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Abstract: The hypothesis that financial development promotes economic growth in developing countries is largely supported by empirical studies, though contrary evidence also exists. This relationship is re-examined using annual panel data for 44 developing countries for 1974–2001. Three sources-of-growth equations, which are specified from aggregate production functions, are estimated: two are theoretically consistent, while the third uses a common proxy (*DEPTH*) for financial development. Results show conflicting evidence: the theoretically consistent models show a positive and statistically significant relationship between financial development and economic growth, whereas the proxy version shows the opposite. Measuring financial development appropriately appears critical for policy advice.

Key words: financial development, economic growth, developing countries, panel data.

I Introduction

The importance of the financial sector stems from two sources: first, money is a unit of account that reduces the transactions costs associated with barter, and second, money is a store of value that reduces the risk of decision-making under uncertainty (Bhatt 1989). The notion that a positive relationship exists between financial development and economic growth was first recognized *inter alia* by Goldsmith (1969) and McKinnon (1973), and a large body of empirical literature has followed.

Summaries of this literature include Levine (2003), and Demetriades and Andrianova (2004). The consensus is of support for the hypothesis, and Levine (2003) concludes that 'Countries with better-developed financial systems tend to grow faster'. One example of the many studies that show a positive relationship between financial development and economic growth is Odedokun (1996), who derives two sources-of-growth equations from aggregate production functions. These are estimated using both time series and panel data for 71 developing countries and '… financial intermediation promotes economic growth in about 85 per cent of the countries …'. However, an example of contrary evidence is Ram (1999), who estimates a sources-of-growth equation with a commonly-used *ad hoc* specification, namely that financial development is proxied by the ratio of liquid liabilities to gross domestic product or *DEPTH*. From time series data

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for 95 developing countries, '… the overall indication is that of a negligible or negative association between financial development and growth'. These competing conclusions have serious consequences for policy-makers.

This article re-examines the relationship between financial development and economic growth using annual panel data for 44 developing countries for 1974–2001. Three sources-of-growth equations, which are specified from aggregate production functions, are estimated: two are theoretically consistent, while the third uses *DEPTH* as a proxy for financial development. The following sections outline the theoretical models and sources-of-growth equations; discuss the empirical method, data and results; and the final section concludes.

II Theoretical framework

The starting point is Solow (1957), where a sources-of-growth equation is derived from an aggregate production function, which is specified in terms of two conventional inputs, capital and labour. The aim here is to derive a sources-of-growth equation which can be estimated, and which includes financial development as an argument and following Odedokun (1996, 1999), the aggregate production function is extended to include financial development as an additional 'input':

$$Y = f(K, L, F) \quad (1)$$

where Y is aggregate real output or gross domestic product (GDP), K is capital, L is labour, and F is financial development. A sources-of-growth equation is derived in continuous time by totally differentiating (1) and dividing by Y; adding a constant, β_1, and an error term, u, gives:

$$GY = \beta_1 + \alpha(I/Y) + \beta_2 GL + \beta_3 GF + u \quad (2)$$

where G denotes a growth rate (for example, $GY = dY/Y$); $\alpha = \partial Y/\partial K$ is the marginal product of capital; β_k for $k = 2,3$ is the production elasticity of the kth input; and I/Y is the investment-income ratio where $I = dK$. Equation (3) is essentially that of Odedokun (1996, equation 3).

Following Ram's (1999) *ad hoc* specification, the second sources-of-growth equation is derived simply by replacing GF in (2) by $DEPTH$:

$$GY = \beta_1 + \alpha(I/Y) + \beta_2 GL + \beta_3 DEPTH + u \quad (3)$$

where $DEPTH = F/Y$. Observe that $DEPTH$ is used to measure financial development, yet in (3) it is used as a proxy for its growth rate.

