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The Nonlinear Relationship between Economic growth and Financial Development:
Evidence from Developing, Emerging and Advanced Economies

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Abstract

This paper studies the relationship between financial development and economic growth in a large sample of developing, emerging and advanced economies and on a separate, longer sample including only OECD countries over the recent period. Estimation results based on nonlinear threshold regression models do not confirm the too-much-finance-is-bad hypothesis, especially if the cross-country variation in the data is accounted for. We cannot indeed identify a tipping point beyond which financial development has a negative relation to economic development. What we see at best is that the positive effect of finance declines at higher levels of finance. Our results also show that banking and market finance are complementary. The positive effect of stock market deepening is larger when banking finance is more pronounced (and the other way around). But the thresholds above which complementarity kicks in are rather low. Finally, our results indicate that finance has a stronger positive effect in more developed countries. At the same time, the positive effect of finance is weaker in countries with lower trade openness. This may suggest that more open economies have access to alternative sources of external financing.

Keywords: financial development, economic growth, nonlinearity, threshold effects.

JEL: C2, G15.

1. Introduction

The relationship between financial development and economic growth has been in the center of both exogenous and endogenous economic growth models (Barro and Sala-i-Martin, 1992). While it is well established from a theoretical point of view that finance and growth are connected, empirical estimates are widely mixed on the matter. Indeed, the sign of this relationship and the question of lead-lag effect have been subject to debate (Levine, 2005; Beck, 2012). On the one hand, a positive relationship between financial development and economic growth is suggested by the fact that more finance might help improve capital allocation, reduce adjustment costs, increase lending to households and firms, and stimulate high-return investment. According to Levine (2005), greater financial development implies the existence of financial instruments and intermediaries that reduce information and transaction costs. On the other hand, more finance could slow economic growth through a misallocation of capital for low-return projects and induce boom-bust short cycles with negative effects on long-term output.

In the empirical literature, several studies have focused on the relationship between financial development and economic growth. This literature that can be broken down into two groups (before and after the recent global financial crisis) points to a switch in this relationship. Until the global financial and economic crisis, financial development and economic growth were shown to exhibit a positive relationship as more developed financial markets would boost economic growth (Goldsmith, 1969; King and Levine, 1993a, 1993b; Beck et al., 2000; Levine et al., 2000, Bassanini et al., 2001; Leahy et al., 2001). This positive link seems to hold in developed, emerging and developing economies. More recent studies have shown, however, that the positive relation between finance and economic growth does not hold anymore when combining the pre- and post-crisis period (Rousseau and Wachtel, 2011). The switch in the finance-economic growth relationship is sometimes justified by the change in the structure of finance and the recent use of finance flows. For example, when capital is used to finance real estate investment (though mortgages) rather than more productive investment, competitiveness and thus growth can suffer (Égert and Kierzenkowski, 2014).

This paper takes a new look at the relationship between financial development and economic growth for a large sample of countries. We contribute to the literature in several ways. First, we use data before the global financial crisis and data after this downturn in order to check whether

there was a shift in this relationship. Second, we use different proxies for financial development in order to capture different heterogeneous effects of the finance on the real economy. Third, we develop a new econometric framework based on threshold models that enables us to capture time-varying, nonlinear and asymmetrical effects of financial development on the economic growth. To our knowledge, this is the first paper that develops a nonlinear dynamical specification to asses for the financial development effects for a large sample of countries during calm and turbulent times.

Our findings show several interesting results. First, it is difficult to identify a too-much-finance-is-bad effect. Second, we are able to identify complementarity between banking and market finance. Finally, our results show that the effect of financial development on economic performance is time-varying and also depends on overall economic development and trade openness.

The remainder of the paper is as follows. Section 2 dresses a brief literature review. We discuss the econometric methodology in Section 3. The main empirical results are discussed in Section 4. Section 5 concludes.

2. Literature

Financial development can underpin economic growth through the reduction of transaction costs, the use of financial innovations, the stimulation of invested saving, the increase of investment, etc. However, it is important to recall that financial instability might induce volatility for productivity, investment and the whole economy. Indeed, financial crises, in particular in emerging economies have been responsible of important economic downturns. Therefore, an inverse relationship between economic growth and financial developed is a credible hypothesis in the related literature. Indeed, from a theoretical viewpoint, five main channels are always cited (Levine, 2005) to document a positive economic growth-financial development relationship: i) greater financial development helps reduce information costs; and this reduction might facilitate the channeling of household savings into corporate-sector investment, improving the allocation of resources. ii) Greater financial development enhances corporate governance and thus increases the productivity of investment projects. iii) Greater financial development improves transparency, increases hedging against further risk (such as credit, exchange rate and sovereign risks) and encourages asset diversification. This would encourage long-term investment. iv) Greater finance increases capital accumulation through a more flexible mobilization of savings, which constitute a

major factor of economic growth. v) Increased financial development facilitates the exchange of goods and services and improves specialization that increases labor productivity and therefore output.

