	0.768***	0.731***	0.726***	0.679***
	(0.098)	(0.113)	(0.103)	(0.116)	(0.106)	(0.121)
h.exp.pri	0.248	0.041				
	(0.206)	(0.179)				
h.oop.exp			-0.060*	-0.073**		
			(0.031)	(0.035)		
h.exp.pc					0.009	0.014**
					(0.005)	(0.007)
income		0.001*		0.001*		-0.000
		(0.000)		(0.000)		(0.000)
inflation		-0.002		-0.002*		-0.002
		(0.001)		(0.001)		(0.001)
rule of law		0.038		0.026		0.010
		(0.027)		(0.024)		(0.023)
corruption		-0.002		0.008		0.012
		(0.016)		(0.015)		(0.015)
trade		0.030*		0.028*		0.023*
		(0.016)		(0.014)		(0.012)
employment		-0.088		-0.134		-0.061
		(0.204)		(0.207)		(0.177)
Constant	3.866**	6.492	7.135**	13.342	3.991***	6.171
	(1.620)	(14.731)	(2.894)	(15.841)	(1.473)	(13.328)
Obs	825	716	825	716	825	716
R2	0.589	0.585	0.593	0.591	0.604	0.601

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 3: The fixed-effects estimates: Dependent variable is liquid liabilities

	1	2	3	4	5	6
L.liquid	0.808***	0.768***	0.882***	0.875***	0.884***	0.869***
	(0.036)	(0.047)	(0.029)	(0.028)	(0.028)	(0.027)
health index	12.164*	16.751*				
	(6.234)	(8.326)				
h.exp.total			0.564***	0.398***		
			(0.168)	(0.123)		
h.exp.pub					0.752***	0.719***
					(0.203)	(0.172)
income		0.000***		0.000***		0.001***
		(0.000)		(0.000)		(0.000)
inflation		-0.012***		-0.003***		-0.003***
		(0.003)		(0.000)		(0.000)
rule of law		-0.080**		-0.055**		-0.064***
		(0.036)		(0.023)		(0.023)
corruption		0.031		0.033**		0.038**
		(0.025)		(0.015)		(0.015)
trade		0.013		0.017**		0.019**
		(0.009)		(0.008)		(0.008)
employment		0.229*		0.149*		0.149*
		(0.118)		(0.077)		(0.074)
Constant	0.048	-18.362**	0.986	-10.597*	2.101***	-10.119*
	(2.923)	(8.775)	(0.888)	(5.660)	(0.749)	(5.343)
Obs	416	372	799	699	799	699
R2	0.732	0.753	0.797	0.824	0.797	0.827

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 3: The fixed-effects estimates: Dependent variable is liquid liabilities (continued)

	7	8	9	10	11	12
L.liquid	0.900***	0.897***	0.896***	0.879***	0.885***	0.874***
	(0.030)	(0.028)	(0.031)	(0.027)	(0.033)	(0.034)
h.exp.pri	0.434*	0.128				
	(0.220)	(0.139)				
h.oop.exp			-0.044*	-0.058***		
			(0.022)	(0.017)		
h.exp.pc					0.005***	0.006**
					(0.001)	(0.002)
income		0.001***		0.000***		0.000
		(0.000)		(0.000)		(0.000)
inflation		-0.003***		-0.003***		-0.003***
		(0.000)		(0.000)		(0.000)
rule of law		-0.034		-0.045**		-0.045*
		(0.022)		(0.019)		(0.023)
corruption		0.030**		0.036***		0.035**
		(0.014)		(0.013)		(0.015)
trade		0.019**		0.018**		0.015**
		(0.007)		(0.007)		(0.007)
employment		0.150*		0.120		0.167*
		(0.081)		(0.078)		(0.091)
Constant	2.231***	-10.147*	5.326***	-4.596	3.008***	-10.220
	(0.765)	(5.960)	(1.540)	(5.668)	(0.832)	(6.560)
Obs	799	699	799	699	799	699
R2	0.792	0.821	0.792	0.824	0.795	0.824

