Non linearity between finance and growth*

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Abstract

We present a simple model which establishes a non linear and possibly non monotonic relationship between financial development and economic growth. Applying a threshold regression model to King and Levine's (1993) data set, we find evidence consistent with the theoretical model.

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1. Introduction

Various models of joint determination of real and financial structure [e.g. Acemoglu and Zilibotti (1997), Greenwood and Jovanovic (1990) and Khan (2001)] present a non linear relationship between financial and economic development. In these models, endogenously emerging financial institutions have generally a positive effect on growth whose magnitude varies positively with the level of economic development. We present a simple OLG model with risk averse agents and costly financial transactions such that, differently from the existing literature, the growth effect of financial development is ambiguous at low levels of development, while it becomes eventually positive as development proceeds.[1] Applying a threshold regression model to King and Levine's (1993) data set we find that in low income countries there is no significant relationship between financial development and growth whereas in high income countries we find that this relationship is positive and strongly significant.[2] While these findings are consistent with our model they are not entirely compatible with models which predict that financial development is associated with higher growth rates at all levels of economic development.

2. The model

Assume an OLG economy with a mass 1 of infinitely lived firms and a mass 1 of identical individuals living for two periods and endowed with a unit of labour in their first period of life. Let $U = c_{2,t}^{1-\rho}$ be the utility function, where $c_{2,t}$ is second period consumption for a member of generation t. Each young agent of generation t supplies labour to firms in their first period of life earning a salary w_t which is entirely saved. Savings take two possible forms: deposits and/or self-financing of investment (I_t) in physical capital, $K_{t+1} = I_t$,[3] to be used in production according to:

$$y_t = x(\phi) K_t^{\alpha} L_t^{1-\alpha} A_t, \tag{2.1}$$

where $x(\phi) \sim N(\phi, \sigma^2)$,[4] and $A_t = K_t/l_t$. Firms have access to a similar production technology, the only difference being in the total productivity parameter, which we assume to be $x(\psi) \sim N(\psi, \sigma^2)$, with $\psi > \phi$. If financial transactions were

[1] Also in Obstfeld (1994), Deveraux and Smith (1994) and Jappelli and Pagano(1994) financial development might have negative growth effects. Yet in these models, the growth impact does not vary with the level of economic development. Furthermore, differently from our model, their results are based on the hypothesis that financial development reduces the propensity to save.

[2] These findings are consistent with Xu (2000) who finds that the low or lower middle income countries in his sample display negative effects of financial development on GDP growth and investment, while the reverse is true for the high income countries. The results are also consistent with Demetriades and Hussein (1996) who find no cointegration between finance and growth in one third of the developing countries in their sample.

[3] We assume full capital depreciation.

[4] The assumption of normality is tenable as long as, given the mean and the variance of $x(\phi)$, the probability attached to negative realisations of $x(\phi)$ is negligible, so that $x(\phi)$ takes virtually only positive values.

feasible, agents would be able to diversify risk and savings could be channelled toward the more productive technology available to firms. Assume that financial transactions imply a fixed cost E, expressed as absorption of physical resources. Therefore, the single intermediary will guarantee a safe return on deposits[5]

$$R_t^d = \alpha\psi - E\alpha\psi/w_t, \tag{2.2}$$

where $w_t = (1-\alpha)y_t$. The certain equivalent to self-financed investment is

$$R^{c*} = \alpha\phi(1 - \rho\alpha^2\sigma^2/2) = \alpha\phi v, \tag{2.3}$$

with $v = (1 - \rho\alpha^2\sigma^2/2) < 1$. The comparison between (2.2) and (2.3) suggests that agents will be willing to save in form of deposits for $y_t \geq E\psi/[(1-\alpha)(\psi - \phi v)]$ which implies financial intermediation emerges at $y^* = E\psi/[(1-\alpha)(\psi - \phi v)]$.