In the literature, several studies, both theoretical and empirical, have investigated the relationship between financial development and economic growth (e.g. King and Levine, 1993a, 1993b). Nevertheless, while most previous studies did not reject the presence of a significant relationship between financial development and economic growth, the sign of this relationship has been controversial among economists. For instance, Levine (1997) developed a theoretical approach and showed a positive relationship between financial development and economic growth. King and Levine (1993a) empirically tested for the financial development- economic growth relationship for 77 countries over the period of 1960-1989. They regressed GDP per capita on three proxies of financial development: the ratio of liquid debt of the financial system over GDP, the ratio of credit of commercial banks as a share of bank credit &domestic assets of the central bank, and the ratio of credit to the private sector to GDP. They found further evidence of a positive correlation between economic growth and financial development measures. Rajan and Zingales (1998) reached same conclusions. Levine and Zervos (1998) and Beck and Levine (2002) also confirm this relationship by showing that the development of financial markets is helpful to better understand the process of economic growth.

More recently, Levine (2005) explained that financial intermediaries would help accumulate capital and improve resource allocation, which stimulate the whole economy. Galindo et al. (2007) suggested that the development of banks can be facilitated by further financial liberalization, which would yield more efficient allocation of credits to stimulate the whole economy. Ang and Mckibbin (2007) and Guiliano and Ruiz-Arranz (2009) also suggest that financial liberalization would enable a better mobilization of savings, an efficient risk diversification and good investment choices. There is another strand of the literature that investigates this link using sectoral data (Rajan and Zingales, 1998; Braun and Larrain, 2005; and de Serres et al., 2006). These studies showed that some sectors are more dependent on external finance than others and thus might grow faster or be more severally affected by financial development shock.

However, recent contributions have shed doubt on this positive relationship (Rousseau and Wachtel, 2011). Arcand et al. (2012), Beck et al. (2014), Ceccehetti and Kharroubi (2012), Law

and Singh (2014) found a hump-shaped relationship between financial development and economic growth. Indeed, deeper financial markets are associated with higher economic growth at low level of financial development and slower economic growth after a certain threshold of economic performance, which is estimated at about 90% of GDP (Cournède and Denk, 2015). Tridico (2013) also showed that larger European stock markets were related to poorer economic performance after the financial crisis.

In particular, in the aftermath of the recent global financial crisis, several authors have revisited this relationship and challenged the earlier results. For example, Cecchetti and Kharoubi (2012) show an inverted U-shaped pattern between financial development and economic growth. The positive relationship turns negative when the financial sector's output of exceeds the GDP or when employment in the financial system is greater than 3.5% of total employment, its impact on economic growth is negative. Interestingly according to the authors, at least for developed economies, this threshold has been exceeded some years ago. Indeed, the authors showed that the rapid increase of finance in advanced countries appears harmful for their real aggregated economic growths. The authors justify this result by the fact that rapid financial industry growth would be competitive with others sectors in term of resource allocation or employment of high qualified persons, and therefore impacting negatively the others sectors of the economy. Eggoh and Villieu (2013) reach similar conclusion for a larger dataset. They point out the presence of different equilibria between economic growth and financial development depending on the growth regime under consideration.

Regarding OECD countries, a recent study by Pagano and Pica (2012) highlighted that higher financial development does not positively affect economic growth. Cournède and Denk (2015) studied the relationship between financial development and output for a large sample of OECD and G20 countries using different proxies for financial development (financial value added, credit as a share of GDP and stock market capitalization) and different empirical specifications. They found that the first two proxies negatively affected economic growth, while the relationship becomes positive when considering stock market capitalization. This finding suggests that the link between financial development and economic growth varies with different forms of finance. For a larger set of countries, Rioja and Valel (2004) show that financial development has different effects at different levels of financial development: little impact at very low levels of financial

development, a large positive effect at intermediate levels of financial development, and a smaller positive impact at high levels of financial development.

Overall, no consensus has been reached on the sign and direction of the link between financial development and economic growth. Indeed, while it was for a long time accepted that these two variables exhibit a positive relationship as financial development and financial innovation imply a high financial integration that boosts economic growth, since the Great recession, an inverse relationship seems to be at work.

In line with the rich but inconclusive literature, our paper tries to contribute and propose a more appropriate framework to better control for these different forms of financial development on economic growth to capture for their different effects.

3. Estimation issues

3.1 Estimating growth regressions

The large body of literature aimed at analysing the drivers of long-term economic output (growth) can be split into three major branches depending on the modelling approach.

A first strand of growth regressions relies on purely cross-sectional data for a large number of countries. Many papers have been using cross-country data to analyse the covariates of economic growth.[1] A typical example is Sala-i-Martin et al. (2004): they use single observations per variable per country for 88 countries. In the long-run, per capita income levels depend on investment, human capita, health, openness and indicators capturing geography, history, religion, culture and institutions.

A second strand of growth regressions uses multi-year averages for a large number of countries.[2]. The main drivers of long-term growth are very similar compared to pure cross-section studies. The main difference is that cross-section studies incorporate a larger number of time-invariant country characteristics (such as geographical, political, cultural and historical differences).

[1] For illustration, see Crespo-Cuaresam and Doppelhofer (2007), Sala-i-Martin et al. (2004), Crespo-Cuaresma (2002), Fernandez et al. (2001), Durlauf et al. (2000), Sala-i-Martin (1997) and Levine and Renelt (1992)
[2] Barro (2001, 2003, 2013, 2015) are examples for such growth regressions for around 90 countries, using 5- and 10-year averages.

Finally, other studies employ annual data for a relatively small number of countries. Exemples are Bassanini et al. (2001), Arnold et al. (2007) and Bouis et al. (2011): they run growth regressions for about 30 years for around 20 OECD countries.

