Working Paper

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Publication Date:
2005-08

Permanent Link:
https://doi.org/10.3929/ethz-a-005104837 →

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Abstract:

This paper addresses the notion of an "optimum level of financial activity" that is contingent on a country's general level of development. Referring to threshold regressions and a bootstrap test for structural shift of the finance regressor in a growth equation, it is shown that countries gain less from a given level of financial activity, if the latter fails to keep up with or exceeds what would follow from a balanced expansion path. The paper contributes to the literature on the finance-growth nexus in providing empirical support for the notion of "balanced" financial development with a development specific optimum level of financial activity.

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1   Introduction

During the recent revival of research on the finance-growth nexus numerous researchers have reported evidence for strong empirical effects from activity in the financial sector to the performance of the economy as a whole.[1] Apart from that, theoretical models give sophisticated rationales for the assumption that well functioning monetary and banking systems and capital markets may be crucial for economic growth. Some authors stress the banking system's ability to create money and to channel it into productive and innovative uses. Others claim that it is the information gathering and processing, which is accomplished by professional actors on credit and capital markets, that helps to improve the efficiency of capital allocation.

This literature is important in generating hypotheses that can contribute to a better understanding of the finance-growth nexus. Yet, our knowledge on the nature of this nexus is still far from firm. While there are many potential causal links, they are likely to be affected by numerous positive and negative interactions as well as by a host of other economic, social, or political phenomena which constitute the framework under which the financial system operates. In addition these latter factors certainly exert a direct influence on economic growth and development, which makes it difficult to identify the effects of finance proper. Moreover, some sceptics warn us that there could be seriously destabilizing effects resulting from financial overtrading and crises in the financial system which they regard as inherently unstable.[2]

Given this complexity, both theoretical and empirical research are facing difficulties to discriminate between the multitude of competing hypotheses. In practical terms, the problem of identifying causal links between finance and growth is aggravated by the fact that the recent empirical studies are typically trying to reveal assumed "long run" or "steady state" relationships referring to cross country data sets that cover no more than a few decades.[3] Accordingly, limited by this short time window, econometric analyses are likely to pick up sample specific historical circumstances rather then a "general" case. This might at least partly explain the uncomfortable fact that the recent empirical studies come to different and in some

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1   A standard reference as the seminal contribution for this view is KING/ LEVINE (1993), though the line of research can be traced back at least to ADELMAN/ MORRIS (1968). In the 1990s, Ross Levine has probably been the most active researcher in this field; for a survey, see LEVINE (1997). After this, the literature has multiplied, and Levine and his co-authors are to this date setting important topics on the agenda. This line of research has been followed among others, by DE GREGORIO/ GUIDOTTI (1995), RAJAN/ ZINGALES (1998) and BENHABIB/ SPIEGEL (2000). For recent studies see GUISO ET AL. (2004) and BERTHÉLEMY/ VAROUDAKIS (2005). LEVINE (2005) provides an updated survey of the finance and growth research program.

2   See among others KEYNES (1936), KINDLEBERGER (1978), DIAMOND/ DYBVIG (1983), SINGH (1997), and CHANCELLOR (1999).

3   The usual data sets cover only years from the post 1945 era, and most of the key series do not go back beyond 1970 or 1960. Moreover, while GDP and its demand components are available on a yearly basis, many of the variables of interest for research on the finance-growth nexus are of lower frequency, so that the common procedure is to construct panel data with observations in five year steps.

instances contradictory results. While most studies tend to confirm a positive causal link from financial activity to economic performance, others fail to find significant evidence for this, and still others find evidence for dysfunctional effects. While different models, variable specifications, econometric methods as well as researcher's priors are certainly responsible for *some* of the contradictory findings, it is plausible to assume that the samples (county coverage and time horizon) account for much of the observed variety. If the finance-growth nexus is neither the same for all times, nor for all countries or regions, the conclusions from a given study will to a large extent be based on the idiosyncrasies of the chosen sample.[4]

Moreover, since the nature of the finance-growth nexus is time- and place dependent, the explicit or implicit theoretical basis of the vast majority of recent empirical work in this field is flawed as it relies on ahistorical theories that should hence be replaced by, or amended with, context specific elements.

Suitable arguments and hypotheses for this can be found in theories of "stages" of economic and financial development[5] as well as in some models of "big pushes",[6] "thresholds" and "development traps". A first and obvious way to approach the finance-growth nexus empirically is hence to look at history, and this indeed offers some relevant insights. As scholars of economic and financial history have argued,[7] in the now developed countries, modern financial systems generally evolved during the very early stages of their industrialisation, and finance seems to have been a growth-stimulating rather than a growth-induced phenomenon.

But does this observation hold today? Do financially less developed countries really have a latent, but unexploited potential for growth? Poor countries suffer from a host of difficulties. These range from a lack of physical capital to a failure to support economic development with adequate skills and include economic policy with a high time preference rate, which is not particularly helpful to promote growth and development in the long run. Hence, in poor countries, other factors might be much more important and potential benefits from financial activity might be more than outweighed by their disadvantageous starting point, where financial interrelations and contracts will cause significantly higher transaction costs than in more favourable environments.[8] In addition, financial development is a highly skill-intensive element

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4   In the light of this argument, the observation that a clear *majority* of the recent studies confirms the view that finance actively boosts growth looks (as highlighted by LEVINE, 1997: 688 f) is less convincing: The majority of the studies in this field draw on basically the same sample and data (downloadable in handy research datasets from public websites), thereby repeating the same partial correlation between finance and growth over and over again, which is a multi-researcher test for *robustness of one finding* rather than *independent evidence* for a generally valid phenomenon.

5   Cf. – among many others – ROSTOW (1960), HILDEBRAND (1864) and CHICK (1993).

6   The concept of "poverty traps" and "big pushes" can be traced back to ROSENSTEIN-RODAN (1943). An early formalization is the paper by NELSON/ PHELPS (1966).

7   The main body of this literature goes back to the 1960s; e.g. GERSCHENKRON (1962), PATRICK (1966), GOLDSMITH (1969, 1987), CAMERON ET AL. (1967).

8   See e.g. CLAGUE ET AL. (1997), (1998), LEVINE (1999) and TADESSE (2002).

of economic development. While it may not be costly in terms of physical capital, a sophisticated financial system absorbs a fair share of a country's highly skilled and motivated manpower, which implies considerable opportunity costs.[9] Consequently, with benefits of finance for growth and development that are contingent on the economic and institutional environment, the poor countries might be caught in a "poverty trap". My argument is therefore that the contribution of the financial system to economic development should be evaluated with attention to possible interactions between financial, and overall development.

In the following section, I review some of the recent research on possible thresholds in the finance-growth nexus. In section 3, I undertake to address these questions empirically. Section 4 concludes. Details on sample and data are given in the appendix.

2   What constitutes the finance growth-nexus

The possibility of a causal relationship between financial development (*F*) and economic growth has for a long time attracted the attention of researchers and policy makers. Generally, economic theory postulates three distinguishable, but not mutually exclusive, and partly unintended, effects of financial activity and development on overall economic performance:

–   The provision of an inexpensive and reliable *means of payment* (coins, later banking money), which historically came as a by-product of fractional reserve banking,[10]

–   secondly, a *volume effect*, where financial activity increases savings and thereby resources that can be channelled into investment, and

–   thirdly, an *allocation effect*, according to which *F* improves the allocation of resources devoted to investment.[11]

In the earliest stages of financial development, monetization was certainly helpful in stimulating market related economic activity (EINZIG, 1949). However, after the initial step of monetization, the contribution of further improvements of monetary and payment systems to economic growth can be expected to be considerably less pronounced, so that the first of the potential finance-growth links has nowadays probably become relatively unimportant.