The third model follows Odedokun's (1996, 1999) extension of Feder (1983). Assume a two-sector economy that produces both financial and non-financial outputs. The output of the non-financial (real) sector is determined *inter alia* by the financial sector's output, that is, financial externalities exist, which improve efficiency in the real sector through, say, better management and training. Formally:

$$\text{Financial Production:} \quad F = G(K^F, L^F) \quad (4)$$

$$\text{Real Production:} \quad R = R(K^R, L^R, F) \quad (5)$$

where K^F and L^F are capital and labour used to produce output in the financial sector, F; K^R and L^R are capital and labour used in production in the real sector, R. Financial externalities enter the real production function in (5), but real output does not determine the financial sector's output in (4).

Marginal productivity may be higher in the financial sector because financial markets tend to be more competitive, which leads to innovation and greater efficiency in resource use. For empirical tractability, two assumptions are invoked: first, the ratio of respective marginal products in each sector deviates from unity by a positive constant, δ; and second, the external effect of an increase in financial output on the real sector's output, $\partial R/\partial F$, is constant across sample observations. With some mathematical manipulation following Odedokun (1996, 1999) along the lines of Feder (1983, equation 11), and by adding a constant term, β_1, and an error term, u, a third sources-of-growth equation can be derived:

$$GY = \beta_1 + \alpha(I/Y) + \beta_2 GL + \beta_3(GF.DEPTH) + u \quad (6)$$

where $\beta_3 = \delta/(1+\delta) + (\partial R/\partial F)$. This term is composed of two elements: the first arises from higher productivities in the financial sector, and the second from the positive financial externalities on the real sector's output. The two elements are both hypothesized to be positive, but cannot be separated empirically. However, manipulation along the lines of Feder (1983, equation 12) reveals that β_3 is the factor productivity differential, that is, it is the difference between the (common) marginal contributions to GDP of capital (and labour) in the two sectors, relative to the marginal contribution to the financial sector's output. Equation (6), which essentially is that of Odedokun (1999, equation 6), has the following interpretation: GDP growth is determined by I/Y and labour growth, and the gains resulting from reallocating resources from the (low productivity) real sector to the (high productivity) financial sector.

The models in (2), (3) and (6) posit a supply-leading hypothesis in that financial development causes economic growth. The implication is that the creation and development of financial institutions and markets increases the supply of financial services, and therefore leads to increases in economic growth. Alternatively, a demand-following hypothesis posits the reverse causality, where increasing demand for financial services increases the financial sector as the economy expands (see, for example, Goldsmith 1969). Whether the financial development variables in (2), (3) or (6) are exogenous or endogenous is an empirical issue.

III Empirical method

A panel data set consists of n individuals (countries) over T time periods (years). Differences between countries can be examined by using fixed or random effects models and classical regression theory. Many economic time series, however, are non-stationary, and regressions between such data are generally spurious. To test for non-stationarity, a number of augmented Dickey-Fuller (ADF) unit root tests have been developed for use with panel data, and the test used here is that of Im, Pesaran and Shin (IPS) (2003), where the null is that each individual series in the panel contains a unit root and the alternative that at least one of the individual series in the panel is stationary. In particular, an ADF-equation is estimated for each individual, heterogeneous dynamics are allowed where the number of lags in each individual equation is determined parametrically using a general-to-specific sequential t-test on the last lag, which is evaluated at the 10 per cent significance level, and heterogeneous trends are admitted. The IPS-statistic, which is essentially the average of the individual ADF-statistics, is adjusted to follow an asymptotically standardized normal distribution. The test is one-sided, and an IPS-statistic in the left tail of the distribution provides evidence for rejecting the null; the critical value is –1.645. Non-rejection of the null implies that the series is I(1). If the nulls for each series are rejected, all variables are stationary and the use of classical regression theory is appropriate.