While these three strands are typically referred to as "growth" regressions in the literature, they are all variants of an error correction specification.[3] Accordingly, the error-correction specification implies that in the long run, only the level of GDP per capita is affected by the independent determinants. Growth rates are only changed during the transition period to the new steady-state level, which, however, depending on the speed of convergence and the short-term dynamics, can last for many years.

3.2 Incorporating financial development in growth regressions

Given our interest in the long-run impact of financial development on output, the level rather than the growth rate of output is regressed on the variables capturing financial development. Adjustment to the long-run and short-term effects are analysed in a separate second step in the framework of a two-step error correction modelling approach.

In accordance with the existing literature, the starting point is a growth regression including the following explanatory variables: i.) physical capital (investment as a % of GDP, *K*), ii.) human capital (*HK)*, iii.) population growth ($\Delta \log(POP)$). All growth regressions are estimated by regressing these variables on the log level of per capita income ($\log(Y)$). This specification can be extended by adding trade openness (measured as export and imports over GDP, *OPEN*) and a measure of innovation intensity[4].

Studies that investigate how policies influence per capita income levels enter the policy variables as additional regressors into (4). For instance, Bassanini et al. (2001) and Bouis et al. (2011) add a measure of financial development. Along these lines, it would be straightforward to add product and labour market policies and regulations to the specifications.

[3] Equations (1) and (2) are reduced error correction models excluding short-term dynamics. They are mostly single-step error correction model whereas a two-step approach could also be used.
[4] Other variables often used are macroeconomic stability (proxied by the inflation rate) or life expectancy.

Adding financial development (FD) to equation (5) would yield the following empirical specification:

$$\log(Y_{j,t}) = f(K_{j,t}, HK_{j,t}, \Delta\log(POP_{j,t}), OPEN_{j,t}, , INNOVATION_{j,t}\, FD_{j,t}) \quad (1)$$

3.3 Nonlinear effects in the finance-growth nexus

3.3.1 Threshold models

Threshold models capture nonlinear effects that can occur when the variable of interest has different coefficients below and above a given threshold. For instance, the impact of financial sector could depend on the level of another variable such as economic development. In such models, the threshold value is determined endogenously through a grid search. In this paper, a grid search with steps of 1% of the distribution is carried out to identify the value of the threshold variable that minimises the sum of squared residuals of the estimated two-regime model. The grid search starts at 15% of the distribution and stops at 85% to ensure that a sufficient number of observations falls into each regime. There is evidence for nonlinearity if the null hypothesis of $\beta_1 = \beta_2$ can be rejected against the alternative hypothesis of $\beta_1 \neq \beta_2$ (Hansen, 1996, 1999).

Formally, a simple two-regime threshold model can be written as follows:

$$Y_{j,t} = \begin{cases} \alpha_{1,0} + \beta_1 non-linear\_\text{var}iable_{j,t} + \varepsilon_{1,t} & if \quad threshold\_\text{var}iable < T \\ \alpha_{2,0} + \beta_2 non-linear\_\text{var}iable_{j,t} + \varepsilon_{2,tt} & if \quad threshold\_\text{var}iable \geq T \end{cases} \quad (2)$$

where T is the threshold value of the threshold variable. When estimating equation (2), the control variables used in equation (1) are added to equation (2) as linear variables.

3.3.2 Parameter heterogeneity: does the level of financial development matter?

In this paper, we study whether the relationship between growth and financial development depends on the level of financial development. To this end, we will try to figure out whether too much finance is already bad for output and if so, where the tipping point is. Equation (2) can be adjusted accordingly:

$$Y_{j,t} = \begin{cases} \alpha_{1,0} + \beta_1 FD_{j,t} + \varepsilon_{1,t} & if \quad FD < T \\ \alpha_{2,0} + \beta_2 FD_{j,t} + \varepsilon_{2,t} & if \quad FD \geq T \end{cases} \tag{3a}$$

where T is the tipping point of financial development. Threshold regressions also make it possible to look at complementarities. The question we can raise is for instance whether more developed stock markets amplify the effect of larger banking sectors or whether the effect of bank credit to the economy could be conditional on the depth of capital markets:

$$Y_{j,t} = \begin{cases} \alpha_{1,0} + \beta_1 BANK\_CREDIT_{j,t} + \varepsilon_{1,t} & if \quad STOCK\_MARKET < T \\ \alpha_{2,0} + \beta_2 BANK\_CREDIT_{j,t} + \varepsilon_{2,tt} & if \quad STOCK\_MARKET \geq T \end{cases} \tag{3b}$$

3.3.3 Parameter heterogeneity: does economic development matter?

A related question is whether the link between growth and finance works differently across countries at different levels of development. More specifically, are finance and growth related differently in advanced, emerging and developing countries? One reason why economic development could matter is because it is tightly correlated with institutions. The quality of institutions differs for different groups of countries and the quality of institutions may be related to the effect of finance on output.

$$Y_{j,t} = \begin{cases} \alpha_{1,0} + \beta_1 FD_{j,t} + \varepsilon_{1,t} & if \quad per\_capita\_income < T \\ \alpha_{2,0} + \beta_2 FD_{j,t} + \varepsilon_{2,t} & if \quad per\_capita\_income \geq T \end{cases} \tag{3c}$$

3.3.4 Other sources of parameter heterogeneity: human capital and openness

There are further reasons why financial development might have a different effect on output. First, countries with a better endowment in human capital might be able to better allocate financial resources. Second, more open countries might need more finance to fund rapidly expanding exports and the related push for more innovation.

