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Access to Finance Thresholds and the Finance-Growth Nexus*

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Based on Aghion *et al.* (2005), this article provides new insights regarding whether financial development can affect economic growth non-linearly by adopting the concept of threshold effects. The empirical approach adopted in this article allows for the finance-growth relationship to be piecewise linear with a set of indicators including access to finance acting as a regime-switching trigger. Using cross-country observations from 144 countries stretching from 1985 to 2009, strong evidence of threshold effects in finance-growth link is found. It is suggested that financial development in general, and access to finance in particular, is among the important forces contributing to cross-country (non)-convergences in growth rates.

Keywords: Financial development, Access to finance, Economic growth, Threshold regression.

1. Introduction

Over the last few decades, there have been countless studies undertaken trying to better understand the link between finance and growth. According to Lucas (1988), financial development is an "*overstressed determinant of economic growth*". While Miller (1998) argues "*that financial markets contribute to economic growth is a proposition too obvious for serious discussion*". To the adherents to the Miller's point of view, the more plausible question should not be if, but how financial development can affect economic growth.

The clear-cut nature of the relationship is as yet to be understood thoroughly. Relatively recent theoretical work suggests there may be pronounced discontinuities and non-linearities in this relationship. Greenwood and Jovanovic (1990) and Acemoglu and Zilibotti (1997) have established that endogenously emerging financial institutions generally affect positively growth, with a magnitude depending on the level of economic development. Deidda and Fattouh (2002) and Rioja and Valev (2004a) show that, while being strongly positive at high levels of *per capita* income, the relationship between financial development and economic growth is generally weak or insignificant at low levels of *per capita* incomes. Further, Rioja and Valev (2004b) find that financial development exerts a strong positive effect on economic growth, but only when it has reached a certain size threshold. Below this threshold, this effect would at best be uncertain.

More recently, Huang *et al.* (2010) have investigated whether the finance–growth relationship differs in conjunction with inflation rates. Specifically, the authors intended to explore whether there

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exists an inflation threshold in the finance–growth nexus. They found strong evidence of a non-linear inflation threshold in the relationship, below which financial development exerts a significantly positive effect on economic growth; and above which, the growth effect of finance appears to be insignificant. This finding adds yet one-more exemplification of how financial development could influence growth non-linearly.

In this article, new insights regarding whether and how financial development can affect economic growth non-linearly are provided, by embracing the concept of threshold effects. The empirical investigation is based on the Schumpeterian endogenous growth model of Aghion *et al.* (2005)(AHM). This investigation reproduces explicitly the innovation channel of finance, and covers the effect of financial development on convergence. According to this model, the better functioning are the financial markets, the higher is the probability that a high-quality technological innovation acquires the necessary finance to realize its potential for growth. However, financial development helps reach the productivity frontier but has limited or no growth effect in countries that are close or at the frontier. Thus, the model provides a relatively sophisticated theoretical justification to the non-linearity of the finance-growth relationship. Moreover, as Aghion and Howitt (2006) rightly note, "*the Schumpeterian* [approach] *holds the best promise of delivering a systematic, integrated, and yet operational framework for analysing and developing context-dependent growth policies…"*, by pointing at key economic variables such as the country's degree of financial development.

Nonetheless, AHM provide an ad hoc empirical support for the non-linear role of financial development using a cross section of 70 countries and splitting the sample into different groups according to an exogenously fixed level of financial intermediation. Although the exogenously imposed data splits allow for straightforward specification testing, they would not allow for addressing the problem of identifying economies with common laws of motion.

Based on cross-country observations from 144 countries over the average period 1985–2009, this article contributes to the existing literature by testing the mechanism through which financial development enhances growth put forward by AHM. Following the approach developed by Hansen (2000) and Caner and Hansen (2004), we search endogenously for multiple regimes in the data while avoiding the endogeneity problem. The specification in this paper allows the relationship between growth and finance to be piecewise linear, with an indicator of access to finance acting as a regime-switching trigger. Besides, using recent statistics on access to finance, namely the number of commercial bank branches per 100,000 adults, as a threshold variable, the paper responds to a rising concern pointed by Demirgüç-Kunt *et al.* (2008) and Kendall *et al.* (2010) regarding the relatively little empirical evidence linking access to finance to development outcomes.

The rest of the article is structured as follows. Section 2 presents the AHM model. Section 3 introduces the adopted specification and econometric methods. Section 4 then analyses and discusses the empirical results. The final section provides some concluding remarks.

2. The AHM Schumpeterian Growth Model

The AHM model fits arguably under what is commonly referred to as the Schumpeterian growth theory, because it focuses on quality improving and innovations that render old products obsolete, and hence involves the force that Schumpeter calls creative destruction. In this type of model, the investment side is put at the core of the growth process and the introduction of innovations is assumed to be an important engine of the contemplated process. The financial development is supposed to fuel this engine by allocating scarce resources towards more innovative entrepreneurs. After presenting a summary of the AHM endogenous growth model, this section discusses their empirical results showing the importance of financial development in the convergence process.

