# 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 that is consistent with the main implications stemming from the theoretical model.

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## 1. Introduction

Various models of joint determination of real and financial structure like, for instance, 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

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level of economic development. We present a simple OLG model with risk averse agents and costly financial transactions such that the impact of financial development on growth is, similarly to the existing literature, positively related to the level of economic development. However, differently from the existing literature, in this model, 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 evidence that is consistent with the hypothesis implied by our model. Specifically, 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.

The paper is organized as follows. Section 2 describes the theoretical model while section 3 presents the empirical methodology and the results. Section 4 concludes.

## 2. The model[3]

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

[1] Obstfeld (1994), Deveraux and Smith (1994) and Jappelli and Pagano(1994) also present theoretical models in which financial development might have negative growth effects as long as it affects adversely the propensity to save. Yet in these models, the growth impact does not vary with the level of economic development. Furthermore, their results are based on the idea that the substitution effect dominates the income effect induced by changes in the return to savings associated with financial development, while in our model the ambiguity of the growth impact of financial development relies on the absorption of economic resources by the financial sector and does not hinge on any particular assumption regarding the sensitivity of the propensity to save with respect to the rate of return.

[2] These findings are also consistent with Xu (2000) who finds that countries concentrated in the low or lower middle income group in his sample display negative cumulative effects of financial development on the growth of GDP and investment, while the reverse is true for the countries concentrated in the higher income group of the sample. The results are also consistent with those of Demetriades and Hussein (1996) who fail to find cointegration between finance and growth in one third of the developing countries in their sample.

[3] The model we present is based on Deidda (2001).

period consumption for a member of generation $t$. Accordingly, each young agent of generation $t$ supplies inelastically 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 related to accumulation of physical capital $K_{t+1} = I_t$,[4] to be used in production according to the production function

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

where $x(\phi) \sim iid(\phi, \sigma^2)$, 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 $x(\psi) \sim iid(\psi, \sigma^2)$, with $\psi > \phi$. If financial transactions were feasible, agents would be able to diversify risk and moreover 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, which in equilibrium operates at zero profits, will be able to guarantee a safe return on deposits equal to[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 $v = (1 - \rho\alpha^2\sigma^2/2) < 1$. As long as the higher moments of $x(\phi)$ are negligible compared to $\sigma^2$, the utility derived from the uncertain return to self-financing is approximately equal to that derived by the certain equivalent return $R^{c^*}$.[6] Under this hypothesis then, the comparison between (2.2) and (2.3), then suggests that

[4] We assume full capital depreciation.

[5] The intermediary makes zero expected profits otherwise it would be undercut by potential competitors. We also note that, in equilibrium, the expected return on loans is, ex ante, equal to the expected marginal productivity of capital, so that firms, which are risk neutral, make zero expected profits. Finally, since productivity is an independently and identically distributed random variable across firms, the bank is able to fully diversify risk so that the ex-post return is equal to its expected value ex ante.

[6] Note that in the special case in which $x(\phi)$ is normally distributed the expected utility derived from the uncertain return is exactly equal to that associated to its certain equivalent. 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. Finally we note that the use of the certain equivalent would be always legitimate if we were to assume a quadratic utility function. We adopted a CRRA utility specification to simplify the exposition of the key results of the model.

agents will be willing to save in form of deposits for $y_t \ \& \ E\psi/[(1-\alpha)(\psi-\phi v)]$ which implies financial intermediation emerges at $y^* \approx E\psi/[(1-\alpha)(\psi-\phi v)]$.[7]

Will endogenously emerging financial intermediation necessarily have an immediate growth effect? The equilibrium growth rate under financial intermediation is $g_{FI} = (1-\alpha)\psi - E\psi/y_t - 1$. 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 the two growth rates indicates that if financial intermediation emerges at $y^*$ the immediate growth rate is surely negative. Of course the level of income in the period of transition from financial autarky to financial intermediation might well be higher than $y^*$. In particular it can be any level between $y^*$ and $(1-\alpha)\phi(y^*-\epsilon) \simeq (1-\alpha)\phi y^*$. For $y_t = (1-\alpha)\phi y^*$ the growth rate of the economy under financial intermediation is

$$g_{FI}|_{y_t=y^*(1-\alpha)\phi} = (1-\alpha)\psi - \frac{\psi}{\phi} + v - 1.$$

