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**Working Paper**

## What determines the finance-growth nexus? An endogenous growth model and empirical evidence

KOF Working Papers, No. 73

**Provided in Cooperation with:**

KOF Swiss Economic Institute, ETH Zurich

*Suggested Citation:* Graff, Michael; Karmann, Alexander (2003) : What determines the finance-growth nexus? An endogenous growth model and empirical evidence, KOF Working Papers, No. 73, ETH Zurich, KOF Swiss Economic Institute, Zurich

This Version is available at:

<https://hdl.handle.net/10419/50832>

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# Arbeitspapiere/ Working Papers

Michael Graff and Alexander Karmann

What Determines the Finance-Growth  
Nexus? An Endogenous Growth Model  
and Empirical Evidence

# What Determines the Finance-Growth Nexus? An Endogenous Growth Model and Empirical Evidence

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Zurich and Dresden  
6th of June 2003

## **Abstract:**

An endogenous growth model on finance and growth is formulated, and empirical analyses are conducted. The model exhibits structural shifts and breaks caused by institutional changes, suggesting that a linear approach is inadequate. To address this point empirically, we fit data for 90 countries from 1960–2000 to a standard growth equation with a proxy for financial activity. Firstly, it is shown that a growth enhancing outcome of financial activity is contingent on a sound institutional framework. Then, we order the sample by control variables which follow from the model as potential causes of breaks in the adjustment process. Threshold regressions reveal non-linearities that are consistent with the model. Most importantly, we find signs for excessive financial development.

JEL-Classification: O16, O42, O57

## **Keywords:**

Financial Development, Endogenous Growth, Cross-country Regressions,  
Institutions, Non-linearities

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# What Determines the Finance-Growth Nexus? An Endogenous Growth Model and Empirical Evidence

## 1 Introduction

During the last few years, there has been a revival of research on the finance-growth nexus, referring to a variety of methodological approaches, which has led to an impressive output both quantitatively and qualitatively. Nevertheless, comparatively little is known about the interaction of financial activity on the one hand and other economic, social, or political phenomena which by themselves are determinants of economic development and growth, or constitute the framework under which the financial system has to operate. This paper aims at addressing some of these questions.

The recent literature concerned with finance and growth can be loosely grouped into four categories. Firstly, financial activity and economic growth are seen as not causally related. In this view, the observable correlation between them is spurious: economies grew, and so did their financial sectors, but the two followed their own logic. Secondly, financial activity is seen as the result of economic activity. As the growing scale of economic activities requires more and more capital, institutional raising and pooling of funds for industry are substituted for individual fortunes and retained profits. It is fair to say, however, that due to the new literature in this field, these two perspectives have lost ground. On the other hand, a third – and now certainly the most prominent – strand of the literature identifies financial activity as a determinant of economic growth.<sup>1</sup> Specifically, recent theoretical models give rationales for the assumption that well functioning monetary and banking systems and capital markets may be crucial for economic growth. The arguments vary, but Schumpeterian authors as well as some Neo-Keynesians usually 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. Fourthly, some scholars see financial activity – at least occasionally – as an impediment to real economic activity.<sup>2</sup> Here, the focus lies on the potentially destabilizing effects of financial overtrading and crises, and the financial system is regarded as inherently unstable.

Unfortunately, there is no simple procedure to determine which view is empirically adequate, since the factors that govern economic growth admittedly include many others besides financial development; and interactions among them are likely to prevail.

A first way to address these questions empirically is obviously to look whether economic history offers any answers. We think that there are indeed at least some fairly general conclusions.

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1 The standard reference as the seminal contribution is KING/LEVINE (1993), though this 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 an authoritative survey of many of his widely cited results, see LEVINE (1997). After this survey, the literature has multiplied, and Levine and his co-authors are to this date setting important accents on the agenda. This line of research has been followed among others, by, DE GREGORIO/GUIDOTTI (1995), BERTHÉLEMY/VAROUKAKIS (1996) and RAJAN/ZINGALES (1998). For a recent study see BENHABIB/SPIEGEL (2001).

2 Apart from a few "monetary cranks", a wide range of distinguished economists give arguments supporting this view, among others KEYNES (1936), KINDLEBERGER (1978), DIAMOND/DYBVIIG (1983), SINGH (1997), and CHANCELLOR (1999).

As scholars of economic and financial history have convincingly argued,<sup>3</sup> in the now developed countries, modern financial systems generally evolved during the very early stages of their industrialization. Moreover, financial development – as measured by GOLDSMITH'S financial interrelation ratio (conveniently proxied by M2/GDP) – generally leveled off after a few decades, reaching its fully developed stage<sup>4</sup> by the beginning of the twentieth century.

These historical observations imply that in the process of industrialization, finance may have been a growth-stimulating rather than a growth-induced phenomenon.