3.3.5 Estimation method

Given the trending nature of the data (even if country and year fixed effects are accounted for), cointegration techniques are needed to estimate the level relationships linking output with its long-term drivers. If the variables are not related through a cointegrating vector, the estimated level equations may be spurious.

We have two panels: i.) one panel covering around 100 countries for about 10 years. For this panel, standard OLS is used to estimate the long-term coefficients. ii.) one panel covering the OECD countries for about 30 years. As the time series dimension of the second panel is large enough, the long-term coefficients are estimated on the basis of the Dynamic OLS (DOLS) estimator: Over the standard OLS estimator, it has the advantage that it corrects for the possible endogeneity of the regressors and autocorrelation in the residuals by incorporating leads and lags of the regressors in first differences (Stock and Watson, 1993):

$$Y_{j,t} = \beta_0 + \sum_{i=1}^{n} \beta_n X_{j,i,t} + \sum_{i=1}^{n} \sum_{l=-k_1}^{k_2} \gamma_{i,l} \Delta X_{j,i,t-l} + \varepsilon_t \qquad (4)$$

where Y is per capita income and $\overline{X}$ is a vector of the independent variables. j stands for individual countries, i for the regressors, and k1 and k2 represent respectively leads and lags. N?

Generally, endogeneity is a critical issue in the finance-growth literature: the financial development is clearly an endogenous variable. One way to tackle it is to use the initial value of financial development (King and Levine, 1993a; Levine and Zervos, 1998) or to use the legal origin of a country to instrument for financial development (Levine et al.,2000). Yet these approaches rely mostly on cross-section datasets. The most recent literature using cross-country time-series datasets instrument financial development with the lagged values of financial development (Rousseau and Wachtel, 2011). We therefore also use the first-difference GMM estimator to cross-check the robustness of the financial development indicators for endogeneity.[5]
Thus, Equation (4) can be estimated using country and time fixed effects. In the empirical analysis, one lead and one lag of the covariates will be used.

Whether or not the variables of interest are cointegrated can be tested in two ways. First, the residuals obtained from the long-term relationship (ε_t) can be used to estimate the error-correction

[5] We thank an anonymous referee for this suggestion.

model in the second stage. Weak evidence for the presence of cointegration is if the error-correction term in this second stage is statistically significant and has a negative sign. This implies an error correction mechanism to be estimated. A second and more formal test of cointegration is when the estimated residuals from the long-term relationship are tested for the presence of a unit root. The rejection of the null hypothesis of a unit root can be interpreted in favour of cointegration, in the spirit of the Engle and Granger (1987) residual-based cointegration approach. This paper uses Kao's residual-based panel cointegration tests (Kao, 1999), which, along equation (10), allow for country-specific intercepts but imposes homogenous coefficients.

4. Data issues

This section describes the database we use for the estimations and provides data definitions. It then provides with some stylised facts.

4.1 The SPIDER database

The data used in this paper are obtained from the OECD's SPIDER database. SPIDER stands for Structural Policy Database for Economic Research. SPIDER is a compilation of data from 43 existing data sources. It draws heavily on a large number of existing OECD databases. It includes a number of non-OECD databases such as the World Bank's Doing Business and World Development Indicators databases of the Penn World Table 8.0. The final source of data in SPIDER are individual research papers, either academically published articles or working papers (for more details, see Égert et al. 2017).

Two different panels are used in this paper. The first panel covers around 100 countries. The time coverage of this dataset goes from the mid-1990s to 2012. The second panel covers most of the OECD countries for over 30 years.

4.2 Measures of financial development

This subsection recalls the variables used in the paper that measure financial development:

- The credit to the domestic economy as a share of GDP, credit to the private domestic economy as a share of GDP, stock market capitalisation as a share of GDP, bank branches per capita and financial liberalisation index.

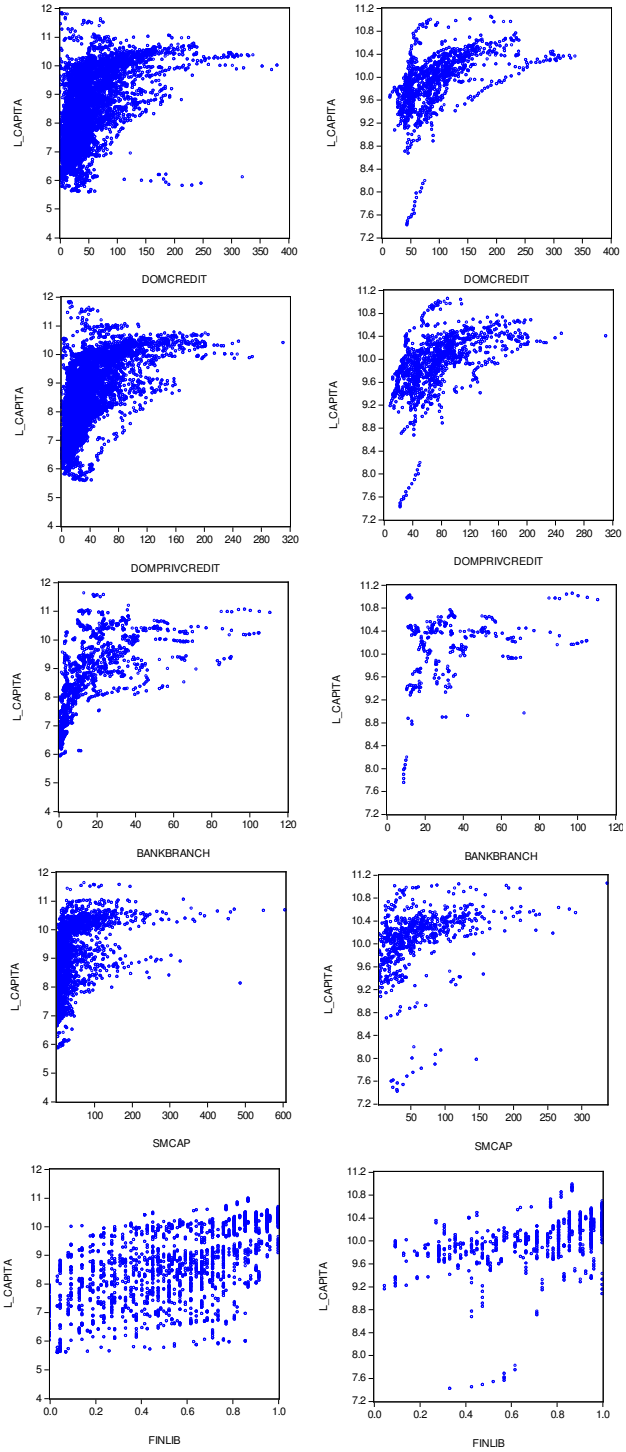
The use of the different of measures for financial development enables us to capture different effects of finance on the economic growth.