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

5. The generalized method of moments (GMM) estimates

In the previous section, we establish a positive relationship between health indicators and financial development indicators using the fixed-effects estimation method. A general concern in these fixed-effects regressions is that the health variable may be correlated with unobserved factors, such as the geographic location, that can also affect financial development. As a result,

the fixed-effects estimator may be biased and inconsistent for the causal effect of health on financial development. In this section, we apply the two-step GMM estimator, an instrumental variables approach, to analyze the relationship between health and financial development. The GMM estimator was developed by Hansen (1982) to provide optimal estimates in the presence of serial correlation, heteroscedasticity, and endogeneity concerns. As a matter of fact, one may judiciously ask if easy credit access for consumption allows workers to stay healthy. Addressing this issue of endogeneity requires suitable instruments. In this study, we use the first three lags of the health variable as instruments for health.

The GMM chooses the parameter estimate $\hat{\theta}$ that solves the following minimization problem:

$$min_{\hat{\theta}}\ \hat{m}(\theta)'W\hat{m}(\theta) \qquad (2)$$

where $\hat{m}(\theta)$ is the sample moment vector and W is the optimal weighting matrix.

The moment conditions used are derived from the first-order condition of equation (1), which is the expectation at time *t* of the error term given the instrument z_t. The law of iterated expectation is then applied to derive the moment condition for different instruments, which is then set equal to zero. These moment conditions will provide the basis for estimating the parameters in equation (1). As a check for the model's validity, we report the test of over-identifying restrictions via Hansen's J statistic:

$$J = n\hat{m}(\theta)'W\hat{m}(\theta) \qquad (3)$$

The J-statistic follows a chi-square distribution under the null of model validity, with degrees of freedom equal to the number of over-identifying restrictions.

Although more efficient, the GMM estimator has some potential drawback that is worth pointing out. Standard errors in the GMM estimator may suffer from severe downward bias because the optimal weight matrix is also estimated and may thus cause inference problems (Arellano and Bond, 1991). Put differently, the GMM estimator may not be unique as it depends on the weight matrix.

The GMM results are reported in Table 4 (domestic credit is the dependent variable) and Table 5 (liquid liabilities is the dependent variable). These results confirm the fixed-effects results in that good health, proxied by health endowments, is conducive to financial development, while poor health, measured by out-of-pocket expenditure, is detrimental to the financial system. Again, we see strong evidence that public health expenditure has a significant impact on financial development, compared to private health expenditure. Overall, the Hansen tests suggest that most of the models are valid (two tests – Table 4, columns 7 and 8 – reject the null hypothesis at 5% and two tests – Table 4, column 3 and Table 5, column 4 – reject it at 10%).

Table 4: Two-step GMM estimates: Dependent variable is domestic credit

	1	2	3	4	5	6
L.credit	0.618***	0.587***	0.829***	0.817***	0.811***	0.785***
	(0.133)	(0.147)	(0.048)	(0.053)	(0.048)	(0.055)
health index	30.906*	33.567*				
	(17.565)	(19.463)				
h.exp.total			0.235**	0.100		
			(0.106)	(0.130)		
h.exp.pub					0.495***	0.403**
					(0.151)	(0.195)
controls	no	yes	no	yes	no	yes
Obs	255	233	737	647	737	647
R2	0.431	0.459	0.731	0.737	0.731	0.739
Hansen *p*-value	0.530	0.534	0.053	0.105	0.930	0.926

	7	8	9	10	11	12
L.credit	0.851***	0.828***	0.797***	0.772***	0.785***	0.763***
	(0.047)	(0.052)	(0.049)	(0.054)	(0.051)	(0.059)
h.exp.pri	-0.022	-0.154				
	(0.156)	(0.172)				
h.oop.exp			-0.079***	-0.089***		
			(0.022)	(0.021)		
h.exp.pc					0.006***	0.009**
					(0.002)	(0.004)
controls	no	yes	no	yes	no	yes
Obs	737	647	737	647	737	647
R2	0.727	0.736	0.731	0.738	0.739	0.747
Hansen *p*-value	0.006	0.049	0.694	0.788	0.562	0.409

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance. In each equation, the first three lags of the health variable are used as instruments. Also, all models control for fixed-effects to mitigate omitted variables bias, as well as for cross-sectional dependence using the Bartlett kernel function with $T^{1/3}$ bandwidth.