The model delves into the hypothesis that financial constraints prevent poor countries from taking full advantage of technology transfer, which is what causes some of them to diverge from the growth rate of the world frontier. It introduces credit constraints into a multi-country version of growth theory with technology transfer, and shows that the model implies a form of convergence "club"; that is, all rich and most middle-income countries seem to belong to one group (convergence club) with the same long-run growth rate, whereas all other countries seem to have diverse long-run growth rates,

all strictly less than that of the convergence club. In the theory, countries above some threshold level of financial development will all converge to the same long-run growth rate, but not generally to the same level of *per capita* GDP.

There are three key components to the AHM theoretical framework:

1 The first key component is in relation to the recognition that technology transfer is costly. The receiving country cannot just take foreign technologies off the shelf and implement them costlessly. In reality, any receiving country must make some technology investments of its own as a prelude to mastering foreign technologies and adapting them to the local environment, because technological knowledge is often tacit and circumstantially specific. The model assigns to R&D the role of determining a country's "absorptive capacity".

2 The second key component is the assumption that as the global technology frontier advances, the size of required investment so as to keep innovating at the same pace as before, must be rising in proportion. This assumption recognizes the force of increasing complexity, which renders technologies more and more difficult to master and to adapt to local circumstances.

3 The third key component is an agency problem that limits an innovator's access to external finance. Specifically it is assumed that an innovator can defraud his creditors by hiding the end results of a successful innovation, at a cost that depends positively on the level of financial development. For this reason, in equilibrium the innovator's access to external finance would be limited to some multiple of the own wage income. The lower the level of financial development in the country, the lower the (private) cost of fraud will be, (and therefore, the lower the credit multiplier and the larger the associated disadvantage of backwardness). Accordingly, the likelihood that a country will converge to the frontier growth rate is an increasing function of its level of financial development.

Based on these components, a country's technological gap in existence of credit constraints evolves according to the following:

$$a_{t+1} = \tilde{\mu}(\omega a_t) + \frac{1 - \tilde{\mu}(\omega a_t)}{1 + \mathrm{g}} a_t, \tag{1}$$

where a_t is country's normalized productivity with respect to technological frontier at time t, g denotes growth of technological frontier and $\tilde{\mu}(\omega a_t)$ is innovation probability where ω accounts for financial development. In the model of AHM, $\tilde{\mu}(\omega a_t)$ depends only on financial development and the country's normalized productivity with respect to technological frontier. This fact is reflected in their adopted growth regression outlined below.

There are three key implications of the AHM theoretical framework under consideration. These are given in the following:

1 The likelihood that a country will converge to the frontier growth rate increases with its level of financial development.

2 In a country that converges to the frontier growth rate, financial development has a positive effect, although eventually vanishing, on the steady-state level of *per capita* GDP relative to the frontier.

3 The steady-state growth rate of a country that fails to converge to the frontier growth rate increases together with its level of financial development.

Moreover, as the authors point-out, their model implies a somewhat stronger version of 1–3. That is,

4 the effect of financial development on steady-state growth should be positive, up to some critical level F_{g}, and zero thereafter. Also, the effect of financial development on the steady-state level of per capita GDP should be positive, up to some critical level F_{y}, and zero thereafter, with $F_{\mathrm{g}} < F_{\mathrm{y}}$.

The empirical methodology adopted to test the AHM model's main implications is based on the following growth regression:

$$g_{\mathrm{i}} - g_{\mathrm{US}} = \beta_0 + \beta_F F_{\mathrm{i}} + \beta_y (y_{\mathrm{i}} - y_{\mathrm{US}}) + \beta_{\mathrm{Fy}} F_{\mathrm{i}} (y_{\mathrm{i}} - y_{\mathrm{US}}) + \beta_X X_{\mathrm{i}} + \varepsilon_{\mathrm{i}}, \tag{2}$$

where $g_{\mathrm{i}} - g_{\mathrm{US}}$ is the average growth rate of per capita real GDP in country i relative to that in the United States (the technology leader), F_{i} the country's average level of financial

development, $y_i - y_{US}$ the initial log of per capita real GDP relative to that in the United States, X_i a set of other independent variables and ε_i is a random disturbance term with a zero mean.