The second potential link – the volume effect – is not related to a specific stage in financial development. However, it is theoretically ambiguous, since sounder financial institutions may guarantee higher interest rates and reduce the incentives for precautionary savings. This theoretical reasoning is supported be the empirically literature, which shows mixed results and in general fails to find conclusive evidence for a volume effect (FRY, 1995).

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9   For a heuristic formalization of this argument, see PAGANO (1993).

10   For a detailed exposition of this, see KINDLEBERGER (1993).

11   For the second and third effect, the seminal contribution is GURLEY/ SHAW (1960)

Hence, if financial activity presently should play a distinctive role in growth and development, it had to be due to the third link, the allocation effect; i.e. through improvements of capital accumulation resulting from financial activity. However, these allocation services are not costless. They absorb considerable resources, most of all highly specialized and motivated human capital, which might be just as helpful or even more helpful to foster economic growth and development when employed otherwise. Accordingly, while financial activity has a potential to enhance growth, we can safely assume that there are time and place specific optimal levels of financial development and activity, and financial "overdevelopment" might be just as or even more detrimental to growth than financial "underdevelopment".[12]

This line of reasoning has been formalized in a number of theoretical multi-sector models. Seminal papers that link financial development with multiple equilibria – the formal equivalent of "poverty traps" – are MURPHY ET AL. (1989) and GREENWOOD/ JOVANOVIC (1990), where externalities and complementarities between inputs into the financial and to the real sector lead to mutual effects on marginal productivities. BERTHÉLEMY/ VAROUDAKIS (1994) formulate an endogenous growth model with reciprocal positive externalities between the financial and the real sector, where growth in the real sector initially helps to transform an oligopolistic into a competitive financial sector, which results in an increase in efficiency. Moreover, competition and improving efficiency help in reducing the interest rate spread, which in turn has positive effects on growth in the real sector. Without an initial "demand pull" from the real sector, the economy thus remains stuck in a poverty trap. Another financial intermediation poverty trap results from the model of LEE (1996). Assuming that financial intermediaries need a solid basis of information about possible applicants before granting a credit and that most of this information stems from being actively engaged in credit banking, we get a stationary equilibrium where the cost of the acquiring information are prohibitively high for potential financial intermediaries. In the model of SAINT-PAUL (1996), the key element is "learning by doing" in the financial sector, which thus gives another rational for a low level equilibrium trap. Yet another big push model is formulated by DA RIN/ HELLMANN (2002), and in this case the driving force are banks that, once they are large enough, can use their market power to invest into coordinated industrial activity.

Apart from these and related theoretical contributions, some recent papers refer to cross-county and panel regressions and find evidence that the theoretical propositions about multiple equilibria and non-linearities do indeed manifest themselves in the data. In particular, HARRISON ET AL. (1999) analyze the financial activity-real development interaction with respect to the cost of financial intermediation in different environments and find that this link can contribute to increasing initial productivity differentials across countries. DEIDDA/ FATTOU (2002) use threshold regressions to confront a financial activity poverty trap model with

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12   For formal derivations of the optimal size for the financial sector in a general equilibrium framework see SANTOMERO/ SEATER (2000) and AMABLE ET AL. (2002).

the data. Using per capita income as their threshold variable, they find support for a threshold of about $800 below which financial activity fails to contribute significantly to economic growth. In a related empirical analysis RIOJA/ VALEV (2004) find that financial activity exerts a positive influence on total factor productivity growth in economically advanced countries. This effect, which they contribute to dynamic improvements in the allocation of factors of production, fails to operate in poorer parts of the world, where they instead find evidence for a volume effect manifesting itself in an increase in saving and investment rates.

Other papers focus on the empirical identification of complementarities between financial activity and other immaterial factors of (or impediments to) production. Inflation thresholds for a negative impact on the finance-growth nexus are highlighted by BOYD ET AL. (2001) and ROUSSEAU/ WACHTEL (2002). GRAFF (2005) shows that the positive link between financial activity and subsequent growth operates only in countries that are classified as high in "rule of law". GUISO ET AL. (2004) find support for the assumption that the efficiency of financial activity to contribute to economic growth is contingent on the provision of social capital and education. In the same line, BERTHÉLEMY/ VAROUDAKIS (2005) look for multiple steady state equilibria due to reciprocal externalities between the banking and the real sector, for which they find empirical correlates in the form of "convergence clubs" that are characterized by similar financial development and educational attainment.

Finally, a few papers find empirical support for the theoretically founded notion of an optimal level of financial activity. MENKHOFF (2000) for example argues that oversized financial sectors have made some economies overly prone to crises, and FAVARA (2003) finds that the positive partial correlation between financial development and subsequent growth of per capita income, which is reported in most of the recent studies on this issue, is non-linear and dominated by intermediate levels of financial development.

To summarise, the recent theoretical and empirical work on the finance-growth nexus has started to direct a new and challenging focus on multiple equilibria as well as empirical poverty traps, thresholds and non-linearities that modify the way in which financial activity affects the rest of the economy. Though still in an initial stage, this new research programme has already produced a number of plausible theoretical explanations for contingency of the finance-growth nexus on a host of factors that constitute the environment into which it is embedded, and empirical analyses, instead of asking "does finance promote growth", have started to investigate under which circumstances this might be the case.

In what follows, I shall perform some explorative analyses in order to deepen our empirical knowledge on thresholds in the finance-growth nexus and the optimum level of finance.

3   Empirical analysis

A large number of empirical studies that include proxies for "financial activity" (*F*) as explanatory variables in cross-country regressions of growth rates of per capita income (or other proxies for economic development and growth *G*) have reported a positive partial correlation between indicators for *F* and *G* in subsequent years.

These findings support the hypothesis that financial activity is one of the ultimate causes of economic growth and development. However, the usual econometric set-up behind these findings suffers from a number of difficulties. In this context – referring to the recent research reviewed above – the main flaw is the assumption of a linear influence of the right hand variables on *G*, which does not allow for development thresholds and poverty traps. I shall hence relax this assumption and instead look for non-linearities in the $F \rightarrow G$ link. In particular, I proceed along the following steps. The first step is to devise a theoretically valid and empirically robust specification for *F* (section 3.1). After this, the basic empirical growth model is specified. This is a standard cross-country growth equation in which the proxy for financial activity *F* serves as one of the explanatory variables (section 3.2). Then a panel regression of the growth rate of per capita income across 90 countries and multiple observations through time (1960, 1965, ..., 2000) is fitted on its presumed determinants. So far, this analysis departs from the standard approach only by incorporating a new proxy for *F* rather than one of the standard variables. I then perform a battery of sensitivity tests that confirm that the basic model sensible and robust. In the final step (section 3.3), the basic model is screened for thresholds in the finance-growth nexus. To this end, I relax the restriction that the point estimate of the coefficient for the *F* regressor, i.e. the marginal contribution of financial activity to growth (controlling for the usual determinants of economic growth) be equal across the entire sample of panel observations. In particular, the panel is repeatedly ordered across dimensions that imply the expectation of shifts or breaks in the finance growth-nexus. For each of these dimensions, a search is conducted for possible locations of a structural break in the basic model by rolling regressions that identify the sample split regarding the *F* regressor that lead to the most pronounced improvement of the model fit. This however invalidates the usual tests for structural breaks, so that I refer to repeated bootstrapping until the sample is broken down into subsamples that are homogenous in terms of marginal contribution of *F* to growth. This results in a description of the finance growth-nexus as non-linear phenomenon where the identified thresholds are delimiting regimes of *higher* and *lower* marginal contribution of financial activity to economic growth.