Table 5: Two-step GMM estimates: Dependent variable is liquid liabilities

	1	2	3	4	5	6
L.liquid	0.563***	0.557***	0.882***	0.895***	0.879***	0.875***
	(0.103)	(0.104)	(0.034)	(0.030)	(0.034)	(0.030)
health index	14.123	34.168*				
	(20.803)	(20.924)				
h.exp.total			0.318**	0.135		
			(0.140)	(0.139)		
h.exp.pub					0.452**	0.467**
					(0.197)	(0.218)
controls	no	yes	no	yes	no	yes
Obs	245	223	716	630	716	630
R2	0.346	0.468	0.777	0.811	0.777	0.814
Hansen *p*-value	0.177	0.277	0.527	0.086	0.494	0.133

	7	8	9	10	11	12
L.liquid	0.892***	0.897***	0.876***	0.861***	0.866***	0.877***
	(0.032)	(0.028)	(0.034)	(0.029)	(0.034)	(0.029)
h.exp.pri	0.249	-0.088				
	(0.190)	(0.175)				
h.oop.exp			-0.058**	-0.096***		
			(0.024)	(0.022)		
h.exp.pc					0.005***	0.004*
					(0.001)	(0.002)
controls	no	yes	no	yes	no	yes
Obs	716	630	716	630	716	630
R2	0.773	0.809	0.772	0.810	0.777	0.813
Hansen *p*-value	0.702	0.585	0.900	0.533	0.168	0.237

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance. In each equation, the first three lags of the health variable are used as instruments. Also, all models control for fixed-effects to mitigate omitted variables bias, as well as for cross-sectional dependence using the Bartlett kernel function with $T^{1/3}$ bandwidth.

6. The pooled-mean group estimates

In this section, we use the cointegration technique to examine the long-run relationship between health and financial development. The cointegration technique has the advantage to mitigate the endogeneity concern raised in the previous section and to bypass the controversy of

the instrumental variables approach, especially as far as the choice of instruments is concerned. As a matter of fact, the cointegration approach assumes that the variables of interest (health and financial development) are endogenous.

With the possibility of some macroeconomic variables to be not stationary, equation (1) is nested in an autoregressive distributed lag (ARDL) specification to capture rich dynamics in the way financial development adjusts to changes in health conditions and other controls. In general, the ARDL (*p*, *q*, …, *q*) model with lags of order *p* and *q* can be written as

$$Y_{it} = \sum_{j=1}^{p} \omega_{ij} Y_{it-j} + \sum_{j=0}^{q} \pi_{ij}' X_{it-j} + \mu_i + \varepsilon_{it} \quad (4)$$

and the error-correction equation is written as:

$$\Delta Y_{it} = \mu_i + \varphi_i (Y_{it-1} - \theta_i' X_{it}) + \sum_{j=1}^{p-1} \vartheta_i Y_{it-j} + \sum_{j=0}^{q-1} \tau_{ij}' X_{it-j} + \varepsilon_{it} \quad (5)$$

where $\varphi_i = -\left(1 - \sum_{j=1}^{p} \omega_{ij}\right), \theta_i = -\frac{\sum_{j=0}^{q} \pi_{ij}}{\varphi_i}$, $\vartheta_{ij} = -\sum_{m=j+1}^{p} \omega_{im}$, $\tau_{ij} = -\sum_{m=j+1}^{q} \pi_{im}$.

The parameter φ_i is the error-correction term that determines the speed of adjustment of Y_{it} towards its long-run equilibrium following a change in X_{it}. When $\varphi_i < 0$, then Y_{it} and X_{it} are cointegrated, while when $\varphi_i = 0$, there is no cointegration. θ_i represents the equilibrium, long-run relationship between Y_{it} and X_{it}. ϑ_{ij} and τ_{ij} represent the short-run coefficients that relate financial development to its past values and other explanatory variables. Also, *i* stands for country, *t* for time, *j* for time lag, while μ_i represents the country fixed-effects.