Under the assumption that $\beta_y + \beta_{Fy}F_i \neq 0$, Equation (2) could be rewritten as follows:

$$g_i - g_{US} = \lambda_i(\hat{y}_i - \hat{y}_i^*), \tag{3}$$

where $\hat{y}_i \equiv y_i - y_{US}$ represents the country *i*'s initial relative *per capita* GDP, the steady-state value $\hat{y}_i^*$ is defined by setting the right-hand side of (2) to zero and λ_i is a country-specific convergence parameter that depends on the level of financial development:

$$\lambda_i = \beta_y + \beta_{Fy}F_i \tag{4}$$

The first main implication of the AHM theoretical model is that the likelihood that a country will converge to the frontier growth rate increases with its level of financial development. Specifically, a country *i* can converge to the frontier growth rate if and only if the growth rate of its relative *per capita* GDP depends negatively on the initial value $\hat{y}_i$; that is, if and only if the convergence parameter λ_i is negative. Accordingly, the likelihood of convergence will increase with financial development if and only if $\beta_{Fy} < 0$.

The second important implication of the model is that in a country that converges to the frontier growth rate, ceteris paribus, financial development has a positive effect, although eventually vanishing, on the steady-state level of per capita GDP relative to the frontier.

The empirical analysis undertaken by the authors uses cross-sectional data from 71 countries over the period 1960–1995, taken from Levine *et al.* (2000). It indicates that the interaction coefficient β_{Fy} is indeed significantly negative for different measures of financial development, and for a range variety of different conditioning sets *X*. The estimation is by instrumental variables, using a country's legal origins, and its legal origins interacted with the initial GDP gap as instruments for F_i and $F_i(y_i - y_{US})$.

AHM adopts a simple way to test the implications 1–3 by splitting the sample into different groups according to their level of financial intermediation, before estimating the following cross-country growth equation without the interaction variable $F_i(y_i - y_{US})$:

$$g_i - g_{US} = \beta_0 + \beta_F F_i + \beta_y(y_i - y_{US}) + \beta_x X_i + \varepsilon_i \tag{2'}$$

As an alternative to the split-sample regressions, which quickly run into serious small sample problems, the authors elect to perform most of their tests using the interaction analysis based on Equation (2).

One problem that the empirical literature on finance and growth has been dealing with is in relation to how to model non-linearities and/or heterogeneity in growth analyses. Typically, what has been carried-out in AHM is to treat this issue in an ad hoc way splitting the sample into different groups according to an exogenously fixed level of financial intermediation or by including interaction terms as in (2). Although the exogenously imposed data splits enable straightforward specification testing, they would not allow for addressing the identification problem of economies with common laws of motion. Moreover, there is no appropriate theoretical or statistical justification for including only an interaction term between F_i and the initial GDP gap, and not the square of F_i or even both in the model. So, the sensible question is why not also include an interaction term between the other exogenous variables? Growth models typically do not provide much guidance as to the exact specification in which growth determinants should also enter the growth equation.

However, while there is little consensus over the exact nature of non-linearities and heterogeneity in the growth literature, there is still a growing consensus that, given that such non-linearities may exist, they could possibly be modelled suitably using empirical tools that emphasize pattern recognition, as rightly stressed by Durlauf (2003). Classification and regression tree (Durlauf and Johnson (1995), Tan (2005)) and threshold regression methods (Hansen (2000), Masanjala and Papageorgiou (2004)) are key constituents of such tools.

3. Threshold Specification of AHM Model

Hansen (2000) develops a statistical theory of threshold estimation in the regression context that allows for cross-sectional observations. Least squares estimation is considered along with developing an asymptotic distribution theory for the regression estimates. The main advantage of Hansen's methodology over the non-parametric regression tree approach is that it is based on an asymptotic distribution theory which can formally test the statistical significance of regimes picked by the data.

In this article, the AHM framework is adopted. Hansen (2000) and Caner and Hansen (2004) are followed to search for multiple regimes endogenously in the data, while avoiding the endogeneity problem.

The pure cross-sectional analysis uses data averaged over the whole period 1985–2009, which produces one observation per country. The basic regression to be estimated is (2)' as specified above:

To allow for non-linearity in the relationship, Equation (2)' is extended into a piecewise-linear two-regime threshold regression model. Formally, the relationship between financial development, economic growth gap and other regressors in a cross section of countries could be encapsulated in the following form:

$$g_{\mathrm{i}} - g_{\mathrm{US}} = \beta_0 + (\beta_F F_{\mathrm{i}} + \beta_y (y_{\mathrm{i}} - y_{\mathrm{US}}) + \beta_X X_{\mathrm{i}}) 1_{\{T_{\mathrm{i}} \le f\}} + (\alpha_F F_{\mathrm{i}} + \alpha_y (y_{\mathrm{i}} - y_{\mathrm{US}}) + \alpha_x X_{\mathrm{i}}) 1_{\{T_{\mathrm{i}} > f\}} + \varepsilon_{\mathrm{i}}, \quad (5)$$

where $1_{\{.\}}$ is the indicator function which takes the value 1 if the argument in parenthesis is valid and 0 otherwise, T_{i} is the threshold variable and f the threshold parameter. The ensuing specification is piecewise-linear, with the unknown threshold parameter f to be estimated. Specification (5) permits the regression parameters to switch between regimes depending on whether $\mathrm{T_i}$ is smaller or larger than the (unknown) threshold value f. The error term is assumed to follow a martingale difference sequence.[1]