3.1   A new proxy for financial activity

The usual proxies for financial development or activity rely on money and credit volumes. However, they suffer from a number of shortcomings which cast doubt on their usefulness in

cross-country and intertemporal comparisons. I therefore refer to a new multi-indicator measurement of financial activity that captures not only the degree of monetization or financial intermediation, but – in addition – the share of resources a society devotes to run its financial system. In particular, this measurement approach rests on the assumption that the following set of indicators which taken one by one are affected by a host of problems (first of all limited validity, but dubious reliability go along with this) can jointly be transformed to result in reasonably reliable and valid measure for the intended notion of financial activity:

–   The share of the labour force employed in the financial system,

–   the share of the financial system in GDP,

–   the traditional *F* variable M2/GDP.

The common variance of the three indicators is identified by means of principal component analysis.[13] The resulting encompassing indicator is likely to be more adequate for investigations into the sources of economic growth than the standard proxies for *F*. It comprises more information and can hence be assumed to deliver a better overall representation of financial activity. Moreover, it stands for a resource based concept of financial activity. This notion of financial development is thus different from the common notion of financial depth; it signifies a real rather than a monetary phenomenon.[14]

Practically, to prepare the raw data, the indicator variables were screened for obvious errors and incompatibilities. Then, operational rules were be formulated how to treat missing values.[15] Finally, the data for the 90 countries and nine points in time (1960, 1965, ..., 2000) were pooled into a panel of $N = 810$, and the first principal component was extracted. The first component already accounts for 75% of total variance, and all communalities (i.e. the bivariate correlations *r* between principal component and indicators) are .69 or higher, which clearly implies a one-dimensional data space. Accordingly, in what follows, I shall take the factor values of the first component as the numerical estimates for *F*.

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13   If the correlations between the desired representations are high, but measurement errors or stochastic shocks have little common variance, such a latent variable can serve as a better proxy for *F* than individual scores for a single indicator alone. To come close to this, a "technical" condition is that the indicator variables have to be measured independently. This condition is satisfied here.

14   It is not claimed that the traditional notion of financial depth is not useful, but the degree of monetization and the aggregate credit volume channelled through the financial system – i.e. the "traditional" variables – and the amount of resources needed to run a given financial system stand for different economic functions. While the former inform about the channels of finance, the latter measure the intensity of financial services. Furthermore, the usual indicators of financial development are likely to suffer from ambiguity (expressing monetary and credit volumes as well as overheating and likelihood of financial crash). Moreover, while monetary indicators like M2/GDP are very hard to compare across time and space due to institutional diversity and change, indicators for the magnitude of financial activity are likely to be less sensitive to minor changes in institutional regulations, domestic and international shocks and business cycles.

15   The general strategy was to estimate missing values in time by interpolation, extrapolation, trend analysis, and – where possible – by regression on exogenous variables, but to exclude all observations, where the majority of data would result from estimation rather than from original data.

3.2 Basic empirical growth model

3.2.1 Growth model and reduced form

The recent empirical literature on economic growth commonly starts from an aggregate production function with the traditional factor inputs plus a number additional knowledge-related variables. As a rule, some of the latter are modelled as public goods; partly in the case of human capital; entirely with respect to technical knowledge or growth enhancing organizational features.[16] The standard procedure is then to refer to a theoretical core, the "augmented" Cobb/Douglas aggregate production function that relates GDP in country i at time t to the factors of production

$$Y_{i,t} = A_{i,t}\, K^{\alpha}_{i,t}\, L^{\beta}_{i,t}\, H^{\gamma}_{i,t}, \tag{1}$$

where Y is GDP, A total factor productivity (TFP), K physical capital, L labour and H human capital. Dividing through L, taking logs and time derivates and rearranging terms yields

$$g(Y/L)_{i,t} = g(A)_{i,t} + \alpha\, g(K/L)_{i,t} + \gamma\, g(H/L)_{i,t} + (\alpha{+}\beta{+}\gamma{-}1)\, g(L)_{i,t}, \tag{2}$$

where the notation $g(X)$ stands for the continuous growth rate of X. With constant returns to scale $(\alpha + \beta + \gamma - 1)\, L$ drops from the right hand side of (2).[17]

In (1), knowledge related growth factors can appear both in H and in A. To incorporate the theoretical contributions of the 1990s, the growth rate of TFP – i.e. $g(A)$ – is modelled as a function f of a set of further variables. A general notation for the common linear approach is

$$g(A)_{i,t} = a_0 + a_1 \ln(Y/L)_{i,t-1} + \Sigma_j\, a_j\, X_{j;i,t-1} \tag{3}$$

where $\ln(Y/L)_{i,t-1}$ captures the "catching-up" potential, and $\Sigma_j\, X_j$ stands for all other variables that may exert a significant influence on subsequent TFP growth. The number of other potentially important determinants of $g(A)$ is of course large and remains open to questions. However, it is obvious that if financial activity indeed improved allocational efficiency, it should appear as a significantly positive exogenous variable in the $g(A)$ function. Accordingly, given my focus on financial activity, we get

$$g(A)_{i,t} = a_0 + a_1 \ln(Y/L)_{i,t-1} + a_2\, F_{t-1}, \tag{4}$$

and inserting (4) into (2) yields the reduced form of the basic model

$$g(Y/L)_{i,t} = \beta_0 + \beta_1\, g(K/L)_{i,t} + \beta_2\, g(H/L)_{i,t} + \beta_3 \ln(Y/L)_{i,t-1} + \beta_4\, F_{i,t-1}, \tag{5}$$

where for notational reasons the constant β_0 in equation (5) stands for a_0 in equation (4).

The reduced form (5) is model based, parsimonious and closely in line with what is referred to in the prevailing research, which eases interpretation and comparison with other studies.

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16 See HOOVER/ PEREZ 2000 for an elaboration of this point.

17 A pre-test using the data to be employed in what follows, failed to reject the null hypothesis $\alpha + \beta + \gamma = 1$.

3.2.2 Sample and data

The empirical data cover 90 countries. If not stated otherwise (for details, see appendix), the data are taken from the Penn World Table 6.1, which comprises annual observations from 1950–2000. With regard to data availability, the panel starts in 1960. The observations for every fifth year (1960, 1965, ..., 2000) are stacked, resulting in a balanced panel of $90 \times 9 = 810$ points, or $90 \times 8 = 720$ five-year growth intervals.

Y is measured as real GDP is in "international \$" with 1996 as the common base. Labour L refers to the number of people aged 15–64, so that the endogenous variable is the growth rate of average real GDP is in "international \$" per person aged 15–64 which can be interpreted as both growth of average labour productivity or growth of average income per capita of working age. Capital stocks are computed on the basis of yearly investment rates and a linear depreciation of 10% using the standard perpetual inventory calculus. Human capital intensity H/L is measured as educational attainment (mean years of schooling per person aged 15–65) and taken from the BARRO/ LEE (2000) web-database. Finally activity F is proxied by the first principal component from the multi-indicator measurement model presented in section 3.1.

3.2.3 Cross-country growth regression results

Equipped with straightforward data or at least reasonably well defined proxies for all variables referred to in the reduced form (5), and drawing on my panel data set of 90 countries and 8 growth periods of five years ($N = 720$), we can now examine how the model fits the data. To this end, I estimate the following fixed effects model where $g(Y/L)_{i,t}$ is regressed on its modelled determinants including lagged F as well as 89 dummy variables β_i for 90–1 countries and seven dummy variables β_t for 8–1 growth intervals:

$$g(Y/L)_{i,t} = \beta_0 + \beta_i + \beta_t + \beta_1\, g(K/L)_{i,t} + \beta_2\, g(H/L)_{i,t} + \beta_3 \ln(Y/L)_{i,t-1} + \beta_4\, F_{i,t-1} + \varepsilon_{i,t} \qquad (6)$$

The result of this basic regression is summarised in the first column of table 1.