In addition to this, the traditional financial sectors of the present LDC's are not dissimilar to the financial systems of the DC's prior to their industrialization. As many observers have noted,<sup>5</sup> financial dualism is the rule outside the developed part of the world: enclaves of modern finance, mostly located in the commercial center, serve but a few export oriented firms, whereas the majority of economic transactions takes place in the traditional sector which – leaving aside local peculiarities – is basically functioning in the same way as it did in the now developed countries before their industrialization. This observation implies that in the financially and economically less developed countries, there might be a latent, but unexploited potential for growth.

On the other hand, however, 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 probably not especially helpful to promote growth and development in the long run.

Hence, in poor countries, the potential benefits from financial development might be more than outweighed by their disadvantageous starting point. In addition to this, the benefits of financial development with respect to growth and development could be contingent on the economic and institutional environment with the result of various "poverty-traps", where a corresponding "big push" is the only way out.<sup>6</sup> Moreover, without "rule of law" and/or "trust", financial interrelations and contracts cause more transaction costs than in more favorable environments.<sup>7</sup> In addition, the character of social organization may affect the way in which financial interrelations operate, so that both the level of financial activity and the type of financial system are embedded in the socio-economic and political environment in which they are supposed to function.<sup>8</sup>

Finally, financial development is a skill-intensive element 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 – from a macro perspective – implies considerable opportunity costs.<sup>9</sup> Our argument is therefore that the

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

4 Note, however, that financial interrelation ratios for developed economies vary considerably (from less than unity to up to three) from country to country due to different institutional frameworks such as government provision of pension schemes, structure of the housing market or the level of commitment to rules and norms in financial relations.

5 SHAW (1973), MCKINNON (1973), FRY (1995), to mention just the most prominent.

6 Seminal papers on "poverty traps" and "big pushes" with respect to financial development are MURPHY ET AL. (1989), GREENWOOD/JOVANOVIC (1990) and GREENWOOD/SMITH (1997). HARRISON ET AL. (1999) analyse the financial activity-real development interaction. An inflation threshold is highlighted by ROUSSEAU/WACHTTEL (2002).

7 See e.g. CLAGUE ET AL. (1997), LA PORTA ET AL. (1998), LEVINE (1999), GRAFF (2003b).

8 See e.g. LEVINE (1999), TADESSE (2002), GRAFF (2003a).

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

marginal contribution of the financial system to economic development cannot be evaluated without an analysis of its interactions with a country's human capital resources, and the suspected interactions are by no means obvious. A priori, the optimum development path might be a balanced co-movement of human capital and financial development, but it could just as well pay to channel highly skilled human capital into the financial sector at higher rates during certain stages, whereas the joint overall contribution to growth might make it more appropriate to employ more human capital outside the financial sector during other stages. In this paper we are going to address some of these questions formally as well as empirically.

## 2 Theoretical analysis

Our framework for the theoretical part is the theory of endogenous growth where we stress the role of human capital inside and outside the financial sector. Human capital enters the aggregate production function of a developed economy in two ways: Firstly, as an input factor for production. Secondly, professionals in financial institutions or on capital markets add to efficient capital allocation by channeling funds into innovative use or by gathering and processing information. Hence, when human capital is highly specialized, it may support both the production of output and adding to sophistication in the financial sector.<sup>10</sup> In this view, we model financial engineering as specialized work which can improve the level of technological efficiency.

### 2.1 What Constitutes the Finance Growth-Nexus

The possibility of a causal relationship between financial development (*FD*) – broadly defined as an increase in the volume of financial services of banks and other financial intermediaries as well as of financial transactions on capital markets – 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, partly unintended (external), effects of financial activity and development on overall economic performance:

- firstly, 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,<sup>11</sup>
- secondly, a *volume effect*, where financial activity increases savings and thereby resources that can be channeled into investment, and
- thirdly, an *allocation effect*, according to which *FD* improves the allocation of resources devoted to investment.<sup>12</sup>

In earlier periods, the first effect of financial development – monetization – was obviously of major importance (EINZIG, 1949). Today, however, its importance is certainly marginal. Moreover, the volume effect is theoretically ambiguous, since sounder financial institutions may guarantee higher interest rates and reduce the incentives for precautionary savings; besides, the empirically evidence is at best very weak (FRY, 1995).

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10 See ROMER (1993: 544) for an earlier model with the financial sector as an immaterial factor of production.

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

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

Hence, if financial development is supposed to play a decisive role in growth and development in our time, the major line of causation should be through improvements in the process of capital accumulation.

From a macro perspective, this allocational service is by no means costless. Quite to the contrary, it absorbs resources, most of all highly specialized and motivated human capital, which might be more helpful to foster economic growth and development when employed otherwise. Hence, while financial activity certainly has a growth enhancing potential, financial "overdevelopment" might be even more harmful than financial "underdevelopment". Our model will look at this in some depth.