Equation (5) is estimated using the Pooled-Mean Group (PMG) estimator of dynamic heterogenous panels. This method, developed by Pesaran et al. (1999), allows intercepts, short-run coefficients, and error variances to differ across cross-sectional units, while it restricts the long-run parameters to be identical. The PMG technique employs a maximum-likelihood method

to estimate the parameters. As in Pesaran et al. (1999), we assume the maximum lag to be equal to one since it helps preserve the degrees of freedom. Therefore, we use the benchmark $p = q = 1$. Tables 6-12 reports the long-run and short-run parameters by the PMG estimator.

In Table 6, we report the results with no controls when the dependent variable is domestic credit. These results indicate that the estimated long-run health coefficients are statistically significant at the 1% level and are properly signed except for the out-of-pocket health expenditure coefficient, which is expected to carry a negative sign. The speed of adjustment estimate (Phi) is within the unit circle and implies significant short-run dynamics across all specifications. With the estimated $\varphi_i < 0$, we conclude that each one of the health variables and domestic credit are cointegrated. Lastly, it also important to point out that in the short-run, none of the health coefficients has a significant effect on domestic credit.

In Tables 7-11, we include controls described in equation (1). However, to keep the model simple and malleable, only one control is included at the time. After controlling for income (Table 7), rule of law (Table 8), corruption (Table 9), trade (Table 10), and employment (Table 11) using the ARDL (1, 1, 1) model specification, the results remain very consistent with those reported without controls. Each one of the health variables has a significant, long-run impact on domestic credit[5]. More importantly, the out-of-pocket health expenditure coefficient has a significant, negative long-run impact on domestic credit as expected. In addition, the error-correction speed of adjustment is statistically significant and less than zero, indicating cointegration relationship between health and domestic credit. Lastly, comparing public health

[5] An exception is made for total health expenditure in Table 9.

expenditure to private health expenditure, the importance of their respective impact on domestic credit varies with the control variable.

Table 6: Pooled Mean Group estimates – no controls: Domestic credit

1	2	3	4	5	6
Long-run					
health index					
h.exp.total	3.368***				
	(0.323)				
h.exp.pub		3.745***			
		(0.423)			
h.exp.pri			5.371***		
			(0.476)		
h.oop.exp				2.065***	
				(0.756)	
h.exp.pc					0.126***
					(0.008)
Short-run					
Phi	-0.171***	-0.171***	-0.077**	-0.040*	-0.202***
	(0.036)	(0.038)	(0.037)	(0.023)	(0.036)
D.health index					
D.h.exp.total	0.518				
	(0.457)				
D.h.exp.pub		0.511			
		(0.418)			
D.h.exp.pri			9.227		
			(8.611)		
D.h.oop.exp				0.207	
				(0.268)	
D.h.exp.pc					-0.006
					(0.009)
Constant	1.920**	3.364***	-0.516	0.103	1.900***
	(0.894)	(1.193)	(2.703)	(1.284)	(0.728)
Obs	823	823	823	823	823

Note: No estimates reported in column (1) because of "initial values not feasible" error message. Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 7: Pooled Mean Group estimates – controls for income: Domestic credit

1	2	3	4	5	6
Long-run					
health index					
h.exp.total	2.472***				
	(0.275)				
h.exp.pub		2.815***			
		(0.344)			
h.exp.pri			5.328***		
			(0.497)		
h.oop.exp				-0.767***	
				(0.049)	
h.exp.pc					0.187***
					(0.015)
income	0.011***	0.012***	0.000	0.006***	-0.004*
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
Short-run					
Phi	-0.223***	-0.223***	-0.105***	-0.204***	-0.208***
	(0.053)	(0.055)	(0.030)	(0.053)	(0.046)
D.health index					
D.h.exp.total	0.318				
	(0.326)				
D.h.exp.pub		0.305			
		(0.474)			
D.h.exp.pri			7.191		
			(6.700)		
D.h.oop.exp				0.235	
				(0.180)	
D.h.exp.pc					0.000
					(0.014)
D.income	-0.018	-0.019	-0.010	-0.020	-0.020
	(0.012)	(0.013)	(0.007)	(0.014)	(0.013)
Constant	-0.421	0.584	0.084	9.327***	1.268***
	(0.762)	(0.807)	(2.250)	(2.472)	(0.421)
Obs	823	823	823	823	823