In the basic fixed effects regression (model 1) the F-statistics for joint significance of the country effects equals 3.41 (df = 7, p < .01) and 1.51 (df = 89, p < .01) for the period effects. Both country and period fixed effects are thus significant on a .01 level so that they are indeed contributing to reduce omitted variable bias. The point estimates for the coefficients β_1 to β_4 are all significant, given their expected signs, in one-tailed tests (t-statistics in brackets, p ≤ .05). Moreover, the magnitudes of the coefficients are compatible with a priori reasoning. Roughly 1/3 for β_1 of is well in line with the empirical production elasticity of physical capital (or capital's factor share) in the traditional Cobb-Douglas-framework, and though little is known about the magnitude of human capital's marginal contribution to growth (in addition to "raw" labour, to which the estimation equation is normalized), a positive elasticity of more than 6% (β_2) is not outside the range of standard calculations of the social rate of return to

human capital. The catching-up variable β_3 enters negatively, as expected. Last but not least, the financial activity coefficient β_4 is significantly positive. Since my proxy for F is a standardised variable without external scale, I cannot give an interpretation in terms of an economic elasticity or factor share for β_4, but the fact that it is significantly positive on a .01 level reveals that what is measured by F exerts a positive influence on subsequent growth of Y/L.

Table 1: Regression of g(Y/L)$_{i,t}$ on determinants of growth

Model	Model 1: basic regression	Model 2: linear time trend	Model 3: no time variables	Model 4: no country dummies	Model 5: simple OLS
β_i	jointly significant	jointly significant	jointly significant		
β_t	jointly significant			jointly significant	
t		–0.001 (–1.70)			
ln(Y/L)$_{i,t-1}$	–0.026 (–5.84)*	–0.032 (–7.63)*	–0.035 (–9.11)*	–0.0001 (–0.26)	–0.001 (–0.33)
g(K/L)$_{i,t}$	0.32 (10.94)*	0.32 (11.25)*	0.32 (11.86)*	0.42 (16.47)*	0.44 (18.22)*
g(H/L)$_{i,t}$	0.064 (1.76)*	0.064 (1.80)*	0.069 (1.97)*	0.049 (1.53)	0.039 (1.19)
$F_{i,t-1}$	0.009 (2.59)*	0.013 (3.74)*	0.010 (3.33)*	0.005 (3.01)*	0.005 (2.73)*
R^2	0.50	0.49	0.48	0.39	0.33
R^2 adjusted	0.42	0.41	0.41	0.39	0.33
N	8×90	8×90	8×90	8×90	8×90

t-statistics in brackets, one-tailed significance tests for regression parameters (two-tailed for time): * $p \leq .05$.

The overall fit of the model ($R^2 = .50$) is not particularly high. Yet a coefficient of determination around 50% is not unusual in cross-country growth regressions, and I am dealing with a

panel of four decades, where other analyses seldom cover more than twenty or thirty years. Moreover, this model is comparatively parsimonious with respect to the number of regressors, so one should expect a considerable share of residual variance. Hence, the fit between data and model is broadly in line with the broad theoretical reasoning behind equation (6).

3.2.4 Sensitivity analysis

Since the aim is to identify of possible thresholds in the finance growth-nexus, we have to ensure that the basic growth regression is a robust implementation of the underlying model.

An informal check for the stability of the results regarding the coefficients consists in re-running model 1 without either country or period or without both country and period fixed effects. Alternatively, we can restrict the time effect to a linear trend t. The results are reported in columns two to five of table 1, showing that while β_1 to b_3 show considerable variation and fail to pass conventional significance levels in some instances, the coefficient β_4 for F remains significantly positive throughout. This informal testing underlines that the full fixed effects specification is superior to more restricted models. In addition, it adds confidence to the function of F in the model.

We now turn to more formal sensitivity tests. First, since this study is concerned with long-run characteristics, we should make sure that its results are not due to the business cycle. To this end, I add the rate of change of a proxy $CapU$ for of overall capacity utilization to my basic regression.[18] The result is shown in the first column of table 2. The overall fit is increased dramatically (from .50 to .83), which implies that a large share of the unexplained variance of the endogenous variable stems from business cycles. Moreover, all explicit regressors, including the financial activity proxy F, remain significantly different from zero with their expected signs. Note however, that β_1 is raised from .32 to .73, which would imply a implausible factor share of physical capital, so that I shall continue without this regressor.

Next, I consider whether the result might be driven by a few influential observations. Different heuristics and procedures are suggested for this, but intersubjectivity is probably best ensured by looking at the studentized residuals, which are asymptotically t-distributed. Taking a low significance level of .1, the tabulation in KLEINBAUM ET AL. (1988: 661) gives a critical value of $|STRES| \geq 3.58$, which is reached for at least one of the panel observations relating to Haiti and Mauritania. Keeping the panel balanced, I remove the 16 observations for these two countries and re-estimate the basic model. The result is shown in the second column of table 2, which reveals a slight increase in R², but qualitatively unchanged results regarding the parameter estimates, implying that these outliers are not responsible for the point estimates.

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18 My measure for overall capacity utilization is the output gap, based on HP filtering of the annual ln GDP series with a smoothing parameter of $\lambda = 100$.

Table 2: Robustness of regression of g(*Y/L*)$_{i,t}$ on determinants of growth

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Model	Model 6: plus capacity utilization	Model 7: |STRES| ≤ 3.58	Model 8 |STRES| ≤ 2 σ	Model 9 |DFBETA| ≤ 2 √ 720	Model 10: bounded influence
ß$_i$	jointly significant	jointly significant	jointly significant	jointly significant	jointly significant
ß$_t$	jointly significant	jointly significant	jointly significant	jointly significant	jointly significant
g(*CapU*)$_{i,t}$	0.77 (35.61)*				
ln(*Y/L*)$_{i,t-1}$	–0.009 (–3.91)*	–0.027 (–6.32)*	–0.024 (–6.75)*	–0.028 (–6.58)*	–0.028 (–7.43)*
g(*K/L*)$_{i,t}$	0.73 (37.66)*	0.34 (11.98)*	0.36 (15.13)*	0.34 (12.31)*	0.33 (14.04)*
g(*H/L*)$_{i,t}$	0.043 (2.11)*	0.083 (2.41)*	0.064 (2.21)*	0.030 (0.89)	0.057 (1.91)*
F$_{i,t-1}$	0.003 (2.04)*	0.010 (3.11)*	0.007 (2.51)*	0.009 (2.68)*	0.008 (3.00)*
R^2	0.83	0.54	0.64	0.58	0.61
R^2 adjusted	0.80	0.46	0.57	0.50	0.55
N	8×90	8×88	680	682	8×90

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t-statistics in brackets, one-tailed significance tests for regression parameters: * $p ≤ .05$.

PINDYCK/ RUBINFIELD (1991: 170) favour a 2σ-criterion and suggest to regard an observation as outlier when the studentized residuals reveal |STRES| ≥ 1.96. In this case this concerns 40 observations. The result of the re-estimation of equation (6) without these outliers in an un-balanced panel is shown in the third column. Removing these outliers from drives R^2 further up, yet, the results regarding the regression coefficients remain virtually unchanged, which adds to my confidence that the results are not driven be a limited number of outliers.