To estimate the sources-of-growth equations in (2), (3) and (6), we use both fixed and random effects models (Greene 2000: 564–65). The two-way fixed effects model, which allows for differences across both countries and time, is:

$$y_{it} = \mu + \phi_i + \varpi_t + \beta' x_{it} + u_{it} \qquad i = 1,\dots,n; \quad t = 1,\dots,T \quad (7)$$

where y_{it} is the dependent variable and x_{it} is a vector of exogenous variables for the ith country in the tth time period, β is a vector of coefficients which are constant across countries and time, and u_{it} is an error term with u_{it}~iid(0, σ^2). Differences across countries are modelled by differential constant terms, ϕ_i, which are estimated by including n–1 country-specific dummy variables in (7). Similarly, differences across time, which reflect technical change, are modelled by differential constant terms, ϖ_t, which are estimated by including T-1 time-specific dummies. The restriction that $\sum_i \phi_i = \sum_t \varpi_t = 0$ is imposed to address the problem of multicollinearity since country and time dummies both sum to unity. While (7) can be estimated by ordinary least squares (OLS), White's robust estimator (Greene 2000: 579–81) is used, which corrects for unknown heteroscedasticity.

The random effects model is:

$$y_{it} = \alpha + \beta' x_{it} + \varepsilon_{it}, \quad \varepsilon_{it} = v_i + w_t + u_{it}$$
$$i = 1,\ldots, n; \quad t = 1,\ldots,T \qquad (8)$$

where the error terms are v_i, w_t and u_{it} which have the properties of v_i~iid $(0,\sigma_v^2)$, w_t~iid $(0, \sigma_w^2)$ and u_{it}~iid $(0, \sigma_u^2)$, and there are zero covariances between components (Greene 2000: 568). Again, β is a vector of coefficients which are constant across countries and time. Differences across time and countries are modelled by differential random differences w_t, and v_i. Equation (8) is estimated using a two-step procedure: variances of the components of ε_{it} are estimated using the residuals from OLS, which are then used to estimate (8) using feasible generalized least squares.

Panel data have two important advantages over cross-section or time series datasets, which improve estimate efficiency (Matyas and Sevestre 1992: 22; Levine 2003). First, observations vary across two dimensions and multicollinearity among the explanatory variables is reduced. This contrasts with a cross-sectional regression where the country-specific effects, which are incorporated into the error term, are correlated with the explanatory variables and estimates are biased. Second, the number of observations is larger, which increases the degrees of freedom.

IV Data and results

The balanced panel was chosen to maximize the sample, and consists of annual data for 44 developing countries for 1974–2001 (World Bank 2004). Total observations number 1,232, of which 1,188 are used since calculation of growth rates require that the first observation be dropped. They consist of GDP and gross domestic investment (both in constant local currencies), total population – which proxies the total labour force, and liquid liabilities, M3, as a proportion of GDP. Financial development is specified as M3 and calculated from this latter ratio as (M3/GDP)×GDP, and is therefore measured in constant local currencies. Growth rates are calculated, as for example $GY_t = \ln(Y_t/Y_{t-l})\times 100$, where ln is the natural logarithm.

To test the order of integration of the variables, the panel unit root tests of Im *et al.* (2003), are used where each country-specific ADF-equation has a maximum of four lags and contains a trend. Table 1 shows the IPS-statistics: the null of a unit root is always rejected and all variables are stationary.

Table 1 Panel unit root tests

Variable	IPS-statistic
GY_t	–20.33
$(I/Y)_t$	–5.70
GL_t	–14.12
GF_t	–22.16
$DEPTH_t$	–4.41
$(GF.DEPTH)_t$	–22.10

Results using the fixed effects model in (7) are shown in columns [1]–[3] of Table 2, while those from the random effects model in (8) are shown in columns [4]–[6]. Robust errors are not estimated for the random effects model because the variance estimator may be negative (Greene 2000: 580–81). Since they are not the focus, estimates of country effects, ϕ_i, and time effects, ϖ_t, in (7) are not reported,