4.3 Stylised facts

Figure 1 plots the five variables measuring financial development against per capita income for the worldwide panel (left) and for the set of OECD countries (right). For both variables capturing credit to the economy, the scatterplots suggest that there is a positive correlation between finance and growth, which might weaken at higher levels of the credit-to-GDP ratio. Data on our OECD sample exhibits very a similar pattern. Let us now turn to the variable looking at the number of bank branches per 100.000 adults that also indicates a possible positive correlation with per capita income, which decreases as the number of bank branches rises. However, there does not seem to be any visual correlation for OECD countries. Looking at stock market capitalisation as a % of GDP shows a kink at about 50% of stock market capitalisation. The slope between stock market capitalisation and per capita income appears very steep before that threshold but it flattens to a great extent beyond that threshold. The positive correlation is apparently much smoother for OECD countries where no tipping point can be identified on the basis of eyeball econometrics. Finally, there might be a positive, though possibly weak correlation between financial liberalisation and economic development. The scatterplot shows that this link could be stronger and more straightforward for OECD countries.

Figure 1. Financial development and per capita income – stylised facts

All countries **OECD countries**



Note: domcredit = credit to the domestic economy/GDP; domprivcredit = private credit to the domestic economy/GDP; bankbranch = bank branches / population; smcap = stock market capitalisation / GDP; finlib = financial liberalisation index.

5. Estimation Results

5.1 Linear effects

Regression results for the linear specifications based on equation (1) are reported in Tables 2 and 3 below. For the worldwide sample, the two credit-to-GDP ratios and the variable measuring bank branches per 100.000 adults are statistically significant with a positive sign. This implies that more credit as a share of GDP and more per capita bank branches go in tandem with higher per capita income. These results are robust for alternative sample size. The estimations are carried out for three samples: i.) full sample; ii.) a sample adjusted for observations for stock market capitalisation (meaning that some observations for the credit variables were dropped; and iii.) a sample excluding small countries with population less than 1 million people, done to eliminate outlier countries. Stock market capitalisation also has a positive effect on per capita income levels but its coefficient is estimated precisely only when small countries are excluded from our sample. The financial liberalisation indicator never gets statistically significant for all samples. One reason for this insignificant finding is that there might be a common trend in financial liberalisation across countries and this trend may be picked up by the year fixed effects used for the estimations. In fact, when only country fixed effects but no time fixed effects are used, the financial liberalisation indicator shows a positive and significant correlation with per capita income. Robustness checks using the GMM estimator indicate that the results are robust to endogeneity (Table A1 in the appendix).

Results obtained for the sample of OECD countries are not very different for the credit variables and bank branches: higher credit-to-GDP ratios go hand in hand with higher per capita income. Nevertheless, stock market capitalisation is not statistically significant and the financial liberalisation indicator has a negative sign when both time and country fixed effects are used. Yet, both variables are precisely estimated with a positive sign when regressions do not include time fixed effects. This indicates that these variables exhibit trends, which are correlated with the common time trend captured by the time fixed effects.[6]

[6] The results for OECD countries are robust to the estimation method used. Results in Table 4 are based on the Dynamic OLS (DOLS) estimator. Results obtained using OLS are very similar.

5.2 Nonlinear effects

Using linear regressions, the above results suppose that the effect of finance on economic growth occurs linearly and symmetrically. However, it might be that finance's effect depends on the level of other factors. To better account for this non-linearity, let us now turn to the threshold regressions. Two sets of results are reported for both samples (worldwide and OECD sample): i.) regressions obtained on a pooled sample; and ii.) regressions including both country and time fixed effects. The reason for doing so is the following. Coefficient estimates from regressions having country and year fixed effects can be interpreted as the impact of the covariates when the cross-country variation is taken out (due to country fixed effects) and around a common time trend (due to year fixed effects). Hence, nonlinear effects obtained from such regressions do not exploit cross-country variations in the data. But considering the cross-country variation in the data is potentially interesting for two reasons. First, some of the data used in this paper (including per capita income and the finance variables) have more cross-country variation than they vary over time (and around a common trend). Second, nonlinear effects obtained using cross-country data allow making conclusions that are valid across countries and they are not only the average time effects across countries.