However, these are global tests, so that I can add power to the procedure if I focus on my central variable of interest, the financial activity proxy *F*. To this end, I refer to the *DFBETA* sta-

tistics, which is defined as $(\beta_k - \beta_{k(i)})/\sigma_{k(i)}$, where β_k stands for the point estimate of regressor k, and $\beta_{k(i)}$ as well as $\sigma_{k(i)}$ for the point estimate and its standard error resulting from a re-estimation excluding observation i. DFBETA is thus a standardized measure of the influence of an individual observation on the k-th regressor. According to PINDYCK/ RUBINFIELD (1991: 171) an observation should be regarded as critically influential when |DFBETA| ≥ 2/√n. I hence exclude 38 observations for which |DFBETA| ≥ 2/√720 with respect to the regressor F. The result of this unbalanced panel re-estimation of the basic equation is shown in the fourth column of table 2. R² is again somewhat higher than in the basic regression, but the coefficient β_4 for F is still significantly positive at the .01 level, which implies that the crucial result, the positive partial correlation of financial activity with subsequent growth, is robust in that it is not driven by a few observations.

An alternative to eliminating influential observations is to limit their influence. To this end, I refer to the DFFIT statistics, which measures the change of the predicted value of the endogenous variable when the i-th observation is removed from the sample. On this basis and with critical values from MADDALA (1992), I run a full sample weighted least squares "bounded influence" regression where the weights are $w_i = .34/|DFFIT_i|$ when |DFFIT| ≥ .34 and $w_i = 1$ otherwise. The result of this re-estimation is shown in the fifth column of table 2. Again, the results are qualitatively unchanged and coefficient for F is still significantly positive at the .01 level, implying that the results are robust to reducing the weights of observations with a critically high influence on the predicted value of the endogenous variable.

The last sensitivity check refers to the validity of the proxy for F. Recall that I measure it as the first principal component of three indicators related to activity in the financial sector, assuming that this proxy is more reliable and valid than the usual proxies that refer to money or credit aggregates in relation to GDP. Let us hence try M2/GDP and M3/GDP.[19] How do these variables perform, when I plug them into the basic regression (model 1)? In this framework M2/GDP yields a coefficient that is significantly positive (t = 2.20), M3/GDP, however, does not contribute significantly in accounting for subsequent growth of per capita income (t = 1.44). Accordingly, I find some evidence that compared to the proxy for F, M3/GDP is indeed inferior in representing the contribution of finance to growth. For the established financial development proxy M2/GDP that dominates the empirical literature, one cannot say the same. Both the F proxy and M2/GDP show a significant coefficient with the expected positive sign, and since the corresponding regressions are not nested, they give no hint which of the two we should prefer. I therefore refer to the J-test for non-nested models that compete in explaining the same endogenous variable.[20] The first step of this test consists in running the two rival models – let's call them models A and B – and saving their predicted values. In the

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19   Data are from the Word Development Indicators, online access 2004.

20   DAVIDSON/ MACKINNON (1981).

second step, these are entered as additional explanatory variables in the competing model. If the vector of predicted values resulting from model A adds significantly to reduce the unexplained variance of model B, model A dominates model 2, and the same applies vice versa. Note that the *J*-test can produce inconclusive results, which is the case when neither model dominates its rival or when both add significantly to each other. Comparing three non-nested models that consist in the basic regression (6) where three different proxies for financial activity – the principal component and the two common variables M2/GDP and M3/GDP – are used for to proxy for *F*, the *J*-test produces the following results (see table 3).

Table 3: *J*-test for three competing proxies for *F* in model 1

column: rival to row	principal component	M2/GDP	M3/GDP
principal component	–	1.22 (0.22)	0.54 (0.59)
M2/GDP	1.84 (0.07)[†]	–	–0.49 (0.63)
M3/GDP	2.22 (0.03)*	1.73 (0.09)[†]	–

The table shows the t-statistics (p-values in brackets) for domination by models in columns over models in rows. Two-tailed significance tests: * $p \leq .05$, [†] $p \leq .1$.

The principal component proxy dominates both M2/GDP and M3/GDP as it significantly reduces error variance to models that rely on the dominated variables to proxy for *F* (see column one). The test passes at the .05 level for M3/GDP and at the .1 level for the M2/GDP, implying that the former might be less inferior to the latter. This is confirmed by the test results reported in columns two and three, where both M2/GDP and M2/GDP fail to dominate the principal component proxy and M2/GDP tends to dominate M3/GDP ($p \leq .1$), but not vice versa. Accordingly, the *J*-test is conclusive in suggesting a rank order for the appropriateness of the tested variables to proxy for *F* in the basic regression that puts the principal component on place one, M2/GDP on place two and M3/GDP on place three.

At this stage I feel comfortable to conclude that the basic model is reasonably robust. The sensitivity tests confirm that the basic model is not driven by outliers or high leverage observations, that the *F* measurement model does indeed produce a sensible quantification of financial activity as a determinant of economic growth and that this variable performs better in terms of fitting the data than the usual regressors. Hence, I am now ready for the final step.

3.3   Looking for structural shifts

The final step of my empirical analysis is to look for potential thresholds in the finance-growth nexus that are indicative for poverty traps and big pushes or context specific optimum levels of financial activity.

The recent literature highlights the possibility of an optimum development path F^*_t which is contingent on other dimensions of social and economic development. In particular two dimensions of this contingency that have been repeatedly named in the literature are real development Y/L and highly qualified human capital TER. A theoretical contingency of this type can in general terms be written as

$$F^*_t = f\,[(Y/L)_{t-\varphi},\, TER_{t-\theta})], \quad \varphi,\, \theta \geq 0. \tag{7}$$

In order to make this approach operable for empirical testing, we need to specify the optimality function f in (7) and fit it to the data. Provided that (7) is specified adequately and that the empirical rule is representing (or at least coming reasonably close to) the optimum, the distance $\delta_{i,t} = F_{i,t} - F^*_{i,t}$ can then be interpreted as a measure of observation specific financial underdevelopment (if negative), or excess financial activity (if positive).

Given our present state of knowledge (or rather ignorance), I shall experiment with a number of different specifications for (7). As a baseline, I start with a regression that avoids problems associated with multi-collinearity due to the fact that the level of highly skilled human capital in a country is highly correlated with its per capita income, so that the characteristic features might already be captured in Y/L alone. Assuming a contemporaneous contingency, i.e. setting the lag operators $\varphi,\, \theta = 0$, and allowing for non-linearity we get

$$F^*_{i,t} = \alpha_0 + \alpha_1 \ln(Y/L)_{i,t} + \alpha_2\,(Y/L)_{i,t} + \alpha_3\,(Y/L)^2_{i,t} + \delta_{i,t}. \tag{8}$$

With $R^2 = .75$, this specification fits the 720 observations of the panel remarkably well. Moreover, all regression coefficients are significantly different from zero at the .05 level, which confirms a non-linear relationship. I shall hence regard the 720 residuals $\delta_{i,t}$ from this regression as a measure for the degree of financial imbalance.