Econometrically speaking, the estimation of Equation (5) is complicated by the fact that financial development is an endogenous variable, and the error term is correlated with the financial development variable F_{i}. Therefore, threshold frameworks developed for the estimation of models with exogenous regressors, such as that proposed by Hansen (2000), cannot be used. Instead, the procedure developed by Caner and Hansen (2004) is more suitable. This procedure allows for the right-hand side variables, in this case financial development, to be endogenous.

The reduced form equation for financial development is the conditional expectation of F_{i}, given the vector of covariates Z_{i}:

$$F_{\mathrm{i}} = h(z_{\mathrm{i}}, \pi) + u_{\mathrm{i}}, \quad (6)$$

where π is an unknown parameter vector, h is a (linear) function and u_{i} is a random error. The vector Z_{i} comprises the selected instrumental variables, which are not built-in in the growth regression, along with other exogenous variables and the imposed condition $\mathrm{E} = (u_{\mathrm{i}}/z_{\mathrm{i}}) = 0$. This equation can be substituted into (5) to yield the following:

$$g_{\mathrm{i}} - g_{\mathrm{US}} = \beta_0 + (\beta_F h(z_{\mathrm{i}}, \pi) + \beta_y (y_{\mathrm{i}} - y_{\mathrm{US}}) + \beta_X X_{\mathrm{i}}) 1_{\{T_{\mathrm{i}} \le f\}} + (\alpha_F h(z_{\mathrm{i}}, \pi) + \alpha_y (y_{\mathrm{i}} - y_{\mathrm{US}}) + \alpha_x X_{\mathrm{i}}) 1_{\{T_{\mathrm{i}} > f\}} + v_{\mathrm{i}}, \quad (7)$$

where

$$v_{\mathrm{i}} = \beta_F u_{\mathrm{i}} 1_{\{T_{\mathrm{i}} \le f\}} + \alpha_F u_{\mathrm{i}} 1_{\{T_{\mathrm{i}} > f\}} + e_{\mathrm{i}} \quad (8)$$

Following Caner and Hansen (2004), the parameters of (7) can be estimated sequentially. First, Least Squares are used to estimate the parameter vector π from the reduced form (6). Second, the threshold f is chosen to minimize the sum of squared residuals from a sequence of regressions of growth gap on the predicted value of financial development from the first stage. Third, the regime specific slope parameters are estimated by the Generalized Method of Moments (GMM) on the split

[1]This assumption is required because simple orthogonality assumptions are insufficient to identify non-linear models.

sample implied by the estimate of *f*. Caner and Hansen (2004) also propose a supremum Wald statistic to test for the existence of a threshold effect and suggest using bootstrap approaches to obtain the correct (asymptotic) p-value.

In estimating the relationship between financial development and long-run growth on cross-country data, robustness becomes a real concern. To deal with this, Equation (7) is estimated using four alternative measures of financial development/intermediation including the preferred measure by Levine *et al.* (2000), that is, the value of credits by financial intermediaries to the private sector as a ratio of GDP. The three other alternative measures are the ratio of broad money supply (M2) to GDP (degree of monetization in the economy), domestic credit provided by the banking sector to GDP (degree of dependence on the banking sector for financing) and stock market capitalization to GDP (a measure of the importance of the equity market).

While the theory focuses on the importance of financial inclusion, Demirgüç-Kunt *et al.* (2008) note that relatively little empirical evidence links access to finance to development outcomes.[2] The limited availability of detailed surveys about household usage of financial services has slowed the accumulation of such evidence (Kendall *et al.*, 2010). Based on relatively recent statistics on the use of financial services in around 140 economies, the same authors point that synthetic headline indicators from surveys and aggregate data show that access to finance is positively, but not very closely, correlated with the levels of economic development and financial deepening. Similarly, cross-country indicators of access to finance, for the 144 countries under consideration in this paper, show a positive, but imperfect, correlation with indicators of financial deepening, such as credit to the private sector divided by GDP or broad money supply to GDP. This correlation shows that access to finance is most probably an important dimension. The positive but imperfect correlations of financial access with economic development and financial deepening raise questions regarding the drivers of cross-country differences in terms of both financial uses and accesses. Consequently, an indicator of access to finance, specifically the demographic branch penetration, namely the number of bank branches per 100,000 adults in 2009, is defined as a regime change trigger T_i. The selection of this accessibility to finance proxy, among others, is dictated by country data availability over the time period under consideration.