Will endogenously emerging financial intermediation necessarily have an immediate growth effect? The equilibrium growth rate under financial intermediation is $g_{FI} = (1-\alpha)\psi - E\psi/y_t - 1$. We note that g_{FI} is increasing in the level of income y_t, and that, in the period of transition, y_t can be take any value between y^* and $(1-\alpha)\phi(y^* - \epsilon) \simeq (1-\alpha)\phi y^*$. For $y_t = y^* = E\psi/(1-\alpha)(\psi - \phi v)$ we have $g_{FI}|_{y_t = y^*} = (1-\alpha)\phi v - 1$. The growth rate under financial autarky is $g_{FA} = (1-\alpha)\phi - 1$. Comparison between g_{FI} and g_{FA} indicates that if financial intermediation emerges at y^* the immediate growth impact is surely negative. For $y_t = (1-\alpha)\phi y^*$ we have $g_{FI}|_{y_t = y^*(1-\alpha)\phi} = (1-\alpha)\psi - \psi/\phi + v - 1$. Comparison with g_{FA} yields:

$$g_{FI}|_{y_t = y^*(1-\alpha)\phi} \geq (<) g_{FA} \Longleftrightarrow \frac{\psi}{\phi} - v \leq (>) (1-\alpha)[\psi - \phi]. \tag{2.4}$$

It is easy to verify that there are combinations of the parameters which fulfil our assumptions and satisfy inequality (2.4) with the " $<$ " sign. Under these circumstances, financial development has initially unambiguously detrimental growth effects. On the other hand, whenever (2.4) is satisfied with the "$\geq$" sign, the immediate growth impact of financial development will be still negative as long as the level of income in the transition period is sufficiently close to y^*, and positive otherwise.

Risk averse agents might prefer to incur financial transaction costs even though the net expected return to savings they get is lower than that under financial autarky, which implies that the growth rate of the economy will also be lower than under financial autarky. This is because financial transactions enable them to achieve full risk diversification. This unpleasant result includes the possibility that the growth rate becomes negative as the economy switches to financial intermediation. This leads to the possibility of vicious circles that the economy cannot possibly escape (see figure 3.1). Alternatively, if the growth rate stays positive, the economy will approach the steady state growth rate $g_{FI}|_{y_t \to \infty} = (1-\alpha)\psi - 1$

[5] The intermediary makes zero expected profits otherwise it would be undercut by potential competitors.

which is greater than that under financial autarky. Hence, financial intermediation might ultimately bring positive growth effects. Yet, this simple model establishes a non linear, possibly non monotonic, relationship between financial development and growth such that the growth impact of financial development depends positively on the level of economic development.

3. Empirical evidence

Methodology. We use cross-country data to test the non monotonic relationship between financial depth and growth. We estimate a model similar to that of King and Levine (1993) where the real growth of per capita income is regressed on initial real income per capita, the initial secondary enrollment rate and the ratio of liquid liabilities to GDP as an indicator of financial depth. In addition to this base regression, we include the ratio of trade to GDP, the ratio of government spending to GDP, the average inflation rate, the index of civil liberties and the number of revolutions to control for other economic phenomena.[6] We use King and Levine's dataset which covers 119 countries over the period 1960-1989.[7]

The model is estimated using a threshold regression model that takes the following form:

$$y_i = \theta_1^{'} x_i + e_i \text{ for } q_i \leq \gamma \tag{3.1}$$
$$y_i = \theta_2^{'} x_i + e_i \text{ for } q_i > \gamma, \tag{3.2}$$

where q_i is the threshold variable used to split the sample into different regimes or groups; y_i is the dependent variable; x_i is an *m-vector* of regressors and e_i is the error term. This model allows the regression parameters to switch between regimes depending on the value of q_i. By defining a dummy variable $d_i(\gamma) = \{q_i \leq \gamma\}$ (where $\{.\}$ is the indicator function) and setting $x_i(\gamma) = x_i d_i(\gamma)$, we can represent equations 1-2 by a single equation:[8]

$$y_i = \theta^{'} x_i + \delta^{'} x_i(\gamma) + e_i, \tag{3.3}$$

where $\theta^{'} = \theta_2^{'}$, δ and γ are the regression parameters. The threshold model is estimated using least squares (LS). To test for the null of no threshold against the alternative of threshold, we use the heteroskedasticity-consistent Lagrange multiplier (LM) test statistic (Hansen, 1996, 2000). Since the threshold γ is not identified under the null hypothesis, the p-values are calculated by bootstrap methods. To derive the asymptotic distribution of the slope coefficients, we can proceed as if the threshold estimate were the true value. In this case, the slope parameters are shown to be asymptotically normal with a standard asymptotic covariance matrix (Hansen, 2000).