## 2.2 An Endogenous Growth Model with Financial Activity-Human Capital Interaction

In this section, a growth model is considered where financial development is based on human capital in two different ways: firstly, part of human capital in the financial sector serves as a direct input factor in the production technology; secondly, part of human capital which is employed in financial business to process information for innovative use adds to technological efficiency of the economy. This is a model where financial development is already in a sophisticated stage.

We adopt an endogenous growth Uzawa/Lukas version (LUCAS, 1988) with product differentiation à la Grossmann/Helpman, as being proposed by FUNKE/STRULIK (2000). We assume knowledge accumulation to boost final-good production technology, but we allow knowledge to enter as an input factor to specialize in real-production process knowledge and in financial-intermediation process knowledge, while FUNKE/STRULIK (2000) treat human capital as an homogeneous input factor of production.

Using a social planner's framework, our model can thus be described as follows. A single homogenous final good  $Y$  is produced with a Cobb-Douglas technology

$$Y = AD^\eta K^\beta H_R^{\gamma_R} H_F^{\gamma_F}, \quad (1)$$

where  $A > 0, \beta, \eta, \gamma_R, \gamma_F > 0$  and  $\beta + \eta + \gamma_R + \gamma_F = 1$ .  $D$  is an index for financial intermediation skills,  $K$  is physical capital, and  $H$  is human capital, which splits into four parts

$$H = H_R + H_F + H_n + H_H. \quad (2)$$

$H_R$  and  $H_F$  are input factors specialized into real and financial engineering in the final-good production,  $H_n$  is accumulated knowledge on financial intermediation which boosts the level  $D$  of intermediation skills by

$$\dot{H}_n = \delta H_n \quad (3)$$

$$D = \left( \int_0^n \bar{x}(i)^\alpha \right)^{1/\alpha} = n^{\frac{1}{\alpha}} \bar{x} \quad \text{for } x(i) \equiv \bar{x}, \quad (4)$$

where  $\delta \geq 0$  is an efficiency parameter of financial intermediation knowledge, and  $\alpha$  controls the rate of substitution  $\varepsilon = 1/(1 - \alpha)$  between different financial intermediation services  $i$ , where the quantities  $x(i)$  are assumed to be the same (due to identical technology and symmetric demand); and  $H_H$  is spent on the development of skilled labor, i.e.

$$\dot{H} = \xi H_H, \quad (5)$$

where  $\xi > 0$  is an efficiency parameter of the society's ability to enforce the development of working skills. In the following, we say that an economy is characterized by *sophisticated financial intermediation* if  $H$  splits according to equation (2).

The social planner's problem is to maximize the society's inter-temporal utility function

$$U = \int_t^{\infty} \left[ e^{-\rho(\tau-t)} (C^{1-\theta} - 1) / (1-\theta) \right] d\tau, \quad (6)$$

where  $\rho > 0$  denotes the time preference rate,  $0 < 1/\theta < 1$  is the inter-temporal elasticity of substitution and  $C$  is consumption. Thereby, utility optimization is subject to the resource constraint

$$\dot{K} = Y - C - n\bar{x} \quad (7)$$

and carried out by using  $C, \bar{x}, H_R, H_F$  and  $H_n$  as control variables. The state variables are  $K, n$  and  $H$ . The costate variables of  $H$  are denoted by  $\lambda, \mu$  and  $\nu$ . A first inspection of the current value Hamiltonian

$$J = U(C) + \lambda [A(n^{1/\alpha}\bar{x})^\eta K^\beta H_R^{\gamma_R} H_F^{\gamma_F} - C - nx] + \mu [\delta H_n] + \nu [\xi H_H] \quad (8)$$

shows that our model can indeed be reduced to a model where only the total amount  $H_Y := H_R + H_F$  of human capital matters as input factor, because the proportions  $H_R/H_Y$  and  $H_F/H_Y$  are always held at their relative production-elasticity levels  $\gamma_R/(\gamma_R + \gamma_F)$  and  $\gamma_F/(\gamma_R + \gamma_F)$ . Indeed, the first order conditions for  $J$  w.r.t.  $H_R$  and  $H_F$  immediately imply  $H_R/H_F = \gamma_R/\gamma_F$ .