4. Empirical Results

The empirical analysis is based on cross-sectional data from 144 countries over the average period 1985–2009, compiled from World Development Indicators and IMF data sets.[3] The article does not pursue a panel data approach because, as emphasized by AHM, financial development is generally measured imperfectly. Hauk and Wacziarg (2009) performed Monte Carlo simulations to evaluate econometric methods commonly used to estimate growth regressions. They found that the estimated convergence speed from cross-sectional regressions is closer to the correct speed of convergence, while all panel data estimators tend to overestimate such speed and underestimate the impact of several common determinants of the steady-state level of income. The efficiency gains trade-off between cross-sectional and panel estimators falls on the side of cross-sectional estimators. This may explain why Benhabib and Spiegel (1997, 2000) found no significant interaction between initial GDP and financial development as they use panel data from 92 countries from 1960 to 1985.

In accordance with standard practice in the finance growth literature, the regression analysis in this article includes standard controlling variables, such as trade openness (Rajan and

[2]Access to finance refers to the possibility that individuals or firms can access financial services, including credit, deposit, payment, insurance and other risk management services. The access concept should be distinguished from the actual use of financial services, because non-use of finance can be voluntary or involuntary. Voluntary non-users of financial services have access to, but do not use, financial services either because they have no need for those services, or because they decide not to make use of such services for cultural, religious or other considerations.

[3]Countries listed on Appendix A.

Zingales (2003) and Yanikkaya (2003)), government size (Ram (1986), Landau (1983) and Demetriades and Rousseau (2010)), secondary enrolment rates (Barro (1991)), inflation (Bruno and Easterly (1998), Huybens and Smith (1999), Huang *et al.* (2010)) and investment rates (Ghani (1992)).

Tables 1 and 2 provide some details about the data, and present key relevant summary statistics.

Table 2 shows that the value of the dependant variable varies from −5.14 to 11.35, which means that convergence forces prevail in some countries and divergence forces prevail in other countries. Independent variables appear to be more volatile especially the four finance

Table 1. *Data Description*

Variable	Description
	Dependent Variable
$g_i - g_{US}$	the difference between the GDP *per capita* average growth rate over 1985–2009 of the country i and the United States
	Explanatory Variables
log (F_i/100)	log of the average level of financial depth measured consecutively by M2 over GDP, Domestic credit provided by banking sector over GDP, Domestic credit to private sector over GDP and Market capitalization over GDP
$y_i - y_{US}$	the difference between the log GDP *per capita* 1985 of the country *i* and the United States
log (n_i + 0.05)	log of the average growth rate of population + 0.05 which reflects the advancement of knowledge following Mankiw *et al.* (1992) and corresponds to g+d
log (Inv./100)	log of the average investment to GDP ratio
log(Gov/GDP)	log of the average government expenditure over GDP
log (School/100)	log of the average secondary school rate
log (Trade/100)	log of the average trade openness as measured by exports + imports over GDP
Inflation	the average annual growth rate of CPI
T_i	threshold variable is the number of banking branches per 100,000 adults in 2009

Table 2. *Summary of statistics*

Variable	Mean	Median	SD	Min	Max	Obs.
g_i	1.95	1.88	1.95	−3.5	12.99	144
$g_i - g_{US}$	0.31	0.24	1.95	−5.14	11.35	144
$y_i - y_{US}$	−1.12	−1.10	0.64	−2.33	0.08	144
M2 (%GDP)	58.31	70.0	39.55	14.03	150.0	144
Domestic credit (%GDP)	59.23	44.75	45.75	6.26	284.08	142
Domestic credit to private sector (% GDP)	45.26	31.51	38.31	2.09	192.36	142
Market Cap. (% GDP)	42.5	26.54	48.95	0.07	332.44	107
n_i	1.51	1.54	1.21	−0.65	6.76	144
Inv./GDP	23.19	21.4	7.1	13.35	41.28	144
School	75.36	85.51	22.06	32.04	98.0	144
Gov/GDP	16.04	16.09	5.46	4.75	36.09	144
Trade openness	83.78	73.49	46.64	20.42	356.9	144
Inflation (%)	57.11	8.6	180.24	0.6	1460.15	144
T_i	17.43	12.07	19.05	0.34	154	144

development indicators in addition to inflation, trade openness and school rate. For instance, domestic credit and market capitalization vary from 6.26 to 284.08 and from 0.07 to 332.44% of GDP, respectively, revealing a large dissimilarity in financing depth between countries regarding banking systems or equity markets, probably heavily affecting growth. Besides, investment and government expenditures vary in a wide interval ranging from 13.35 to 41.28 and 4.75 to 36.09% of GDP respectively. Likewise, the threshold variable, the number of bank branches per 100,000 adults, is shown to vary from only 0.34 to 154, which suggests that inadequacies in access to finance in some countries may be one of the key obstacles to achieve better linkage between finance development and growth.