The first question we seek to answer is this: does more finance mean less growth beyond a tipping point? Generally, our results do not support this view (Tables 4 and 5). For both samples, the positive effect of private credit to the economy kicks in beyond a threshold, which is low: around 20% of GDP for the worldwide sample and around 50% for OECD countries. The relationship between per capita income and stock market capitalisation is also positive already at very modest levels (around 10%) for the worldwide sample. For OECD countries, the relationship is positive when cross-country variation is allowed for. Nevertheless, it becomes negative, which is broadly in line with the linear estimation results. The picture emerging for bank branches is more blurred. When considering cross-country variations (pooled regressions), the positive impact weakens beyond the threshold value. Nevertheless, when controlling for time fixed effects, more bank branches are clearly associated with higher per capita income.

The second question to be answered is the extent to which bank and market financing are complementary. For the worldwide sample, the complementarity hypothesis cannot not be rejected. Stock markets have a larger positive effect if private credit is higher above a given level and private credit has a larger positive correlation to per capita income if stock markets are larger.

This result needs some qualification: the threshold effects are very low. This means that countries with modestly developed capital markets and banking sectors can benefit from these mutually reinforcing effects. Nevertheless, this finding cannot be confirmed for OECD countries, especially when using time fixed effects.

The third issue arising in our context is whether the correlation between financial development and output depends on the level of development, trade openness and the level of human capital a country has. Results reported in Tables 4 and 5 provide answers to this question. Clearly, banking and capital markets have stronger positive effects in more developed countries. In the worldwide sample, the threshold is around 1000 to 2000 USD per capita. In the OECD sample, it is slightly higher than 10000 USD. An exception is stock market capitalisation when using year fixed effects. As for trade openness, results suggest that a more developed financial sector is associated with greater per capita income in countries with trade openness below a certain threshold. Two observations are particularly relevant here. On the one hand, the estimated threshold is fairly uncertain: it ranges from 50% to 90% across alternative specifications. On the other hand, this finding might support the view that more open economies can finance themselves through alternative sources of external funding.

Finally, results conditional on the level of human capital are very ambiguous: they can go in all direction depending on the country sample, finance variable and econometric specification (use of country and time fixed effects).

Table 2. Linear growth regressions, worldwide sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	full sample					common sample with stock market capitalisation around 100 countries					excluding small countries				
investment ratio	0.005**	0.004**	0.009**	0.004**	0.01**	0.009**	0.009**	0.009**	0.007**	0.008**	0.005**	0.004**	0.009**	0.005**	0.01**
trade openness	0.003**	0.003**	0.001**	-0.001**	0.002**	0.001**	0.001**	0.001**	-0.001**	0.002**	0.003**	0.003**	0.001**	-0.001**	0.002**
inflation	-3e-05*	-3e-05**	1E-05	4E-04	-1E-05	1E-05	1E-05	1E-05	1E-03	2E-05	-3e-05*	-3e-05**	1E-05	2E-05	-1E-05
population growth	1.879**	1.343**	-1.337**	0.372	4.724**	-1.354**	-1.404**	-1.352**	-0.481	3.263**	2.55**	1.725**	0.27	1.273	4.724**
human capital	0.259**	0.263**	0.106**	0.132	0.128**	0.096**	0.118**	0.1**	0.082	0.173**	0.254**	0.246**	0.113**	0.027	0.128**
domestic credit/GDP	0.002**					5.00E-05					0.002**				
private domestic credit/GDP		0.003**					0.0005**					0.004**			
stock market capitalisation / GDP			0.0001					0.0001					0.0002**		
bank branches				0.003**					0.002**					0.003**	
financial liberalisation					-0.009					0.046					-0.009
Kao test of cointegration, p-values, null hypothesis = no cointegration	0.049	0.013	0.147	0.205	0.244	0.005	0.014	0.046	0.398	0.145	0.483	0.473	0.063	0.191	0.244
error correction term	-0.044**	-0.045**	-0.065**	-0.177**	-0.04**	-0.059**	-0.057**	-0.061**	-0.203**	-0.103**	-0.036**	-0.037**	-0.058**	-0.218**	-0.04**
country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
adjusted R-squared	0.977	0.978	0.993	0.999	0.986	0.993	0.993	0.993	0.999	0.996	0.978	0.979	0.993	0.999	0.986
No. observations	4150	4167	1870	938	1990	1811	1821	1821	681	1019	3748	3763	1736	876	1990
No. countries	128	128	101	127	75	100	100	100	94	71	120	120	96	119	75

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively, based on heteroscedasticity-robust standard errors.