Table 2 Results

	Two-way fixed effects (7)			Two-way random effects (8)		
	[1]	[2]	[3]	[4]	[5]	[6]
Constant	–	–	–	–0.685 (1.08)	0.479 (0.54)	–0.728 (1.11)
$(I/Y)_t$	0.131 [5.30]	0.161 [5.83]	0.135 [5.05]	0.103 (7.02)	0.142 (8.50)	0.104 (6.88)
GL_t	0.685 [2.45]	0.707 [2.39]	0.688 [2.38]	0.497 (2.37)	0.383 (1.48)	0.545 (2.52)
GF_t	0.097 [6.91]	–	–	0.104 (10.70)	–	–
$DEPTH_t$	–	–0.063 [4.45]	–	–	–0.037 (3.23)	–
$(GF.DEPTH)_t$	–	–	0.002 [4.59]	–	–	0.002 (7.64)
$\hat{\sigma}^2_v$	–	–	–	0.935	2.839	1.014
$\hat{\sigma}^2_w$	–	–	–	0.887	0.992	0.951
$\hat{\sigma}^2_u$	–	–	–	18.014	19.233	18.804
R^2	0.26	0.21	0.22	0.24	0.19	0.21
$\bar{R}^2$	0.21	0.15	0.17	0.24	0.19	0.20

Notes: *GY* = GDP growth, *I/Y* = ratio of gross domestic investment to GDP, *GL* = labour growth, *GF* = growth of M3, and *DEPTH* = M3/GDP.
$\hat{\sigma}^2_v$, $\hat{\sigma}^2_w$ and $\hat{\sigma}^2_u$ are estimates of the variances of the error terms in (8).
t-statistics from robust errors in square brackets and *t*-statistics in parentheses.

as is the constant, μ, which *per se* has no economic meaning.

From the fixed effects results in [1]–[3], Wald tests (Greene 2000: 390–91) test first the nulls that the country effects are absent, that is, $\phi_i = 0$ ($i = 2,\ldots,n$), and second, the nulls that the time effects are absent, that is $\varpi_t = 0$ ($t = 2,\ldots,T$). Table 3 shows that for each model, both hypotheses are rejected, and economic growth differs between countries and over time. Next, using the random effects results in [4]–[6], the Hausman test (Greene 2000: 576–77) is used to test between the fixed and random effects models, where the null is that the country effects are uncorrelated with other regressors. Table 3 shows that all nulls are rejected and the fixed effects model in (7) is preferred, and we focus hereafter on [1]–[3].

The Cox test (Greene 2000: 303–5) is now used to test between the non-nested equations in [1]–[3], and results in Table 3 imply that statistically, we cannot distinguish between them. This conclusion is substantiated by J-tests (Greene 2000: 302–3), which are not reported. The Schwartz criterion (Greene 2000: 306) can also be used to select between non-nested models, and Table 3 shows that there is a slight preference for [1].

Next, the Wu-Hausman test (Greene 2000: 385–86) is used to test the null that the financial development variable in each of [1]–[3] is exogenous. This is done within a fixed effects framework using White's robust estimator, and the results are shown in Table 3. For [1] and [3], the nulls are not rejected, and GF_t and $(GF.DEPTH)_t$ are exogenous. However, in [2], the null that $DEPTH_t$ is exogenous is rejected, implying that simultaneity exists between GY_t and $DEPTH_t$, and the estimates are biased and inconsistent (Greene 2000: 654). Thus, two-way fixed effects results in [1]

Table 3 Hypothesis tests

H_0	Test statistic	*GF*-model (2)	*DEPTH*-model (3)	(*GF.DEPTH*)-model (6)
Country effects: $\phi_i = 0$ for $i = 2,\ldots, n$	χ^2_{43}	118.69 (0.00)	322.57 (0.00)	122.18 (0.00)
Time effects: $\varpi_t = 0$ for $t = 2,\ldots,T$	χ^2_{26}	93.33 (0.00)	188.57 (0.00)	96.71 (0.00)
Hausman test	χ^2_3	9.82 (0.02)	23.58 (0.00)	9.81 (0.02)
Cox test	q~N(0,1)	(2) against (3) –6.86 (0.00)	(3) against (2) –76.52 (0.00)	(6) against (2) –10.57 (0.00)
		(2) against (6) 2.97 (0.00)	(3) against (6) –21.80 (0.00)	(6) against (3) –5.56 (0.00)
Schwartz criterion		3.28	3.35	3.33
Wu-Hausman test	χ^2_1	1.79 (0.18)	25.38 (0.00)	0.23 (0.63)