**Proposition 1.** Maximizing utility (6) under the constraints (3), (5) and (7) does not change when replacing the technology (1) by

$$Y = A_1 D^\eta K^\beta H_Y^{1-\beta-\eta}, \quad (1')$$

where

$$A_1 := A \gamma_R^{\gamma_R} \gamma_F^{\gamma_F} / (\gamma_R + \gamma_F)^{(\gamma_R + \gamma_F)} < A \quad (9)$$

and  $H_Y = H_R + H_F$ . Thereby, we identify

$$H_R := H_Y \gamma_R / (\gamma_R + \gamma_F)$$

and

$$H_F := H_Y \gamma_F / (\gamma_R + \gamma_F). \quad (10)$$

Hence, our model of an economy with sophisticated financial intermediation just reduces to the GH model variant considered in FUNKE/STRULIK (2000) of an innovative economy with one human capital input factor  $H_Y$  of size  $H_R + H_F$ , by changing the scaling factor of technological efficiency from  $A$  to  $A_1$  appropriately, where  $A_1 < A$ . This change has a level effect on output but does not affect the steady-state characteristics. This means that an



economy with sophisticated financial intermediation ('stage III') has the following simple characteristics for the steady-state growth rates  $g_Y^* = g_K^*$  and  $g_H^* = g_n^*$ :<sup>13</sup>

$$g_Y^{III*} = g_K^{III*} = (\xi - \rho) \frac{A_5 + 1}{(\theta - 1) + \theta A_5} \quad (11)$$

and

$$g_H^{III*} = g_n^{III*} = (\xi - \rho) \frac{A_5}{(\theta - 1) + \theta A_5}, \quad (12)$$

where  $A_5 := \frac{\alpha}{1-\alpha} \frac{1-\beta-\eta}{\eta}$ . From equations (11) and (12), we have

$$g_K^{III*} > g_H^{III*}. \quad (13)$$

We proceed by considering different stages of financial intermediation. Let us consider the case where no innovation takes place, i.e.  $\dot{n} = 0$ . As FUNKE/STRULIK (2000: 499) point out, equation (1') then can be rewritten in a condensed version by accounting for the trade-off between  $Y$  and  $\eta$  where the number  $n$  of innovative activities is held constant:

$$\bar{x} n = \eta Y. \quad (14)$$

This follows from the first order condition w.r.t.  $\bar{x}$ . Inserting equation (14) into  $D = n^{1/\alpha} \bar{x}$  and rearranging for  $Y$  yields

$$Y = \left( A_1^{\frac{1}{1-\eta}} \left( \eta n^{\frac{1-\alpha}{\alpha}} \right)^{\frac{\eta}{1-\eta}} \right) K^{\frac{\beta}{1-\eta}} H_Y^{\frac{1-\beta-\eta}{1-\eta}}. \quad (1'')$$

Hence, total factor productivity  $\beta/(1-\eta) - (1-\beta-\eta)/(1-\eta)$  again sums up to one for any given number  $n$  of innovative activities.

Characterizing an economy of *advanced financial intermediation* ('stage II'), we assume that there are no further innovations, i.e.  $\dot{n} = 0$ , and that there are no innovation skills, i.e.  $H_n = 0$ , but working skills may specialize into factor substitutes  $H_R$  and  $H_F$ . The steady-state growth rates of  $Y$ ,  $K$  and  $H$  are then identical and given by

$$g_Y^{II*} = g_K^{II*} = g_H^{II*} = (\xi - \rho) \frac{1}{\theta} \quad (15)$$

and

$$g_n^{II*} = 0. \quad (16)$$

Comparing equations (15) and (11), we conclude that an economy with sophisticated financial intermediation grows at an higher steady-state rate than an economy with advanced financial intermediation because

$$\frac{g_Y^{III*}}{g_Y^{II*}} = \frac{\theta (1 - A_5)}{\theta (1 - A_5) - 1} > 1. \quad (17)$$

An early stage of financial intermediation may be characterized by human resources being so scarce that a perpetual accumulation of knowledge in financial services cannot be sustained

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13 See FUNKE/STRULIK (2000: 13–14, and appendix)

by the economy. Formally, in an economy with *rudimentary financial intermediation* (stage I) there will be only one type of knowledge,  $H_R$ , being used as a flexible input in the production.  $H_F$  is either kept at some constant level  $\bar{H}_F$  causing some kind of imbalance effect, or, more restrictively, output elasticity of  $H_F$  does not differ significantly from zero, say  $\gamma_F = 0$ . To ease comparison between stage-I and stage-II growth rates, we assume that for the stage-I and stage-II technologies the scaling factors  $A$  of technological efficiency and the capital productivity  $\beta$  are the same. For stage I, we have

$$Y = \left( A^{\frac{1}{1-\eta}} \left( \eta \quad n^{\frac{1-\alpha}{\alpha}} \right)^{\frac{\eta}{1-\eta}} \right) K^{\frac{\beta}{1-\eta}} \bar{H}_F^{\frac{\gamma_F}{1-\eta}} (H_Y - \bar{H}_F)^{\frac{\gamma_R}{1-\eta}}$$

or, for  $\gamma_F = 0$ ,

(1''')

$$Y = \left( A^{\frac{1}{1-\eta}} \left( \eta \quad n^{\frac{1-\alpha}{\alpha}} \right)^{\frac{\eta}{1-\eta}} \right) K^{\frac{\beta}{1-\eta}} H_Y^{\frac{1-\beta-\eta}{1-\eta}} .$$