Given this, I am ready to conduct a *financial imbalance threshold regression* for the coefficient of lagged F. In particular, I perform 719 repeated sample split regression with β_4 set free across subgroups, where the total is divided into a group that scores low on $\delta_{i,t}$ and a corresponding high scoring group. Practically, we obtain $n = 719$ sample splits by defining a vector of dummy variables $D(\delta)_n$ that equals zero if an observation belongs to the low-scoring subgroup and one otherwise, and n denotes the rank position of the split variable $\delta_{i,t}$ in ascending order. Then, the product $D \times F_{i,t-1}$ is added as an additional regressor to (6) so that

$$g(Y/L)_{i,t} = \beta_0 + \beta_i + \beta_t + \beta_1\,g(K/L)_{i,t} + \beta_2\,g(H/L)_{i,t} + \beta_3 \ln(Y/L)_{i,t-1} + \beta_4\,F_{i,t-1} \tag{9}$$
$$+ \beta_5\,D \times F_{i,t-1} + \varepsilon_{i,t}\,,$$

which I run 719 times (i.e. for n = 1, 2, ..., 719). For every n, we get a corresponding β_5 which is the point estimate of the difference of β_4 between group $D_n = 1$ and group $D_n = 0$. The corresponding t-statistics are indicative for the drop in the sum of squared error variance as compared to the restricted basic model where $\beta_5 = 0$, so that we can readily identify the location of the split that is optimal in improving the fit of the model to the data. However, this procedure invalidates the t-test for structural breaks, since the sequential search for the optimum split process deprives us of the null hypothesis of "no structural beak". Therefore, I follow a strategy proposed by HANSEN (1999, 2000) which is to refer to bootstrapping. In particular, at a candidate location for the optimum sample split suggested by the t-statistics, I run a specifically tailored non-parametric test.[21] In particular, this test relies on 1000 regressions according to equation (9) that are based on bootstrapped samples, each of which is resulting from 820 draws with replacement from the original data set. The 1000 bootstrap point estimates $\beta_5 = 0$ are saved, and the 5% and 95% percentiles are determined, which provides us with the upper and lower limits of the difference of the regression coefficients for F between the two subsamples. Whenever a possible threshold location survives the bootstrap, the screening and testing procedure is repeated in both of the resulting subsamples, and this is carried on until the original sample is broken down into subsamples that are homogenous in terms of marginal contribution of F to growth.

The screening and test results can conveniently be displayed as graphs. The screening results point estimates and t-statistics for β_5, which I plot on the vertical axis, for all of the possible 719 sample splits excluding some 30 split points at the left and right margins, which are disregarded because subsamples below cell numbers of 30–40 are too small to constitute homogenous *groups* and hence do not allow for generalisations. To facilitate interpretation, I add a zero line and mark the ±1.961 limits of that would apply for 5%-significance if a two-tailed t-test were feasible. Note that in the absence of systematic shifts or breaks in the finance-growth nexus with respect to a given threshold control variable, the t-statistic plots should not exhibit any pronounced peaks or troughs. To illustrate this, graph 1 shows the result for a threshold screening with respect to a random variable. As expected, the point estimate for β_5 fluctuates around the zero line in an irregular manner, and the t-statistics hardly go beyond ±1. Accordingly, no candidate for a sample split emerges from this procedure.

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21   The Hanson threshold test HANSEN (1999, 2000), which has recently gained some prominence and for which Hansen's GAUSS programme is downloadable on his website, is not feasible for my purposes, since it is designed to screen and test for thresholds regarding a regression as a whole, whereas I focus on one parameter – the coefficient for F – only and restrict all others to be equal across subgroups. I therefore modify the Hansen test for thresholds regarding a single parameter. This procedure ensures to satisfy the *ceteris paribus* condition without which the coefficient for F would not be comparable across subgroups.

Graph 1: Threshold variable: random; point estimate and t-statistics for β_5; traditional 95% confidence interval
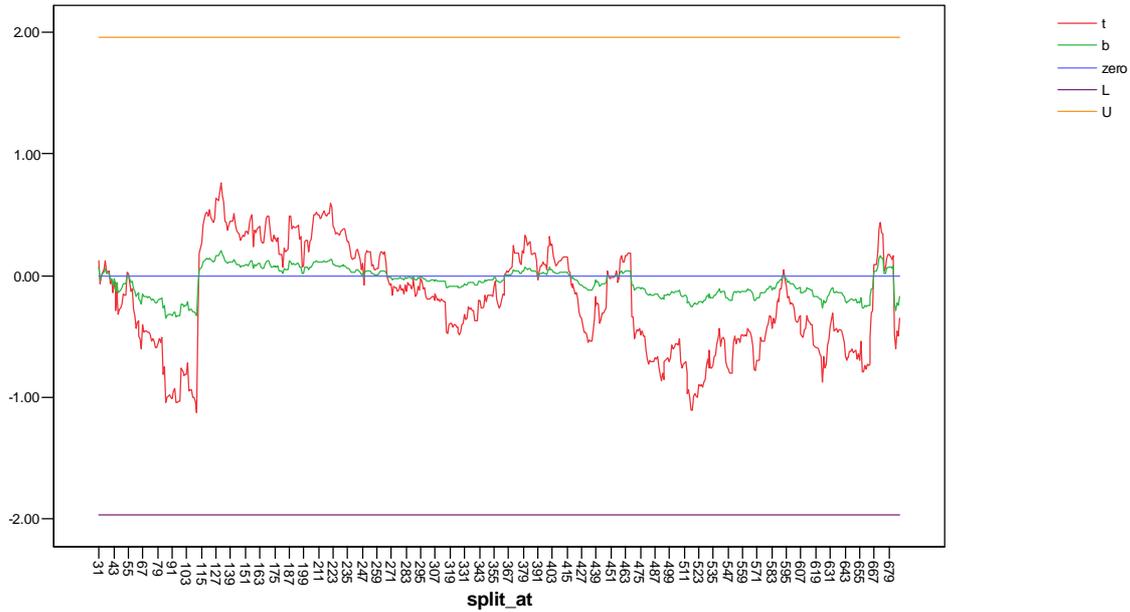

A very different picture results when I perform this test with respect to the financial imbalance proxy δ from the balanced growth path regression (8). As graph 2 shows, there is a peak at observation 147 with t = 2.14, which would pass a conventional test. The trough at observation 465 is slightly less pronounced, so that observation 147 is the fist candidate for bootstrapping. As graph 3 shows, the break point indeed survives the bootstrap; less then 2.5% of the bootstrapped coefficients fall below zero (the value of the β_5 distribution at the 2.5% percentile equals 0.46 which is positive), so that a two-tailed 5% significance test is passed.