Table 3. Linear growth regressions, OECD countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	no country and time fixed effects					**country fixed effects only**					**country and time fixed effects**				
investment ratio	-0.012**	-0.013**	-0.019**	-0.019**	-0.003	0.009**	0.006**	0.005**	0.004	0.009**	0.015**	0.013**	0.007**	0.005	0.02**
trade openness	0.002**	0.002**	0.001**	0.0004	-0.0003	0.002**	0.003**	0.003**	0.003**	0.002**	0.002**	0.002**	0.002**	0.001	-0.0001
inflation	-0.004**	-0.003**	-0.013**	-0.121**	-0.004**	-0.001**	-0.0004	-0.003**	0.01	-0.0003	-0.001**	-0.001**	-0.002**	0.004	-0.001**
population growth	-7.258**	-7.551**	4.967**	18.332**	-10.805**	-3.581**	-3.237**	-0.551	-0.102	2.078	-2.175	-1.766	-1.117	-0.351	-1.339
human capital	0.39**	0.38**	0.25**	0.421**	0.352**	0.887**	0.881**	0.596**	-0.222	0.615**	0.374**	0.389**	-0.061	-0.351*	0.19**
domestic credit/GDP	0.003**					0.002**					0.002**				
private domestic credit/GDP		0.005**					0.003**					0.002**			
stock market capitalisation / GDP			0.004**					0.001**					-4.00E-06		
bank branches				0.001					0.006**					0.004**	
financial liberalisation					0.402**					0.353**					-0.17**
Kao test of cointegration, p-values, null hypothesis = no cointegration	0.136	0.383	0.195	0.003	0.030	0.136	0.383	0.195	0.003	0.030	0.136	0.383	0.195	0.003	0.030
error correction term	-0.029**	-0.033**	-0.044**	-0.027**	-0.022**	-0.03**	-0.036**	-0.093**	-0.474**	-0.028**	-0.036**	-0.04**	-0.083**	-0.36**	-0.027**
country fixed effects	**NO**	**NO**	**NO**	**NO**	**NO**	YES	YES	YES	YES	YES	**YES**	**YES**	**YES**	**YES**	**YES**
year fixed effects	**NO**	**NO**	**NO**	**NO**	**NO**	NO	NO	NO	NO	NO	**YES**	**YES**	**YES**	**YES**	**YES**
adjusted R-squared	0.607	0.615	0.61	0.576	0.546	0.919	0.92	0.973	0.996	0.939	0.936	0.934	0.985	0.997	0.957
No. observations	1125	1127	640	165	750	1125	1127	640	165	750	1125	1127	640	165	750
No. countries	33	33	33	33	29	33	33	33	33	29	33	33	33	33	29

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively, based on heteroscedasticity-robust standard errors.

Table 4. Nonlinear growth regressions, worldwide sample

Threshold variable		per capita income			openness			human capital			domestic private credit			stock market capitalisation			bank branches		
no country and year fixed effects																			
Threshold value		1879.0	9050.7	1432.1	94.4	94.4	92.9	2.4	2.4	2.4	14.0	14.4	45.3	11.9	11.9	24.0	7.7	24.2	18.4
Test of nonlinearity, p-value, H0: linear model; H1: two-regime model		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
non-linear variables																			
domestic private credit	when thresold var below threshold	-0.038**			0.01**			0.013**			-0.024**			0.004**			-0.003*		
	when thresold var above threshold	0.009**			0.007**			0.008**			0.008**			0.008**			0.009**		
stock market capitalisation	when thresold var below threshold		-0.003**			0.007**			0.012**			-0.045**			-0.03**			0.002**	
	when thresold var above threshold		0.007**			0.003**			0.004**			0.004**			0.004**			0.006**	
bank branches	when thresold var below threshold			-0.191**			0.022**			0.06**			0.007**			0.008**			0.061**
	when thresold var above threshold			0.017**			0.013**			0.018**			0.021**			0.018**			0.024**
adjusted R-squared		0.741	0.634	0.777	0.655	0.572	0.75	0.659	0.581	0.763	0.661	0.578	0.749	0.606	0.57	0.685	0.771	0.66	0.764
No. observations		3763	1736	876	3763	1736	876	3763	1736	876	3763	1693	856	1693	1736	658	856	658	876
No. countries		120	96	119	120	96	119	120	96	119	120	95	117	95	96	90	117	90	119
country and year fixed effects																			
Threshold value		1625.2	2304.3	1483.6	60.2	53.1	45.4	1.6	1.8	2.2	17.3	16.4	35.2	11.9	11.9	31.5	12.6	4.6	9.9
Test of nonlinearity, p-value, H0: linear model; H1: two-regime model		0.000	0.000	0.000	0.076	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.014	0.004	0.004	0.003	0.001	0.000
non-linear variables																			
domestic private credit	when thresold var below threshold	-0.006**			0.004**			0.007**			-0.00003			0.0001			-0.001**		
	when thresold var above threshold	0.004**			0.004**			0.004**			0.004**			0.001**			-0.00004		
stock market capitalisation	when thresold var below threshold		-0.005**			0.001**			-0.002**			-0.004**			-0.003**			-0.0004*	
	when thresold var above threshold		0.0002**			0.0001*			0.0002**			0.0002**			0.0002**			0.0004**	
bank branches	when thresold var below threshold			-0.008**			0.0003			-0.002			0.002**			0.002**			-0.003*
	when thresold var above threshold			0.003**			0.004**			0.003**			0.003**			0.002**			0.003**
adjusted R-squared		0.981	0.993	0.999	0.979	0.993	0.999	0.979	0.993	0.999	0.979	0.993	0.999	0.993	0.993	0.999	0.999	0.998	0.999
No. observations		3763	1736	876	3763	1736	876	3763	1736	876	3763	1693	856	1693	1736	658	856	658	876
No. countries		120	96	119	120	96	119	120	96	119	120	95	117	95	96	90	117	90	119

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively, based on heteroscedasticity-robust standard errors. Sample excludes countries with population less than 1 million people.