Tables 3–6 report the estimates using the threshold estimation technique performed using a code written by Caner and Hansen (2004) for Matlab. Each table reports as a benchmark the estimated model on the whole sample of countries without taking the possibility of thresholds into account (whole sample), and the regime specific estimates (the first regime versus the second regime) of the impact of financial development and other regressors on the gap in economic growth. Following Aghion *et al.* (2005), the variable capturing legal origins (L) is used as instrument for F. This instrument, whose primary impact on the growth process, works through the laws and institutions that determine the extent of creditor rights in a given country.

Legal origins (L) is a set of three zero-one variables, also used by Levine *et al.* (2000), indicating whether the country's legal system is based on French, English or German traditions (the omitted case is Scandinavian). According to them, L constitutes a valid set of instruments for financial intermediation in a growth regression, because it is clearly exogenous and its main effects on growth should work through financial development.

Using the number of banking branches as a threshold variable, it is found that all estimates are significant, given that they all fall within the confidence intervals in the four models (Tables 3–6). The threshold estimates are 4.93, 4.93, 5.33 and 14.95, respectively. The high value of the variable threshold results from the reduced sample size when market capitalization over GDP is used as a measure of financial deepening (107 countries instead of 144). Several developing countries with limited performances in the area of direct finance are excluded from the sample, thereby moving the minimum number of branches from 0.34 (as in Table 2) to 1.5, and the mean from 17.43 to 20.42.

Table 3. *GMM results using M2/GDP*

	Whole sample			First regime (<threshold)			Second regime (>threshold)		
	coef.	SE	T. Stat.	coef.	SE	T. Stat.	coef.	SE	T. Stat.
M2 over GDP (log)	−0.517	1.613	−0.320	9.568	3.744	2.556	0.314	1.064	0.295
GDPpci − GDPpc usa 1985	0.107	0.463	0.231	−1.707	1.079	−1.583	−0.035	0.450	−0.078
log(ni+g+d)	−4.950	1.234	−4.012	−3.441	2.091	−1.646	−2.773	1.016	−2.730
Inv over GDP (log)	10.908	2.256	4.836	10.923	5.599	1.951	5.807	1.510	3.844
School (log)	−1.758	1.030	−1.707	−4.848	1.863	−2.602	−0.870	1.009	−0.862
Gov. exp. Over GDP (log)	−1.715	1.143	−1.501	−6.287	2.270	−2.770	−1.051	1.102	−0.954
Trade over GDP (log)	−0.024	0.637	−0.038	5.117	2.802	1.826	0.198	0.520	0.381
Inflation	−0.002	0.001	−1.959	−0.0004	0.0008	−0.482	0.001	0.001	0.991
	Threshold Estimate: 4.933								
	Confidence Interval -Uncorrected: 4.903 5.333								
	Confidence Interval -Het Corrected Quad: 4.903 5.333								
	Confidence Interval -Het Corrected NP: 4.903 5.333								
Obs. Number	144			39			105		

Table 4. *GMM results using Domestic Credit provided by banking sector/GDP*

	Whole sample			First regime (<threshold)			Second regime (>threshold)		
	coef.	SE	T. Stat.	coef.	SE	T. Stat.	coef.	SE	T. Stat.
DCPBS over GDP (log)	0.325	1.930	0.168	7.507	3.546	2.117	1.655	1.845	0.897
GDPpci − GDPpc usa 1985	−0.049	0.520	−0.095	−2.406	1.058	−2.273	−0.267	0.594	−0.449
log(ni+g+d)	−4.589	1.377	−3.333	−4.592	2.184	−2.103	−1.801	1.383	−1.302
Inv over GDP (log)	10.266	2.395	4.287	16.531	3.586	4.610	4.557	2.012	2.264
School (log)	−1.778	1.116	−1.593	−6.357	3.060	−2.077	−0.886	1.148	−0.772
Gov. exp. Over GDP (log)	−1.831	1.173	−1.561	−5.862	2.833	−2.069	−1.605	1.141	−1.406
Trade over GDP (log)	0.011	0.759	0.014	6.067	4.834	1.255	0.664	0.733	0.906
Inflation	−0.0012	0.0007	−1.709	−0.0006	0.0009	−0.672	0.002	0.0018	1.250
Threshold Estimate: 4.933									
Confidence Interval -Uncorrected: 4.903 5.333									
Confidence Interval -Het Corrected Quad: 4.903 5.529									
Confidence Interval -Het Corrected NP: 4.903 5.333									
Obs. Number	142			38			104		

The results suggest that access to finance is a good regime change trigger with respect to the non-linear link between finance and growth. Accordingly, in each model the sample is split into two regimes.[4]

The relationship between financial deepening and economic growth is insignificant in the four models without threshold effects. However, this relationship is found to be positive and significant only for the first regime when using M2 over GDP (*M2*) and domestic credit provided by banking sector over GDP (*DC*). When using domestic credit to private sector over GDP (*DCPS*) and market capitalization over GDP (*MC*), finance-growth relationship is no longer significant for countries of the first regime. On the contrary, countries belonging to the second regime do not benefit from finance banking depth as measured by *M2*, *DC* and *DCPS*. But they do benefit from equity market as measured by *MC*. In fact, Table 6 shows that *MC* is positively associated in a significant way with subsequent growth.