Graph 2: Threshold variable: $\delta_{i,t}(Y/L)$; full sample point estimate and t-statistics for β_5; traditional 95% confidence interval
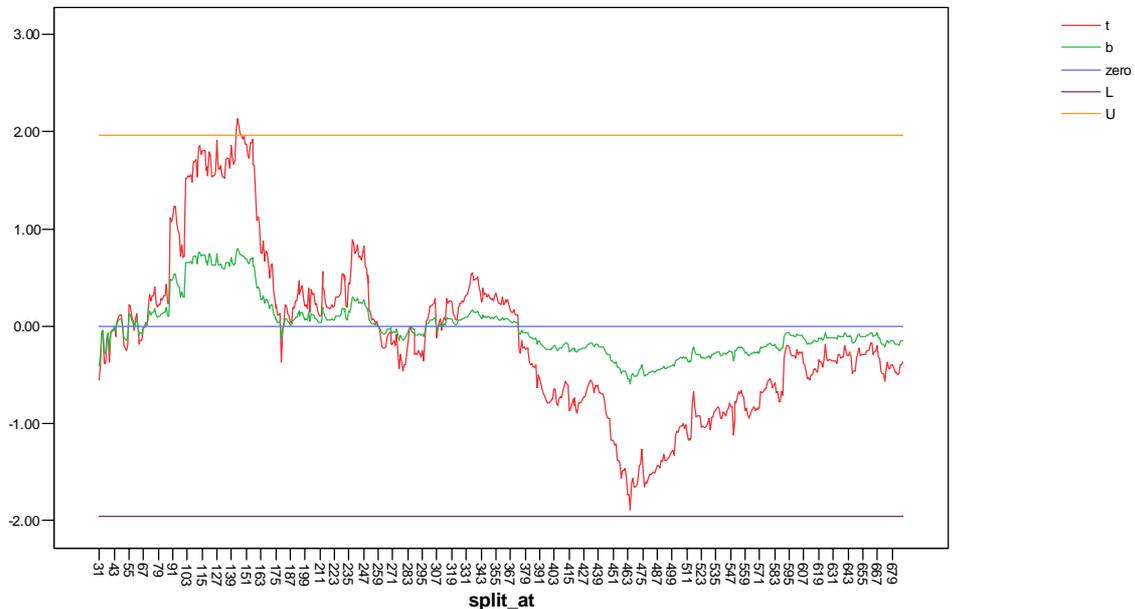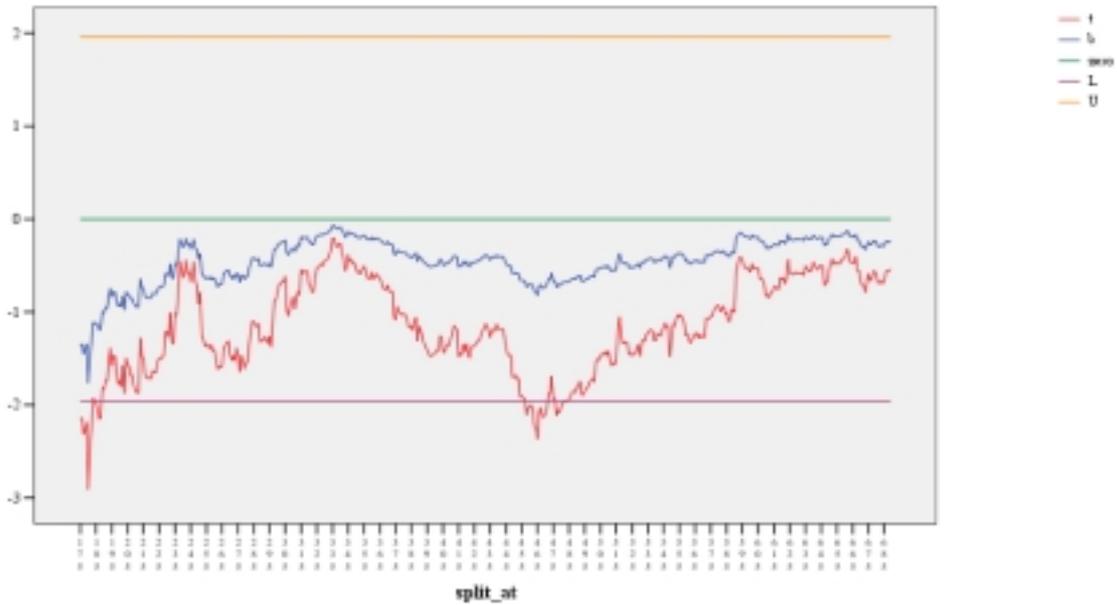
Graph 3: Threshold variable: $\delta_{i,t}(Y/L)$; full sample point estimate bootstrap (n=1000) for β_5 at observation No. 144
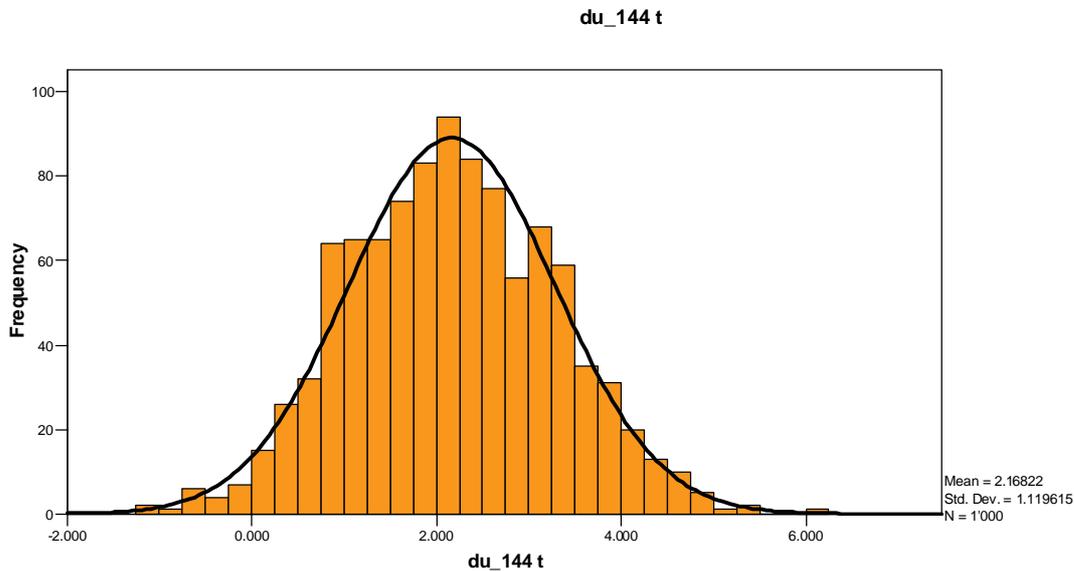

To interpret this result, recall that $\delta_{i,t}$ is the deviation of $F_{i,t}$ from $F^*_{i,t}$, given $(Y/L)_t$. For the test at observation 144, $D(\delta)_{144}$ equals zero for all points from there to the left, and one for all points to the right. In this case, a significantly positive β_5 implies that taken together, the subgroup to the left – characterised by relatively low levels of financial activity with respect to the yardstick from the balanced finance equation (8) – is ceteris paribus benefiting less from the same degree of financial activity than the subgroup to the right, characterised by relatively high levels of finance. Accordingly, this finding is consistent with the proposition of a threshold value that constitute a potential poverty trap for roughly 20% (144:720) of the countries that devote less then the optimum amount of resources to run their financial sectors.

Yet, the story does not end here. I now submit the two resulting subsamples to the same screening and testing procedure, and whereas no further candidates for a threshold show up at the left, the screening of the subsample ranging from observation 145–720 reveals two troughs that might constitute potential thresholds, one at observation 177 and another at observation 465 (see graph 4). Since observation 177 is less than 40 steps away from the first identified threshold, I disregard this candidate and proceed to perform the bootstrap at observation 465 (t = –2.37). Graph 5 shows a histogram of the 1000 bootstrapped point estimates for at this location β_5. More than 97.5% of the distribution lies below zero (at the 97.5%-percentile, the value is –.14), so that this constitutes a second threshold. In this case, the group of 355 that is found to be most unbalanced in having driven its financial development beyond the individual optimum levels in regression (8), i.e. close to 45% of the total sample, benefits less from a given level of financial activity than the group of observations 145–465.

Graph 4: **Threshold variable: $\delta_{i,t}(Y/L)$; sample = observations 145–820, point estimate and t-statistics for β_5; traditional 95% confidence interval**