The steady-state growth rates are

$$g_Y^{I*} = g_K^{I*} = (\xi - \rho) \frac{1}{\theta + \frac{\gamma_F}{\gamma_R}} \quad (18)$$

and

$$g_H^{I*} = \frac{\gamma_F + \gamma_R}{\gamma_R} g_Y^{I*} \quad (19)$$

$$g_n^{I*} = 0 .$$

Comparing equations (18) and (15), we see that an economy with advanced financial intermediation grows at a steady-state rate which is at least as high as the one for an economy with rudimentary intermediation because

$$\frac{g_Y^{II*}}{g_Y^{I*}} = \frac{\theta + \frac{\gamma_F}{\gamma_R}}{\theta} \geq 1 . \quad (20)$$

From equation (18), it follows that in stage I, real growth decreases with increasing human capital productivity  $\gamma_F$ .

Passing from stage I to stage II, an economy experiences higher steady-state growth when  $\gamma_F > 0$ . In this case, the short-run dynamics are characterized by an upward jump in growth rates, after specialized human capital is allowed to adjust, and a subsequent decrease of growth, thereafter, towards the new steady-state rate  $g_Y^{II*}$  which exceeds  $g_Y^{I*}$ . But an economy with rudimentary intermediation and  $\gamma_F = 0$  will not only be unable to improve growth when adopting advanced financial intermediation, because of  $g_Y^{II*} = g_Y^{I*}$ . This economy will experience a negative scaling effect according to factor specialization, due to  $A_1 < A$  (eq. (1'') and (1''')). This results in a lower level of output  $Y$ , given the same human capital and physical capital endowments. Economically speaking, to avoid this detrimental level effect of factor specialization, a social planner should devote part of disposable human

skills  $H_Y$  for an 'instantaneous' increase of the intermediation level  $D = n^{\frac{1}{\alpha}} \bar{x}$ , thus pushing the effective scale  $(AD^\eta)^{\frac{1}{1-\eta}}$ , to offset the negative impact of factor specialization on real output when passing to advanced financial intermediation.

Summarizing, an economy passing from rudimentary to sophisticated financial intermediation may first experience a negative level effect when opening itself for advanced intermediation. Moving to sophisticated intermediation will definitively increase the steady-state growth rates which overcompensates any earlier detrimental effect of financial intermediation.

### 2.3 Institutions, adjustment and growth

Let us now analyze the effect from changes of institutional or socio-economic characteristics on short-run aspects, like output level and the speed of adjustment to the steady state, and on long-run growth levels. The following observations are direct consequences of section 2.2.<sup>14</sup>

**Proposition 2:** Consider an economy passing c.p. from rudimentary to advanced to sophisticated financial intermediation. Let  $T_1$  denote the time when the economy leaves stage-I intermediation.

(i) (Growth effect) The economy's steady-state growth rates increase, i.e.

$$g_Y^{III*} > g_Y^{II*} > g_Y^{I*}.$$

(ii) (Breaks, 'poverty trap') There may be a short-term negative impact on output upon entering the stage of advanced intermediation where working skills will enter production as differentiated inputs, i.e.

$$Y_{T_1}^{II} < Y_{T_1}^I.$$

(iii) (Imbalance effect) There may be a balancing effect spurring initial growth to decline thereafter to steady-state growth, i.e.

$$g_Y^{II}(T_1) > g_Y^{II}(T_1 + \Delta t) > g_Y^{II*}.$$

Straightforward arguments show that the two short-term reactions, poverty trap and imbalance effect, also hold for an economy passing directly from rudimentary to sophisticated intermediation. The next three results hold for any stage of financial intermediation.

**Proposition 3:** Good institution always favor long-run growth rates, i.e.  $dg_Y^*/d\xi > 0$ .

**Proposition 4:** A smaller fragmentation of the financial intermediation sector, in terms of a higher degree of intermediates substitution, always favors long-run growth rates, i.e.  $dg_Y^*/d\alpha < 0$ .

While the above results characterize shifts in steady-state behavior, the following is on short-term aspects and the adjustment behavior only, as parameter  $\delta$  does not influence the steady-

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14 For the imbalance effect see also BARRO/SALA-I-MARTIN (1995: 176–178)

state. An increase in  $\delta$  enhances total factor productivity ( $AD^n$ ), i.e. it can be interpreted as an expression of society's long-term commitment to innovations.