This evidence shows the non-linear relationship between finance and growth using access to finance as change trigger. The results also show that the banking system depth affects growth in countries characterized by low access to finance. On the contrary, countries endowed with more developed and mature financial systems enjoying high access to finance, tend to rely more on equity markets. In these countries, people generally earn higher incomes and have more non-bank investment options available to them, therefore reducing their demand for banking products below what they would otherwise be. The banking model has also evolved in many developed countries, becoming increasingly dominated by wholesale markets and derivatives, to the detriment of the more traditional deposit-taking and lending activities. In other words, well developed financial systems offer more diversification opportunities through equity markets leading to adopt

[4]Aghion *et al.* (2005) test their theory of thresholds in financial intermediation by including a proxy for financial intermediation interacted with the initial output gap relative to the technological leader (the United States) in a standard cross-sectional growth regression (reference to Equation (2)). A significant negative influence of the interaction term on the growth differential relative to the leader is taken as evidence of the non-linearity in the variable under scrutiny. The approach followed in this paper considers endogenously the presence of a threshold variable (access to finance) which justifies the non-inclusion of the interaction term.

Table 5. *GMM results using Domestic Credit to private sector/GDP*

	Whole sample			First regime (<threshold)			Second regime (>threshold)		
	coef.	SE	T. Stat.	coef.	SE	T. Stat.	coef.	SE	T. Stat.
DCPS over GDP (log)	0.607	1.858	0.326	4.689	3.405	1.377	1.216	1.560	0.779
GDPpci − GDPpc usa 1985	−0.175	0.683	−0.257	−2.576	0.832	−3.098	−0.231	0.593	−0.389
log(ni+g+d)	−4.414	1.481	−2.980	−1.964	2.135	−0.920	−2.233	1.152	−1.938
Inv over GDP (log)	9.902	2.695	3.675	11.089	5.653	1.961	5.227	1.585	3.298
School (log)	−1.758	1.052	−1.671	−3.333	1.887	−1.766	−0.986	1.013	−0.973
Gov. exp. Over GDP (log)	−1.830	1.157	−1.582	−4.626	1.951	−2.371	−1.608	1.213	−1.326
Trade over GDP (log)	−0.028	0.646	−0.043	3.415	2.429	1.406	0.380	0.543	0.700
Inflation	−0.0012	0.0007	−1.520	−0.0008	0.0007	−1.150	0.0018	0.0014	1.303
	Threshold Estimate: 5.333								
	Confidence Interval -Uncorrected: 4.903 5.333								
	Confidence Interval -Het Corrected Quad: 4.903 6.198								
	Confidence Interval -Het Corrected NP: 4.903 5.333								
Obs. Number	142			40			102		

Table 6. *GMM results using Market capitalization/GDP*

	Whole sample			First regime (<threshold)			Second regime (>threshold)		
	coef.	SE	T. Stat.	coef.	SE	T. Stat.	coef.	SE	T. Stat.
Market Cap. over GDP (log)	0.265	0.553	0.479	0.514	0.547	0.939	2.451	1.179	2.080
GDPpci − GDPpc usa 1985	−0.212	0.373	−0.567	−0.325	0.404	−0.803	−0.551	1.204	−0.458
log(ni+g+d)	−2.955	1.312	−2.252	−1.376	1.721	−0.799	−5.651	2.182	−2.590
Inv over GDP (log)	7.452	1.943	3.836	7.463	2.594	2.877	6.140	2.592	2.369
School (log)	−0.603	0.871	−0.692	0.094	0.811	0.116	−8.531	4.002	−2.132
Gov. exp. Over GDP (log)	−2.126	1.257	−1.691	−4.384	1.213	−3.615	3.180	2.087	1.524
Trade over GDP (log)	−0.331	0.620	−0.533	−0.543	0.734	−0.740	0.014	0.680	0.021
Inflation	−0.002	0.0006	−2.994	−0.0017	0.0007	−2.462	0.010	0.008	1.283
	Threshold Estimate: 14.953								
	Confidence Interval -Uncorrected: 12.585 18.503								
	Confidence Interval -Het Corrected Quad: 12.585 18.503								
	Confidence Interval -Het Corrected NP: 14.953 18.456								
Obs. Number	107			53			54		

more risky but productive technology and hence higher growth, while banking credit prevails at earlier stages of development.