Graph 5: **Threshold variable: $\delta_{i,t}(Y/L)$; sample = observations 145–820, point estimate bootstrap (n=1000) for β_5 at observation No. 147**
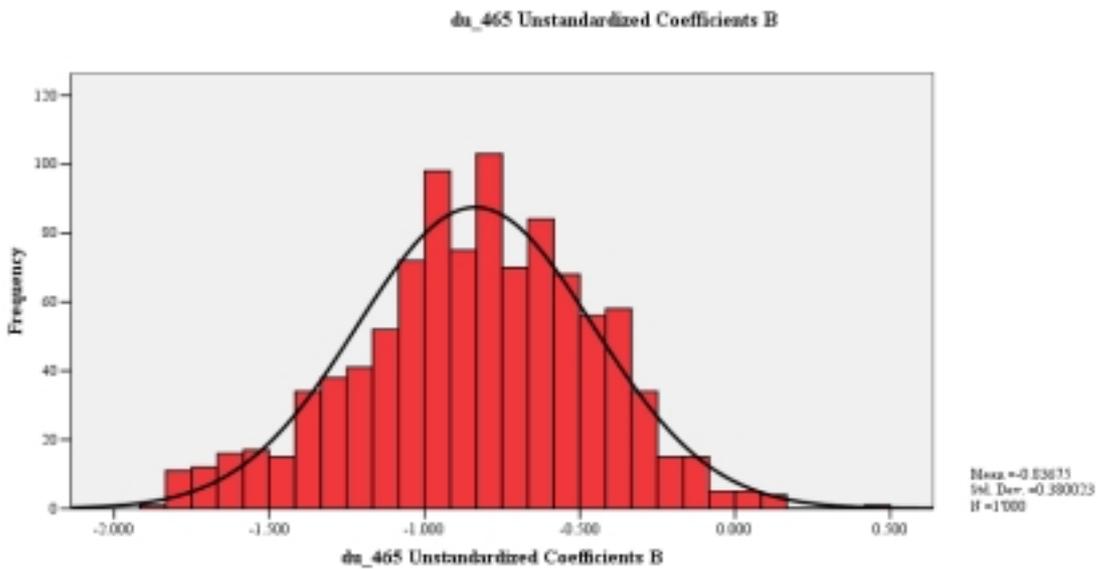
The two groups resulting from the second split were again screened for possible thresholds, but no further candidates showed up. Accordingly, I find that the overall sample of 820 is characterised by two thresholds with respect to the deviation of an observation from its optimum level. In particular, on the continuum from financial underdevelopment to excess activity, the lowest scoring 20% benefit less from the same level of financial activity than the in-

termediate 35%, and these in benefit more than the 45% that score highest on the "deviation from optimum" scale.

This interpretation rests on the validity of this approach to determine the optimum level of finance in terms of equation (8). To check for robustness, I hence tried out a large number of different specifications of the general approach (7). Expressing human capital resulting from enrolment in tertiary education institutions *TER* in terms of mean years per adult of the population (from BARRO/ LEE 2000), I ran regressions of *F* on both *Y/L* and *TER* and on *TER* alone and, repeating the screening and testing procedures reported above, found repeated evidence for a poverty trap threshold in the financially relatively underdeveloped group as well as for a threshold that indicates excess financial activity.[22]

In other words, based on the assumption that the empirical fits of the "balanced finance" equations are useful approximations to the optimum level of finance, the subsequent analyses have revealed a non-linear relationship where under-as well as over-development of the financial sector impairs its efficiency in contributing to overall economic growth and development. This gives empirical support to the concept of an optimum level of finance that is contingent on a country's development.

4   Summary and conclusions

Many recent empirical studies include proxies for "financial activity" (*F*) as explanatory variables in cross-country regressions of growth rates of per capita income (or other proxies for economic development and growth) on its supposed determinants. These studies have repeatedly reported positive partial correlation between different indicators of *F* and growth rates of per capita income or investment in subsequent years.

Only a small fraction of this literature, however, devote attention to possible breaks, poverty traps, imbalance effects and structural shifts in the finance-growth nexus. In fact, the linear approach that dominates empirical studies on the effect of financial activity and growth, may not be appropriate.

Starting from the notion of a "balanced" degree of financial development that is contingent on a country's general level of development, I argue that financial activity can be both too low and too high in terms of efficiently contributing to economic growth and development.

I then develop an empirical framework to address this point. To this end, I first fit the data (referring to a panel of 90 countries from 1960–2000) to a standard growth equation which –

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22   The R²s obtained range from .44 to .75. Low level thresholds that pass the bootstrap test fall in the range of observations 88–304, and upper thresholds between observations 309–593. Accordingly, the thresholds at 144 and 465 that result from the baseline specification (8), lie well centred in the range of locations that can be found with different specifications of (7), which adds confidence to the balanced finance equation.

apart from the focal variable: a proxy for financial activity – includes the usual growth regressors as well as fixed country and period effects. Then, I order the sample by a new measure of financial imbalance which results from fitting a "balanced" finance regression. Finally, I refer to exploratory threshold regressions and a bootstrap test for structural shift of the finance regressor in the growth equation. I find that countries seem to gain less from a given level of financial activity, if the latter fails to keep up with or exceeds what would follow from a well balanced expansion path given its overall state of development.

This paper hence contributes to the literature on the finance-growth nexus in providing empirical support for the notion of "balanced" financial development with a development specific optimum level of financial activity as well as two thresholds for relative financial underdevelopment and a wasteful excess levels of financial activity.

5 Appendix: country sample, data and sources

The sample consists of all countries for which the necessary data could be collected, with the exception of very small countries (population less than one million), of countries with centrally planned economies through most of the period 1970–90, of countries in which oil exports accounted for more than 20% of GDP in 1985, and of countries with war or civil war claiming a death toll exceeding 2.5% of the population during 1970–88. The exclusion of these countries is to acknowledge that it makes little sense to run regressions with countries which are fundamentally different from usual conditions (HARBERGER 1998). Ordered by their per working age capita income, the World bank codes for the countries in the sample are:

> TZA BDI BFA ETH MWI ZAR BEN NPL NER RWA HTI LSO MLI KEN IND
> NGA TGO SLE GHA BGD CAF ZMB PAK LKA TCD GIN CMR IDN THA
> CIV MRT PNG ZWE HND JAM EGY PHL BOL BWA TUR MAR DOM SYR
> KOR MYS SLV PRY COL NAM IRN ECU GTM TUN PER CRI PAN CHL
> BRA DZA JOR HKG PRT URY MEX ZAF VEN SGP JPN TTO IRL ARG GBR
> ISR GRC FIN ESP NZL SWE DNK NOR AUT GER FRA AUS CAN ITA BEL
> NLD USA CHE.

Income (*Y*) is measured in "international $" with 1996 as the common base and taken from the Penn World Table 6.1 (HESTON ET AL. 2002).

Labour (*L*) refers to the number of people aged 15–64 (source: HESTON ET AL., 2002).

Physical capital (*K*) is estimated by the perpetual inventory method as specified for LDC's by HARBERGER (1978) and refined by NEHRU/ DHARESHWAR (1993), using a common depreciation rate of 10%.

Human capital (*H/L*) is taken from the BARRO/ LEE (2000) web-data base (http://www.cid.harvard.edu/ciddata) referring to mean years of schooling in the population aged 15–65.

Highly qualified human capital (TER) is proxied by the share of the working age (15–65) population with tertiary education as tabled in the BARRO/ LEE (2000) web-database (http://www.cid.harvard.edu/ciddata).

CapU is the output gap Y_i/Y_i^*-1, where Y_i^* results from HP filtering of the annual ln GDP series (Y_i) with a smoothing parameter of ($\lambda = 100$) and subsequent de-loging.

Financial activity (*F*) is computed as the first principal component of three standardized indicators for financial activity:

(1) the share of the financial sector in GDP (from the UN NATIONAL ACCOUNT STATISTICS, referring to "finance, insurance and business services". The series have been extended by corresponding data from the Word Development Indicators online access data base),

(2) the share of labour employed in the financial system (from the ILO YEARBOOK OF LABOUR STATISTICS. The corresponding ISIC-2 classification is "major division 8": financial institutions, insurance, real estate and business services),

(3) *M2/GDP* is taken from the Word Development Indicators (online access 2003).

M3/GDP is likewise from the Word Development Indicators (online access 2003).

Descriptive statistics for variables in the growth equations (n = 720) are given below.

Variable	Minimum	Maximum	Mean	Standard deviation
$g(Y/L)_{i,t}$	–12%	13%	1.6%	3.2%
$g(K/L)_{i,t}$	–11%	22%	1.8%	4.0%
$g(H/L)_{i,t}$	–12%	33%	2.3%	3.2%
$g(CapU)_{i,t}$	–11%	15%	0.0%	3.1%
$\ln(Y/L)_{i,t-1}$	6.48	10.93	9.08	1.07
$F_{i,t-1}$	–1.39	4.44	.00	1.00

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