**Proposition 5:** Long-term commitment accelerates the speed of adjustment to the steady state, formally  $dY^*/d\delta > 0$ . Similarly, if banking based financial systems are more costly than market-based systems, i.e. banking based systems are characterized by an innovation rate  $\delta$  higher than for market based systems, then banking based systems allow for higher output levels than market based systems for any given level of endowments  $K$  and  $H$ , i.e.  $Y_{banking}^* > Y_{market}^*$ .

### 3 Empirical analysis

The recent interest in the ultimate sources of economic growth, the revival of the "Schumpeterian" view of finance as a means of channeling society's savings into innovative activity as well as the availability of international data sets, and the computational resources to handle them have led to a large number of empirical studies that include proxies for 'financial development' ( $FD$ ) 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  $FD$  and growth rates of per capita income or investment in subsequent years for large cross samples of heterogeneous countries.

The objective of the following empirical cross-country analysis is to take a closer look at the nature of this partial correlation, which allows for an empirical evaluation of some of the hypotheses derived above. To this end, a three-stage research strategy will be followed.

The first step is a multi-indicator measurement of financial development ( $FD$ ). Specifically, we collect for a large sample of countries and various years different indicators for financial activity that capture not only the degree of monetization or financial intermediation, but, in addition, the share of resources a society devotes to run its financial system. Recall that the usual indicators of financial repression/liberalization and financial depth frequently suffer from ambiguity (expressing monetary and credit volumes as well as financial 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 financial activity are likely to be less sensitive to minor changes in institutional regulations, domestic and international shocks and business cycles. Last but not least, since the shape and the scope of a financial system is firmly rooted in a country's history, our set of indicators may be assumed to capture very basic characteristics of an economy's structure. Consequently, the quantitative approximation of the notion 'financial development' suggested here is probably less endogenous to current economic activity than the traditional  $FD$  variables. Accordingly, we consider our encompassing set of indicators to be more adequate for investigations into the sources of economic growth than the usual  $FD$  proxies.

The second step is to fit a standard growth equation within a comparative cross-country framework. Specifically, based on a balanced panel data set on a large sample of countries with multiple observations through time, the growth rate of per capita income (or rather: labor productivity) is regressed on its presumed determinants, which follow from an extended version of the neo-classical aggregate production function. This set-up allows for the inclusion of country-specific (time invariant) and period-specific (country invariant) "fixed effects", and this procedure is generally regarded as an elegant way to reduce the inevitable

omitted-variable bias. Our analysis so far only departs from the standard approach by introducing our new *FD* variable.

The third and final step of the empirical analysis consists of a standard as well as an innovative approach to relax the equality restriction for one of the structural parameters in order to look for structural breaks or shifts in the finance-growth nexus. Specifically, standard tests for structural breaks are applied to the regression parameter of interest with respect to median splits of the sample by two socio-economic and political controls, "institutional quality" and "type of financial system", which *de facto* amounts to a reduction of these controls on a dichotomous measurement level. Finally, in a more flexible approach we order the sample by metric control variables, which emerge from our model as potential causes or signals for structural shifts or breaks: financial development and real development itself, measures for educational attainment, and – last, but not least – the degree of deviation of the empirical level of financial activity from what we would expect when looking at the level of general and educational development, respectively. Referring to these dimension, threshold regressions are run, and the results (each of them based on  $N-1 = 719$  single regressions, where  $N$  is the total number of observations) are presented as graphs.

### 3.1 A new proxy for financial development

The construction of our new 'latent' variable *FD* for financial development is motivated by the interest to get a reasonably reliable and comparable quantification of the share of resources a society devotes to run its financial system. While this intention bears some resemblance to the core argument of transactions costs and institutionalize economics (see NORTH 1990, WILLIAMSON 1985), namely that aggregate transaction costs are very far from negligible and that financial institutions are a major response to this problem, we depart from the closely connected evolutionist argument that prevailing institutions – having survived the selection mechanism of the market – are the 'adequate' solution. Instead, we regard the amount of resources devoted to run these institutions as an indicator of the effort to keep transaction costs (as well as frictions and market failures due to informational asymmetry that are mitigated by the financial system) low. This notion of financial development is thus very different from the common notion of financial depth; it signifies a real rather than a monetary phenomenon,<sup>15</sup> and it corresponds closely to what is denoted as  $H_F$  and  $D$ , resp.  $H_n$ , in the theoretical exposition above.

The idea to measure the operating costs of a given financial system seems plain enough – why has this not been tried before? Presumably, part of the answer lies in the fact that no international statistics supply reliable and readily comparable data. What follows, therefore, rests on the assumption that a set of indicators which taken one by one are affected by a host of measurement problems (limited validity, dubious reliability, missing values) can jointly be transformed in a way that makes them reasonably reliable, complete and valid measures for the intended notion of financial activity. Specifically, we refer to the following three indicators:

- the share of the labor force employed in the financial system,
- the share of the financial system in GDP,
- the traditional *FD* variable  $M2/GDP$ .