Comparison with the growth rate under financial autarky yields:

$$g_{FI}|_{y_t=y^*(1-\alpha)\phi} > (\leq) g_{FA} \tag{2.4}$$
$$\Leftrightarrow$$
$$+\frac{\psi}{\phi} - v > (\leq)(1-\alpha)[\psi-\phi]. \tag{2.5}$$

It is easy to verify that there are combinations of the various parameters which fulfil our assumptions and satisfy inequality (2.5) with the " $<$ " sign. In simple words, financial development might initially have unambiguously detrimental growth effects. More generally, even if (2.5) is satisfied with the "$>$" sign, as long as the level of income in the transition period is sufficiently close to $y^*$ the immediate growth impact of financial development could be still negative or equal to zero. The intuition for this result is that 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 diversify risk, and since they are risk averse

[7] For $y_t \approx y^*$, agents are actually indifferent between self-financing their investment activity and deposits to the extent that $R^{c*} \approx R^d_t$. According to standard principles we assume that under these circumstances, they choose deposits.

they might prefer a lower but safe return to the uncertain return associated with self-financed investments. 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, such that the economy switches to financial intermediation as it reaches $y^*$ and then experiences negative growth such that the level of income falls below $y^*$ so that financial autarky is restored (see figure 4.1, page 10 for an exposition of the various possibly dynamic paths of the model economy). Alternatively, if we assume that the growth rate stays positive, the economy will approach a steady state growth rate $g_{FI}|_{y_t \to \infty} = (1 - \alpha)\psi - 1$. This growth rate is surely 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. In low income countries the impact of financial development tends to be comparatively lower than in high income economies. Moreover, in low income economies the growth impact of financial development can be negligible or even negative.

## 3. Empirical evidence

**Methodology.** We use cross-country regressions 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.[8] We use King and Levine's dataset which covers 119 countries over the period 1960-1989.[9]

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

[8] See King and Levine (1993), Levine and Zervos (1998) among others for a motivation of similar empirical specifications.

[9] For a detailed description of the data set, see King and Levine (1993).

$$y_i = \theta_1' x_i + e_i \text{ for } q_i \leq \gamma \quad (3.1)$$

$$y_i = \theta_2' x_i + e_i \text{ for } q_i > \gamma, \quad (3.2)$$

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:[10]

$$y_i = \theta' x_i + \delta' x_i(\gamma) + e_i, \quad (3.3)$$

where $\theta' = \theta_2'$ , $\delta$ and $\gamma$ are the regression parameters. The threshold model is estimated using least squares (LS). The LS point estimators $\hat{\gamma}$, $\hat{\theta}$, and $\hat{\delta}$ are those that minimize the residual sum of squares. 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 $\gamma$ is not identified under the null hypothesis, the p-values are calculated by bootstrap methods.[11] We use the bootstrap analog suggested by Hansen (1996, 2000) which produces asymptotically correct p-values for the threshold estimate. 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 (Chan, 1993; Hansen, 2000).

**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

[10] See Hansen (2000) for details of the empirical methodology.

[11] The asymptotic distribution of the threshold estimate, under the assumption of stationary data, has also been investigated by Davies (1987), Chan (1991), and Andrews and Ploberger (1994).

LS estimates of the threshold in the three models are quite similar (\$756, \$852, and \$852 respectively).[12]

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.[13] 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).[14] This evidence is consistent with the non monotonic relationship implied by our model.

In Table 2, we replicate the same analysis using the initial values of financial depth to investigate whether the predetermined component of financial depth is associated with subsequent growth. 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 financial depth and growth also hold when we use initial values: in the low income group, there is no significant relationship between initial financial depth and subsequent growth whereas in the high income group, this relationship is positive and highly significant.[15]

[12] We employ the LM test on each of the two income groups to test whether we can split each of these groups into further sub-groups. 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.