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 8: Pooled Mean Group estimates – controls for rule of law: Domestic credit

1	2	3	4	5	6
Long-run					
health index					
h.exp.total	3.059***				
	(0.256)				
h.exp.pub		4.738***			
		(0.556)			
h.exp.pri			5.795***		
			(0.673)		
h.oop.exp				-0.977***	
				(0.126)	
h.exp.pc					0.085***
					(0.007)
rule of law	-0.236***	0.270***	-0.241***	0.729***	0.487***
	(0.031)	(0.052)	(0.061)	(0.075)	(0.052)
Short-run					
Phi	-0.151***	-0.128***	-0.078***	-0.108***	-0.137***
	(0.035)	(0.027)	(0.026)	(0.028)	(0.034)
D.health index					
D.h.exp.total	-0.260				
	(0.469)				
D.h.exp.pub		0.551			
		(0.651)			
D.h.exp.pri			4.033		
			(3.989)		
D.h.oop.exp				0.311	
				(0.240)	
D.h.exp.pc					-0.015
					(0.021)
D.rule of law	-0.307	-0.342	-0.201	-0.367	-0.354
	(0.375)	(0.361)	(0.259)	(0.340)	(0.328)
Constant	2.095**	0.989	1.229	5.502***	0.171
	(0.876)	(1.007)	(1.642)	(1.900)	(0.493)
Obs	782	782	782	782	782

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 9: Pooled Mean Group estimates – controls for corruption: Domestic credit

	1	2	3	4	5	6
Long-run						
health index						
h.exp.total		-0.214				
		(0.295)				
h.exp.pub			2.612***			
			(0.320)			
h.exp.pri				2.989***		
				(0.448)		
h.oop.exp					-0.867***	
					(0.110)	
h.exp.pc						
corruption		0.479***	0.461***	-0.359***	0.634***	
		(0.053)	(0.050)	(0.060)	(0.086)	
Short-run						
Phi		-0.094***	-0.096***	-0.053*	-0.075***	
		(0.025)	(0.026)	(0.029)	(0.022)	
D.health index						
D.h.exp.total		-0.371				
		(0.756)				
D.h.exp.pub			-0.123			
			(0.790)			
D.h.exp.pri				5.406		
				(5.130)		
D.h.oop.exp					0.508	
					(0.316)	
D.h.exp.pc						
D.corruption		-0.180	-0.184	-0.064	-0.180	
		(0.193)	(0.184)	(0.121)	(0.173)	
Constant		1.115*	0.441	1.976	3.147*	
		(0.639)	(0.844)	(2.194)	(1.642)	
Obs		781	781	781	781	

Note: In column (6), Hessian has become unstable or asymmetric. Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 10: Pooled Mean Group estimates – controls for trade: Domestic credit