Note: p-values in parentheses.

and [3] are preferred and, reassuringly, the estimates of their common parameters are robust to either specification. These preferred equations correspond to the two theoretically consistent sources-of-growth equations and, while not a test of causality, these results lend some support to the supply-leading hypothesis where financial development causes economic growth.

The *I*/*Y*-coefficients in [1] and [3] imply that a one percentage point increase in the *I*/*Y*-ratio leads approximately to a 0.13 percentage point increase in GDP growth. The *GL*-coefficients imply that a one percentage point increase in labour growth increases GDP growth by 0.69 percentage points, and surplus labour is absent. These estimates are similar to those of Odedokun (1996).

Turn now to consider the effect of financial development on economic growth. The *GF*-coefficient in [1] is positive and significant, and implies that a one percentage point increase in the growth of M3 leads to a 0.10 percentage point increase in GDP growth. This estimate is similar to the estimate of 0.13 of Odedokun (1996). The (*GF.DEPTH*)-coefficient in [3] is the difference between the marginal contributions to GDP of capital (and labour) in the two sectors, relative to the marginal contribution to the financial sector's output. Thus, factor productivities in the real sector are 0.002 per cent lower than those in the financial sector and, while this appears low when compared with Odedokun's (1996) estimate of 0.32, it is positive and significant.

V Conclusions

The hypothesis that financial development promotes economic growth in developing countries is largely supported by empirical studies, though contrary evidence also exists. This article re-examines the relationship using annual panel data for 1974–2001 for 44 developing countries. We examine three sources-of growth equations which are based on aggregate production functions. The first includes financial development as an additional input, and growth is determined *inter alia* by the growth of M3. The second uses a common but *ad hoc* proxy for financial development, namely the M3/GDP ratio or *DEPTH*. The third is based on a two-sector economy, where the output of the financial sector produces positive externalities in the real sector. Here, GDP growth is determined *inter alia* by a composite of financial development, namely growth of M3 interacted with *DEPTH*.

Results show that financial development promotes economic growth in both theoretically consistent sources-of-growth equations.

In contrast, the use of the proxy variable *DEPTH* indicates that it inhibits economic growth. Hypothesis tests indicate that the fixed effects estimator is preferred, but no preference can be made between the three models. However, the financial development variables in the theoretically consistent sources-of-growth equations are statistically exogenous, whereas in the *ad hoc* specification, *DEPTH* is endogenous and parameter estimates are therefore biased and inconsistent. Thus, using *DEPTH* as a proxy for financial development growth results in a poorly specified sources-of-growth equation, and conclusions should be treated with caution.

In summary, alternative measures of financial development can lead to conflicting conclusions about its empirical relationship with economic growth. The preferred results show that financial development and economic growth are positively related. There are two further insights: first, a one percentage point increase in the growth of M3 leads to a 0.10 percentage point increase in GDP growth; and second, while real-sector factor productivities are only 0.002 per cent lower than those in the financial sector, this difference is statistically significant. To conclude, policies in developing countries that promote the development of financial sectors through the growth of liquid liabilities also promote economic growth.

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Countries
Algeria, Argentina, Bangladesh, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Chile, Colombia, Congo, Costa Rica, Cote d'Ivorie, Dominican Republic, Ecuador, Egypt, Gabon, Ghana, Guatemala, Guyana, Haiti, Honduras, India, Indonesia, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mexico, Morocco, Pakistan, Paraguay, Peru, Philippines, Senegal, Sri Lanka, Swaziland, Thailand, Togo, Tunisia, Uruguay, Venezuela.

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