[13] 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. For completeness, we report the regression results for all three models though in the discussion of the empirical results, we focus only on the base regression model.

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

[15] 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 for this model are not reported in Table 2.

## 4. Conclusion

In this paper, we present a simple model which establishes the possibility of a non monotonic relationship between economic growth and financial development. Applying a threshold regression model to King and Levine's (1993) data set we find evidence consistent with the hypothesis implied by our model.

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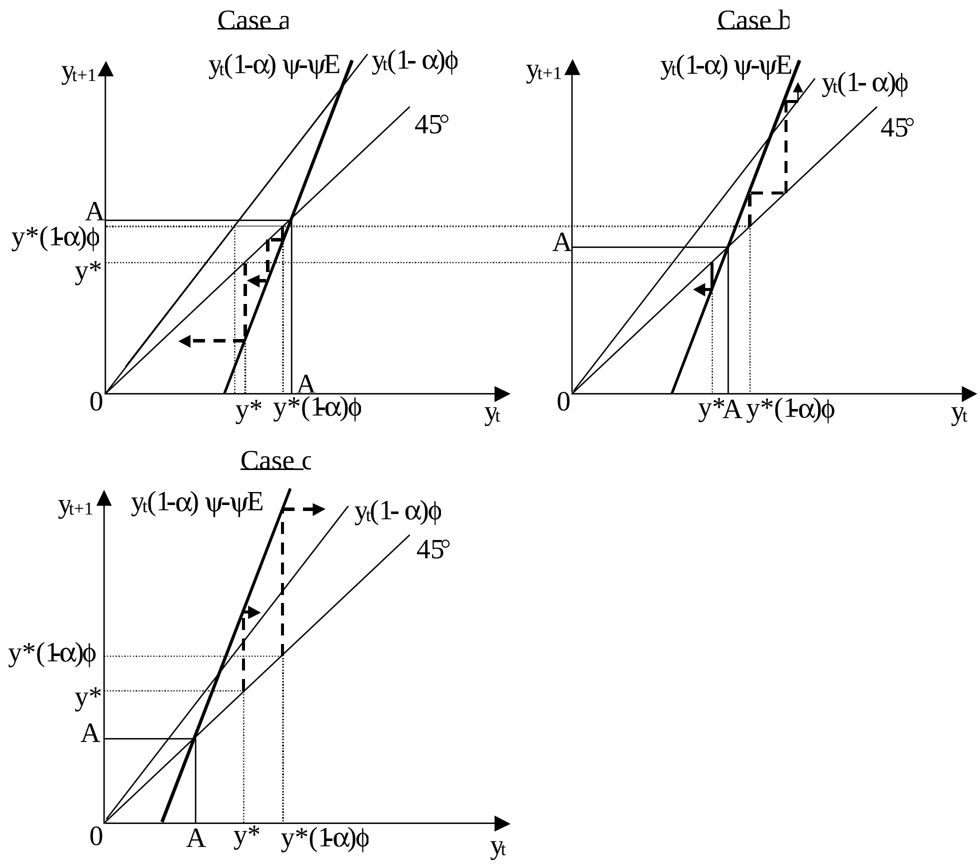


Figure 4.1: The graphs show three of the possible dynamic patterns of the economy. In case $a$ the economy suffers a poverty trap. Financial development occurs at $y_t \in [y^*, y^*(1-\alpha)\phi)$. For any of these values, the growth rate of the economy with financial intermediation is negative, so that as financial development occurs the economy shrinks until financial autarky is restored. In case $b$ the economy shrinks subsequently to financial development if and only if financial development occurs at $y_t$ lower than point $A$. Otherwise, i.e. for values of $y_t$ sufficiently close to $y^*(1-\alpha)\phi)$, the growth rate under financial development is positive so that the economy converges to a self-sustainable growth path characterized by a steady state growth rate $g^* = (1-\alpha)\psi$. In case $c$ the growth rate under financial intermediation is always positive so that the economy never experience vicious cycles. Moreover, we note that differently from the other two situation depicted above, the growth rate under financial development is always greater than that under financial autarky.

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.

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