	1	2	3	4	5	6
Long-run						
health index	34.832***					
	(2.940)					
h.exp.total		4.403***				
		(0.502)				
h.exp.pub			5.315***			
			(0.702)			
h.exp.pri				3.767***		
				(0.645)		
h.oop.exp					-0.523***	
					(0.090)	
h.exp.pc						0.130***
						(0.009)
trade	0.035***	0.160***	0.236***	0.202***	0.312***	0.061***
	(0.006)	(0.019)	(0.023)	(0.027)	(0.030)	(0.009)
Short-run						
Phi	-0.520***	-0.124***	-0.125***	-0.045	-0.125***	-0.189***
	(0.115)	(0.036)	(0.033)	(0.048)	(0.031)	(0.034)
D.health index	-199.372					
	(241.546)					
D.h.exp.total		1.200				
		(1.387)				
D.h.exp.pub			1.217			
			(1.257)			
D.h.exp.pri				14.500		
				(13.915)		
D.h.oop.exp					0.047	
					(0.304)	
D.h.exp.pc						0.029
						(0.038)
D.trade	0.000	-0.233	-0.234	0.123	-0.197	-0.137
	(0.033)	(0.232)	(0.237)	(0.120)	(0.196)	(0.144)
Constant	1.284	-0.197	0.710	-2.949	5.152***	0.787
	(3.660)	(0.732)	(0.993)	(3.875)	(1.861)	(0.652)
Obs	325	776	776	776	776	776

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 11: Pooled Mean Group estimates – controls for employment: Domestic credit

1	2	3	4	5	6
Long-run					
health index					
h.exp.total	3.084***				
	(0.284)				
h.exp.pub		4.104***			
		(0.501)			
h.exp.pri			4.090***		
			(0.421)		
h.oop.exp				-0.337***	
				(0.048)	
h.exp.pc					0.137***
					(0.009)
employment	0.517***	-0.972***	0.222**	0.313**	1.467***
	(0.135)	(0.175)	(0.088)	(0.152)	(0.258)
Short-run					
Phi	-0.195***	-0.157***	-0.129***	-0.186***	-0.202***
	(0.038)	(0.037)	(0.035)	(0.032)	(0.040)
D.health index					
D.h.exp.total	0.287				
	(0.317)				
D.h.exp.pub		0.425			
		(0.401)			
D.h.exp.pri			7.607		
			(7.292)		
D.h.oop.exp				0.278	
				(0.233)	
D.h.exp.pc					-0.044*
					(0.024)
D.employment	1.854	2.095	1.620	1.907	1.718
	(1.363)	(1.344)	(1.440)	(1.486)	(1.576)
Constant	-6.073***	13.319***	-2.353	2.459**	-20.800***
	(1.697)	(3.404)	(2.485)	(1.220)	(4.472)
Obs	804.000	804.000	804.000	804.000	804.000

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

Table 12: Pooled Mean Group estimates – no controls: Liquid liabilities

1	2	3	4	5	6
Long-run					
health index					
h.exp.total	1.482***				
	(0.147)				
h.exp.pub		1.281***			
		(0.156)			
h.exp.pri			3.190***		
			(0.398)		
h.oop.exp				5.391***	
				(0.945)	
h.exp.pc					0.035***
					(0.004)
Short-run					
Phi	-0.176***	-0.187***	-0.137***	-0.024*	-0.188***
	(0.043)	(0.042)	(0.039)	(0.013)	(0.035)
D.health index					
D.h.exp.total	1.242***				
	(0.364)				
D.h.exp.pub		1.530***			
		(0.420)			
D.h.exp.pri			1.283		
			(0.935)		
D.h.oop.exp				-0.118	
				(0.077)	
D.h.exp.pc					0.008
					(0.025)
Constant	3.951***	5.236***	3.398***	-0.114	4.589***
	(0.838)	(1.064)	(0.771)	(1.486)	(0.882)
Obs	798	798	798	798	798

Note: Robust standard errors are in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels of significance.

In Table 12, we run a robustness check using liquid liabilities as financial development indicator. For brevity, we only report the results without the control variables. The results do not differ from those of domestic credit. However, in the short-run, we see significant, positive impacts of total and public health expenditure on liquid liabilities.

In sum, three key results are of interest in this section. First, there is a long-run relationship between financial development and health. Second, although both public and private health expenditures promote financial development, it is not clear whether public expenditure promotes it more than private expenditure in the long-run. Third, we do not find strong evidence that health has significant effects on financial development in the short-run.

7. Concluding remarks

In this paper, we investigate the relationship between financial development and health in Sub-Saharan African countries. The results using the fixed-effects and GMM estimators indicate that, while health expenditure or infrastructure fosters financial development, out-of-pocket expenditure drains saving out of the financial system and impedes financial development. In addition, the results also show that public health expenditure is more conducive to financial development than private health expenditure.