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15 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.

The common variance of the three indicators is identified by means of principal component analysis.<sup>16</sup> Practically, to prepare the raw data, the three normalized indicator variables (share of manpower employed in the financial system, share of the financial system in GDP, M2/GDP) were carefully screened for obvious errors and incompatibilities. Then, operational rules had to be formulated how to treat missing values.<sup>17</sup> Finally, all data – for 90 countries and nine points in time (1960, 1965, ..., 2000) – were pooled into a panel of  $N = 810$ , and the corresponding principal components were computed.

The principal component analysis gives unambiguous results. The first component already accounts for 75% of total variance, and all communalities are .69 or higher, which implies a one dimensional solution where the resulting 810 element column vector of the first principal component gives a reasonable characterization of the total  $3 \times 810$  indicator matrix, and components two and three are interpreted as noise. Accordingly, in what follows, we shall take the factor values of the first component as our numerical estimates for *FD*.

### 3.2 Derivation of reduced form for estimation

The empirical work in the new literature on economic growth usually starts from an aggregate production function with the traditional neo-classical inputs plus additional knowledge-related variables. As a rule, some of the latter are modeled as public goods; partly in the case of human capital; entirely with respect to technical knowledge or growth enhancing organizational features.<sup>18</sup> The standard procedure is 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

$$Y_{i,t} = A_{i,t} K^{\alpha}_{i,t} L^{\beta}_{i,t} H^{\gamma}_{i,t}, \quad (21)$$

where  $Y$  is GDP,  $A$  total factor productivity (*TFP*),  $K$  physical capital,  $L$  labor and  $H$  human capital. Dividing through  $L$ , taking logs, derivating with respect to time and rearranging terms yields

$$g(Y/L)_{i,t} = g(A)_{i,t} + \alpha g(K/L)_{i,t} + \gamma g(H/L)_{i,t} + (\alpha + \beta + \gamma - 1) g(L)_{i,t}, \quad (22)$$

where the notation  $g(X)$  stands for the continuous growth rate of  $X$ . First, note that assuming constant returns to scale

$$(\alpha + \beta + \gamma - 1), \quad (23)$$

$L$  drops from the right hand side of (22).<sup>19</sup> To incorporate the theoretical contributions of the 1990s, the growth rate of the overall efficiency level (*TFP*) variable  $A$  itself is modeled as a function  $f$  of a set of further variables. A general notation for a linear approach is

$$g(A)_{i,t} = a_0 + a_1 \ln(Y/L)_{i,t-1} + a_2 X_{i,t-1} \quad (24)$$

16 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 *FD* 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.

17 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.

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

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

where  $\ln(Y/L)_{i,t-1}$  captures the 'catching-up' potential, and  $X$  is a variable matrix containing a large number of other potentially important determinants of  $g(A)$ , which, of course, remain open to questions, but can be further decomposed in the spirit of our theoretical model as follows.

A comparison between equation (1) on the one hand with equations (22) and (24) on the other hand reveals that our theoretical starting point is a distinctive specification of the traditional empirical approach, where the *TFP* is disaggregated into a finance component  $D^\eta$  and a remaining  $A'$ , and  $L^\beta H^\gamma$ , i.e. the labor related inputs, are split into the different human capital components employed in the financial and the real sector.

For the time being, however, aiming at a broad sample of countries, the data basis is not sufficient to operationalize (1) in a straight-forward manner. We therefore have to let  $H$  stand for skilled labor  $H_F$  and  $H_R$  without further disaggregation. However, a distinction of  $D^\eta$  and  $A'$  is feasible, if we take  $FD$  as a proxy for  $g(D)$ . Accordingly, the reduced form to be estimated is

$$g(Y/L)_{i,t} = \beta_0 + \beta_1 g(K/L)_{i,t} + \beta_2 g(H/L)_{i,t} + \beta_3 \ln(Y/L)_{i,t-1} + \beta_4 FD_{i,t-1}. \quad (25)$$

where  $\beta_4$  in equation (25) corresponds to  $\eta$  in equation (1).

### 3.3 Data

Before proceeding further, a few remarks concerning the sample and the data are in order (for details, see appendix). The sample consists of 90 countries. If not stated otherwise, the data are taken from the PWT, Version 6.1, which now consists of annual (albeit frequently incomplete) observations from 1950–2000. Due to missing data, our panel starts in 1960. For our analyses, we stack observations for every 5th year (1960, 1965, ..., 2000) so that we can refer to a balanced panel of  $90 \times 9 = 810$  points, or  $90 \times 8 = 720$  five-year growth intervals.