[6] See King and Levine (1993) among others for a motivation of similar empirical specifications.
[7] For a detailed description of the data set, see King and Levine (1993).
[8] See Hansen (2000) for details of the empirical methodology.

Empirical Results. Using initial income per capita as the threshold variable, we find that the p-values for the threshold models are significant at the conventional levels (Table 1). This suggests that we can split the sample into two income groups (low income and high income groups). This holds whether we use the base regression (model 1) or after controlling for the ratio of trade to GDP, the ratio of government spending to GDP and the average inflation rate (model 2), plus the index of civil liberties and the number of revolutions (model 3). The LS estimates of the threshold in the three models are quite similar ($756, $852, and $852 respectively).[9]

The regression results in Table 1 are consistent with those of Barro and Sala-i-Martin (1992) and King and Levine (1993). Specifically, we find that initially rich countries tend to grow slower after controlling for the initial level of investment in human capital; that higher initial secondary school enrollment rates are associated with faster subsequent growth and that higher levels of financial development are associated with higher growth rates.[10] However, the positive relationship between the level of financial depth and economic growth that is found in the model without threshold effects, holds only for countries with high income per capita. In countries with low income per capita, there is no significant relationship between financial depth and economic growth. This is reflected in the coefficient on financial depth which is highly significant in the second regime (the high income group), but not significant in the first regime (the low income group).[11] This evidence is consistent with the non monotonic relationship implied by our model.

We replicate the same analysis using the initial values of financial depth. The results of Table 2 clearly suggest that financial depth is a good predictor for subsequent growth. The results concerning the non monotonic relationship between initial financial depth and growth still hold, where the relationship between these two variables is significantly positive only in the high income group.[12]

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[9] We employ the LM test to verify whether we can split each of these groups into further subgroups. For the high income group, the split produces inisginifcant p-values in all specifications. For the low income group, we could not perform similar analysis due to the small number of observations.

[10] Unlike the financial depth indicator, the conditioning variables have only a fragile association with long term growth. These results are consistent with Levine and Renelt's (1992) sensitivity analysis.

[11] The only exception is model 3 where financial depth is marginally significant in the first regime.

[12] Model 3 which incorporates the index of civil liberties and number of revolutions (both insignificant) produces an insignificant p-value (0.33) for the threshold estimate and hence the results are not reported.

References

[1] Acemoglu, D. and F. Zilibotti, 1997, Was Prometeus unbound by chance? Risk, diversification and growth, Journal of Political Economy 105, 709-755.

[2] Barro, R. and X. Sala-i-Martin, 1992, Convergence, Journal of Political Economy 100, 223-251.

[3] Demetriades, P., and K. Hussein, 1996, Does financial development cause economic growth? Evidence for 16 countries, Journal of Development Economics, 51, 387-411.

[4] Deveraux, M.B., and G. W. Smith, 1994, International risk sharing and economic growth, International Economic Review 35, 535-60.

[5] Greenwood, J. and B. Jovanovic, 1990, Financial development, growth and the distribution of income, Journal of Political Economy 98, 1076-1107.

[6] Hansen, B.E, 1996, Inference when a nuisance parameter is not identified under the null hypothesis, Econometrica 64, 413-430.

[7] Hansen, B.E, 2000, Sample splitting and threshold estimation, Econometrica 68, 575-603.

[8] Jappelli, T. and M.Pagano, 1994, Saving, growth, and liquidity constraints, Quarterly Journal of Economics 109, 83-109.

[9] Khan, A., 2001, Financial development and economic growth, Macroeconomic Dynamics (Forthcoming).

[10] King, R.G. and R. Levine, 1993, Finance and growth: Schumpeter might be right, Quarterly Journal of Economics 109, 83-109.