Table 5. Nonlinear growth regressions, OECD sample

Threshold variable		per capita income			openness			human capital			domestic private credit			stock market capitalisation			bank branches		
no country and year fixed effects																			
Threshold value		11382.2	11382.2	11382.2	94.4	46.2	83.6	1.7	2.1	2.6	45.3	30.2	49.5	11.9	11.9	43.7	16.2	13.4	13.4
Test of nonlinearity, p-value, H0: linear model; H1: two-regime model		0.000	0.000	0.067	0.000	0.000	0.000	0.000	0.004	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
non-linear variables																			
domestic private credit	when thresold var below threshold	-0.009**			0.005**			-0.007**			-0.002*			0.001			0.008**		
	when thresold var above threshold	0.005**			0.004**			0.005**			0.004**			0.004**			0.004**		
stock market capitalisation	when thresold var below threshold		-0.015**			0.004**			0.04**			-0.015**			-0.018**			0.008**	
	when thresold var above threshold		0.003**			0.003**			0.003**			0.003**			0.003**			0.003**	
bank branches	when thresold var below threshold			-0.011			0.003**			0.002			-0.016**			0.0003			0.033**
	when thresold var above threshold			0.004**			0.01**			0.005**			0.003**			0.005**			0.006**
adjusted R-squared		0.714	0.586	0.423	0.618	0.546	0.471	0.621	0.552	0.427	0.632	0.613	0.578	0.635	0.548	0.469	0.662	0.51	0.464
No. observations		1277	741	266	1277	741	266	1277	741	266	1277	704	257	704	741	266	257	266	266
No. countries		34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
country and year fixed effects																			
Threshold value		8047.3	11382.2	11382.2	46.2	88.8	81.1	1.7	2.6	2.4	45.3	26.3	41.8	35.3	24.5	25.3	18.0	11.9	21.3
Test of nonlinearity, p-value, H0: linear model; H1: two-regime model		0.000	0.009	0.069	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.208	0.143	0.045	0.014	0.025	0.000
non-linear variables																			
domestic private credit	when thresold var below threshold	-0.009**			0.003**			0.012**			-0.001*			0.001**			-0.0005*		
	when thresold var above threshold	0.001**			0.001**			0.001**			0.001**			0.0004**			-0.0001		
stock market capitalisation	when thresold var below threshold		-0.003**			0.0001			0.002**			-0.002**			-0.001*			-0.001*	
	when thresold var above threshold		-0.0001*			-0.0003**			-0.0002**			-0.0002**			-0.0002**			0.0001	
bank branches	when thresold var below threshold			-0.001			0.002**			0.021**			-0.004**			0.002**			-0.0004
	when thresold var above threshold			0.002**			0.003**			0.002**			0.001			0.002**			0.002**
adjusted R-squared		0.947	0.98	0.993	0.934	0.979	0.994	0.934	0.979	0.993	0.933	0.978	0.995	0.978	0.979	0.993	0.993	0.993	0.993
No. observations		1277	741	266	1277	741	266	1277	741	266	1277	704	257	704	741	266	257	266	266
No. countries		34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively, based on heteroscedasticity-robust standard errors.

6. Concluding remarks

This paper sought to investigate the relationship between financial development and economic growth in a sample of developing, emerging and advanced economies. Using non-linear estimation techniques, the paper's objective was to answer three questions. Firstly, does the relationship between financial development and economic development become negative at high levels of financial development? Secondly, are banking and market finances complementary or substitutes for economic development? Thirdly, is effect of financial development on economic development conditional on the overall level of economic development, trade openness and human capital?

Our estimation results cannot confirm the hypothesis that the effect of financial development becomes negative beyond a given level of financial development. This is a strong result in particular if the cross-country variation in the data is accounted for. Our results show that the positive effect of finance declines at higher levels of finance across countries. Regarding the second question, our results show that banking and market finances reinforce each other's positive effect on economic performance. For instance, the positive effect of banking finance is greater in the presence of deepener capital markets (measured the stock markets as a share of GDP). Finally, our results indicate that finance has a stronger positive effect in more developed countries. At the same time, the positive effect of finance is weaker in countries with lower trade openness. This may suggest that more open economies have access to alternative sources of external financing.

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Appendix: Robustness checks

Table A1. **Linear growth regressions, worldwide sample, GMM estimator**

	(1)	(2)	(3)	(4)	(5)
			full sample		
	7.512**	7.509**	8.455**	8.331**	8.033**
investment ratio	0.007**	0.006**	0.011**	0.005**	0.013**
trade openness	0.003**	0.003**	0.001**	-0.001**	0.003**
inflation	0.000*	0.000*	0.000	0.003	0.000
population growth	0.996*	0.409	-2.659**	-0.241	3.695**
human capital	0.269**	0.267**	0.152**	0.209	0.108**
domestic credit/GDP	0.002**				
private domestic credit/GDP		0.003**			
stock market capitalisation / GDP			0.0003*		
bank branches				0.003**	
financial liberalisation					-0.002
country fixed effects	YES	YES	YES	YES	YES
year fixed effects	YES	YES	YES	YES	YES
adjusted R-squared	0.978	0.979	0.993	0.999	0.986
No. observations	3947	3964	1743	809	1899
No. countries	128	128	98	125	75

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively, based on heteroscedasticity-robust standard errors. Instruments are variables lagged with one period