Furthermore, other results shown in Tables 3–6 are consistent with previous findings. For instance, initial conditions are found to be negatively and significantly related to economic growth in countries belonging to the first regime, when using banking finance depth measures. In addition, the working-age population is negatively and significantly related to growth in most cases for the whole sample and both regimes. Secondary school rates, as well as Government expenditures, are negatively related to growth. Their negative impacts are even worse for the countries relevant to the first regime.

Likewise, inflation is detrimental to economic growth for the whole sample, except when *DCPS* is used as financial deepening indicator, and only for the first regime with *MC* as financial deepening indicator. Trade openness is unrelated to growth in most cases. Most importantly, investment is found to affect heavily and significantly growth in all cases, notably for countries in the first regime, regardless of the finance depth measure in use.

5. Conclusion

The aim of this article was to broaden the empirical literature on the relationship between access to finance, financial development and economic growth by investigating the relationship among these three variables. For this purpose, the endogenous growth model of Aghion *et al.* (2005), considered an interesting framework that characterizes critical thresholds in the financial development of a country, is re-examined to test for the finance-growth non-linearity using access to finance as change trigger. The results suggest that changes in access to finance, as proxied by the number of banking branches per 100,000 adults, constitute one important factor that cause structural change in the relationship between financial development and economic growth, which should be taken into account when constructing estimation and prediction models of economic growth for both developing and developed countries. Moreover, the policy implication derived from this study is that before policymakers adopt any policy to promote or accelerate financial development the role of access to finance should not be neglected especially when borrowing from banks is the largest source of credit for businesses and consumers.

There are some engaging problems that remain unsolved in this article. First, the used empirical approach is based on the strict exogeneity of the threshold variable. To the extent that it is a proxy for the value placed on travel time to the branch, income *per capita* should be positively related to the number of branch locations offered by banks and, consequently, development in a considered country could influence to some extent the number of bank branches per 100,000 adults as a proxy of access to finance, thus emphasizing the endogeneity of this proxy. Very recently, work by Kourtellos *et al.* (2011) has extended the model considered in Caner and Hansen (2004) to account for endogeneity in the threshold variable by proposing an estimator based on a concentrated least squares method that involves an inverse Mills ratio bias correction term in each regime. This extension is potentially useful in assessing the financial-growth nexus. Second, given that the policy implication of the results here would clearly indicate a focus on improving accessibility to finance, more research is warranted so as to identify why access to finance is important, how best to measure it and how to improve it on the national scale.

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Appendix

List of countries

Albania	Denmark	Liberia	Slovak Republic
Algeria	Djibouti	Libya	Slovenia
Angola	Dominican Rep.	Lithuania	South Africa
Antigua and Barbuda	Ecuador	Luxembourg	Spain
Argentina	Egypt, Arab Rep.	Madagascar	Sri Lanka
Armenia	El Salvador	Malawi	Sudan
Australia	Equatorial Guinea	Malaysia	Suriname
Austria	Estonia	Mali	Swaziland
Azerbaijan	Ethiopia	Malta	Sweden
Bangladesh	Finland	Mauritania	Switzerland
Belarus	France	Mauritius	Syrian Arab Republic
Belgium	Gabon	Mexico	Tajikistan
Belize	Gambia, The	Mongolia	Tanzania
Benin	Georgia	Morocco	Thailand
Bhutan	Germany	Mozambique	Togo
Bolivia	Ghana	Namibia	Tonga
Botswana	Greece	Nepal	Trinidad and Tobago
Brazil	Grenada	Netherlands	Tunisia
Bulgaria	Guatemala	New Zealand	Turkey
Burkina Faso	Guinea	Nicaragua	Uganda
Burundi	Guinea-Bissau	Niger	Ukraine
Cambodia	Hong Kong	Norway	United Arab Emirates
Cameroon	Hungary	Oman	United States
Canada	Iceland	Pakistan	Uruguay
Cape Verde	India	Panama	Vanuatu
Central African Rep.	Indonesia	Paraguay	Venezuela
Chad	Iran, Islamic Rep.	Peru	Vietnam
Chile	Ireland	Philippines	Yemen, Rep
China	Israel	Poland	Zambia
Colombia	Italy	Portugal	Zimbabwe
Comoros	Jamaica	Qatar	
Congo, Dem. Rep	Japan	Romania	
Congo, Rep.	Jordan	Russian Federation	
Costa Rica	Kazakhstan	Rwanda	
Cote d'Ivoire	Kenya	Saudi Arabia	
Croatia	Latvia	Senegal	
Cyprus	Lebanon	Serbia	
Czech Republic	Lesotho	Sierra Leone	