[11] Levine, R. and D. Renelt, 1992, A sensitivity analysis of cross-country growth regressions, American Economic Review 82, 942-961.

[12] Obstfeld, M., 1994, Risk-taking, global diversification, and growth, American Economic Review 84, 1310-1329.

[13] Xu, Z., 2000, Financial development, investment, and economic growth, Economic Enquiry 38, 331-344.

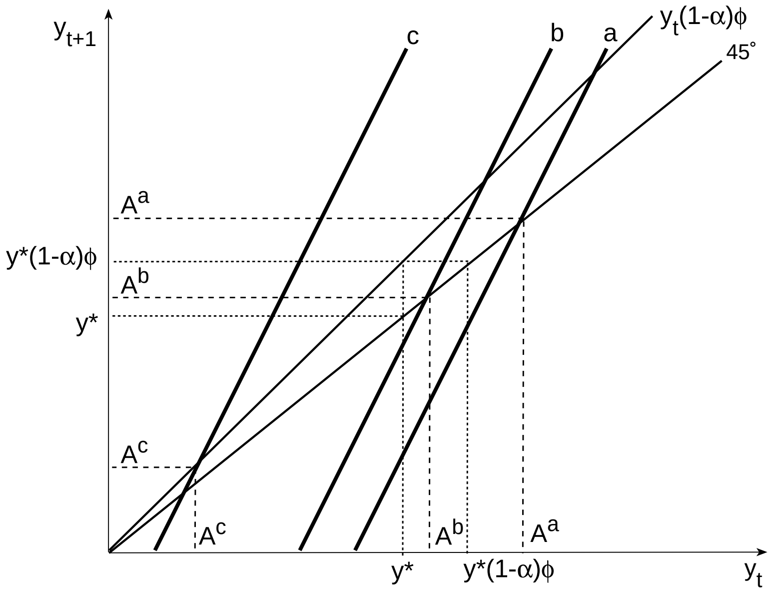

Figure 3.1: Types of dynamic paths. Case *a*: the economy suffers a poverty trap. Financial development occurs at $y_t \in [y^*, y^*(1-\alpha)\phi)$. For any of these values, the growth rate of the economy with financial intermediation is negative, so that the economy shrinks until financial autarky is restored.

Case *b:* the economy shrinks subsequently to financial development if and only if financial development occurs with the growth rate under financial development is positive such that the economy converges a steady state growth rate $y_t < A^b$. For $y_t > A^b$. the growth rate under financial development is positive such that the economy converges a steady growth rate $g^* = (1-\alpha)\psi$.

Case c: the growth rate under financial intermediation is always positive so that there are not vicious cycles.

Table 1-Growth and Financial Depth (1960-1989): Regression Results

	OLS without threshold	First Regime	Second Regime
MODEL 1			
Threshold Estimate	0.756		
LM Test for no threshold	**11.34 [*0.06*]**		
Constant	0.005 (0.002)	-0.001 (0.008)	0.012(0.002)
RGDP60	-0.004 (0.001)	-0.003 (0.011)	-0.004 (0.001)
SEC60	0.043 (0.010)	0.178 (0.053)	0.029 (0.009)
LLY	***0.035 (0.004)***	***0.025 (0.026)***	***0.031 (0.004)***
Number of observations	99	38	61
R^2	0.443	0.448	0.475
MODEL 2			
Threshold Estimate	0.852		
LM Test for no threshold	**16.79 [*0.03*]**		
Constant	0.007 (0.004)	-0.000 (0.010)	0.013 (0.004)
RGDP60	-0.004 (0.001)	-0.015 (0.009)	-0.004(0.000)
SEC60	0.044 (0.010)	0.195 (0.038)	0.028(0.008)
LLY	***0.030 (0.004)***	***0.038 (0.024)***	***0.027(0.004)***
GOV	-0.018 (0.026)	-0.132 (0.047)	-0.024(0.073)
TRAD	0.004 (0.004)	0.037 (0.009)	-0.011(0.006)
INF	-0.001 (0.001)	0.007 (0.022)	-0.003 (0.0008)
Number of observations	95	38	57
R^2	0.463	0.591	0.577
MODEL 3			
Threshold Estimate	0.852		
LM Test for no threshold	***18.12* [*0.05*]**		
Constant	0.011 (0.006)	-0.016 (0.012)	0.017 (0.006)
RGDP60	-0.004(0.001)	-0.011(0.009)	-0.004 (0.000)
SEC60	0.041(0.011)	0.205 (0.030)	0.025 (0.009)
LLY	***0.029(0.004)***	***0.047 (0.027)***	***0.026 (0.004)***
INF	-0.0008 (0.002)	0.007 (0.022)	-0.002(0.002)
GOV	-0.015 (0.026)	-0.163 (0.055)	0.029 (0.024)
TRAD	0.003 (0.004)	0.038 (0.011)	-0.003 (0.004)
CIVIL	-0.0005 (0.0009)	0.002 (0.001)	-0.000 (0.001)
NREV	-0.003 (0.007)	-0.002 (0.009)	-0.002 (0.007)
Number of observations	95	38	57
R^2	0.467	0.611	0.581