The results using the pooled-mean group estimator show more dynamics between financial development and health. First, there is a long-run relationship between financial development and health. Second, although both public and private health expenditures promote financial development, it is not clear whether public expenditure promotes financial development in the long-run more than private expenditure. Third, we do not find strong evidence that health has a significant effect on financial development in the short-run.

Our results are consistent with the theory. Better health implies more saving. That is, better health, through more spending on health care, produces healthier workers according to the efficiency wage theories. Ceteris paribus, healthier workers work and save more and contribute to deepening the financial system, while the unhealthy workers will spend more of their labor income on health, which means less saving for the financial system. This is consistent with Smith (1999), who argues that savings may fall as current health gets worse.

Two policies can be derived from these results. First, it follows that improving health conditions increases total saving and promotes financial development. It is thus important African governments design policies that help expand health infrastructure. Buying equipment, building hospitals, staffing, educating medical personnel, and subsidizing nutrition, among others, are some ways to keep populations healthy in order to promote financial development. Market economy may play a significant role in fostering financial development in that it may reduce bribery related to buying equipment or staffing and increase the transparency of the procurement of government contracts to build hospitals.

Second, our results also suggest that less deductible promotes financial development. In a market economy characterized by the law of demand and the law of supply, deductible will be pushed downward because of the competition in the health sector. As a result, countries with liberal healthcare systems may experience more financial development, unlike countries with centralized healthcare systems.

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Appendix: Definition of variables

Variable	Definition	Source
credit	Domestic credit to private sector (% of GDP). Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. The financial corporations include monetary authorities and deposit money banks, as well as other financial corporations where data are available (including corporations that do not accept transferable deposits but do incur such liabilities as time and savings deposits).	WDI
liquid	Liquid liabilities (%GDP). Liquid liabilities are also known as broad money, or M3. They are the sum of currency and deposits in the central bank (M0), plus transferable deposits and electronic currency (M1), plus time and savings deposits, foreign currency transferable deposits, certificates of deposit, and securities repurchase agreements (M2), plus travelers' checks, foreign currency time deposits, commercial paper, and shares of mutual funds or market funds held by residents.	GFD
health index	Life expectancy at birth expressed as an index using a minimum value of 35 years and a maximum value of 85 years.	UNDP, HDR Office
h.exp.total	Health expenditure, total (% of GDP). Total health expenditure is the sum of public and private health expenditure. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation.	WDI
h.exp.pub	Health expenditure, public (% of GDP). Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds.	WDI
h.exp.pri	Health expenditure, private (% of GDP). Private health expenditure includes direct household (out-of-pocket) spending, private insurance, charitable donations, and direct service payments by private corporations.	WDI
h.oop.exp	Out-of-pocket health expenditure (% of total expenditure on health). Out of pocket expenditure is any direct outlay by households, including gratuities and in-kind payments, to health practitioners and suppliers of pharmaceuticals, therapeutic appliances, and other goods and services whose primary intent is to contribute to the restoration or enhancement of the health status of individuals or population groups. It is a part of private health expenditure.	WDI
h.exp.pc	Health expenditure per capita, PPP (constant 2011 international $). Total health expenditure is the sum of public and private health expenditures as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does	WDI

	not include provision of water and sanitation. Data are in international dollars converted using 2011 purchasing power parity (PPP) rates.	
income	GDP per capita (constant 2010 US$).	WDI
inflation	Inflation, consumer prices (annual %).	WDI
rule of law	Rule of Law: Percentile Rank. Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	WGI
corruption	Control of Corruption: Percentile Rank. Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	WGI
trade	Trade (% of GDP) is the sum of exports and imports of goods and services measured as a share of gross domestic product.	WDI
employment	Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate).	WDI

Note: WDI stands for World Development Indicator, WGI for Worldwide Governance Indicators, GFD for Global Financial Development, and UNDP, HDR Office for UNDP Human Development Reports Office.