Notes:
(1) The dependent variable is real per capita GDP growth, 1960-1989. The list of explanatory variables is: RGDP60 = initial per capita GDP in 1960; SEC60=secondary school enrollment rate in 1960; LLY=ratio of liquid liabilities to GDP; GOV= ratio of government consumption to GDP; PI= the inflation rate; TRD= ratio of imports plus exports to GDP; CIVIL=Index of civil liberties; NREV=number of revolutions.
(2) Values in brackets are the bootstrap p-values for the threshold estimates. The bootstrap p-values have been calculated using 1000 replications.
(3) Standard errors (in parentheses) are White corrected for heteroskedasticity.
(4) The results correspond to trimming percentage of 15%. The results (available from the authors upon request) are robust to different trimming regions. We have used Gauss for all estimations.

Table 2-Growth and Financial Depth (1960-1989): Regression Results (Initial Values)

	OLS without Threshold	**First Regime**	**Second Regime**
MODEL 1			
Threshold Estimate	*0.690*		
LM Test for no threshold	***11.18* [*0.05*]**		
Constant	0.011 (0.002)	-0.015 (0.013)	0.014(0.002)
RGDP60	-0.006 (0.001)	0.025 (0.024)	-0.005 (0.001)
SEC60	0.050 (0.009)	0.188 (0.050)	0.038 (0.007)
LLY60	***0.035 (0.004)***	***0.019 (0.025)***	***0.034 (0.003)***
Number of observations	67	16	51
R^2	0.480	0.448	0.572
MODEL 2			
Threshold Estimate	*0.748*		
LM Test for no threshold	***14.40* [*0.08*]**		
Constant	0.009 (0.004)	-0.012 (0.022)	0.011 (0.004)
RGDP60	-0.006 (0.001)	-0.013 (0.035)	-0.005(0.0008)
SEC60	0.044 (0.011)	0.202 (0.062)	0.031(0.010)
LLY60	***0.034 (0.004)***	***0.051 (0.044)***	***0.031(0.004)***
GOV60	0.042 (0.052)	-0.0004 (0.096)	0.058(0.039)
TRAD60	-0.003 (0.005)	0.011 (0.014)	-0.012(0.008)
INF60	0.010 (0.040)	0.15 (0.12)	-0.060 (0.050)
Number of observations	61	14	47
R^2	0.498	0.725	0.603

Notes:

(1) The dependent variable is real per capita GDP growth, 1960-1989. RGDP60 = initial per capita GDP in 1960; SEC=secondary school enrollment rate in 1960; LLY60=ratio of liquid liabilities to GDP in 1960; GOV60= ratio of government consumption to GDP in 1960; PI60= the inflation rate in 1960; TRD60= ratio of imports plus exports to GDP in 1960.

(2) Values in brackets are the bootstrap p-values for the threshold estimates. The bootstrap p-values have been calculated using 1000 replications.

(3) Standard errors (in parentheses) are White corrected for heteroskedasticity.

(4) The results correspond to trimming percentage of 15%. The results (available from the authors upon request) are robust to different trimming regions. We have used Gauss for all estimations.