Real GDP is from the PWT 6.1 (in "international \$", with 1996 as the common base year for deflating and adjusted for differences in purchasing power parities). Labor refers to the number of people aged 15–64. In other studies, capital accumulation is frequently proxied by the investment rate. We choose to compute capital stock estimates and growth rates instead. The reason is that we assume the well-known problems of capital stock estimates (most of all the arbitrariness of assumptions regarding depreciation and obsolescence) to be more than outweighed by the provision of a variable that is closer to the theoretical derivation of the long-run growth equation. Specifically, investment rates are likely to change more than capital stock growth rates along the business cycle and after macro-economic shocks. Human capital accumulation is proxied by the rate of change of educational attainment using data on mean years of schooling and reflects  $H_Y$ .

### 3.4 Cross-country growth regression results

We are now equipped with either straightforward data or at least with reasonably well defined proxies for all variables specified in the discussion of the relationships postulated in the general equations above.

Drawing on our panel data set of 90 countries and 8 growth periods of five years ( $N = 720$ ), we estimate a fixed effects model with dummy variables for  $I-1$  countries  $i$  and  $T-1$  periods, where  $g(Y/L)_{i,t}$  is regressed on its presumed determinants including lagged  $FD$ :

$$g(Y/L)_{i,t} = \beta_0 + \beta_i + \beta_t + \beta_1 g(K/L)_{i,t} + \beta_2 g(H/L)_{i,t} + \beta_3 \ln(Y/L)_{i,t-1} + \beta_4 FD_{i,t-1} + \varepsilon_{i,t}. \quad (26)$$

The results are as follows: The fixed effects – country as well as period – are jointly highly significant, so that they indeed have to be entered in order to reduce missing variable bias. The coefficients  $\beta_1$  to  $\beta_4$  are given in equation (27):

$$g(Y/L)_{i,t} = \text{f.e.} + .319 g(K/L)_{i,t} + .064 g(H/L)_{i,t} - .026 \ln(Y/L)_{i,t-1} + .009 FD_{i,t-1} + \varepsilon_{i,t}, \quad (27)$$

(11.0)                      (1.76)                      (-5.84)                      (2.57)

where "f.e." denotes the fixed effects, and the numbers in brackets are t-values. All point estimates are significantly different from zero, given their expected signs, in one-tailed tests ( $p \leq 5\%$ ).

As a first comment, it is obviously justified to say that these results are in line with the theoretical reasoning that led to the formulation of equation (26). The overall fit of our model ( $R^2 = .50$ ), however, shows that much remains to be explained. Yet a coefficient of determination around 50% is not quite unusual in cross-country growth regressions, and here we are dealing with a panel of four decades, where other analyses seldom cover more than twenty or thirty years. Moreover, our model is comparatively parsimonious with respect to the number of explicit regressors, so one should expect the residuals to account for a considerable share of  $g(Y/L)_{i,t}$ 's variance. Finally, note that with respect to our theoretical model, the coefficients  $\beta_2$  and  $\beta_4$  relate to  $H_F + H_R$  and  $D$ , respectively.

### 3.5 Looking for structural shifts

Now, let us proceed to the third and final step of our empirical analysis. Recall, that the model discussed above (section 2) implies various structural breaks or shifts in the finance-growth nexus. Specifically, potential causes or signals for structural shifts or breaks are the prevalence/absence of good institutions, the way a society handles its financial interrelations (type of financial system) as well as the levels of financial development as well as deviations of financial activity from its appropriate intensity, given its state of development.

To address these hypotheses empirically, we relax the equality-restriction  $\beta_4 = .009$  in (27) and let it take two different values for complementary subgroups of the sample, which we split by a control variable.

First, we address propositions 3 and 5 from our theoretical modeling which state that good institutions are a prerequisite for the growth enhancing properties of financial activity (*proposition 3*) and that a financial system which favors long-term commitment might be superior to "arm's length" type financial systems (*proposition 5*).

Socio-economic factors like "institutional quality" have long been considered as crucially important for economic growth and development. As far as financial activity is concerned, the importance of institutional quality ("rule of law") as well as "trust" is fairly obvious. To capture this dimension we refer to the following four variables which are frequently used in cross-country growth regressions and address this notion from slightly different angles

- the "rule of law index" (by Political Risk Inc.), taken from EASTERLY/LEVINE (1997),
- the "corruption index" with the same source as above,
- institutional quality index ICRGE80, taken from SACHS/WARNER (1997),
- prevalence of market segmentation (black market premium  $BMP$ ) here transformed as  $\ln(1 + BMP)$ , where  $BPM$  is taken from EASTERLY/LEVINE (1997)



and extract the common variance as the first principal component, by which we order the 90 countries and split them at the median into a "poor institutional quality" (*PIQ*) and a "high institutional quality" subgroup (*HIQ*), respectively.

Secondly, a "bank-based" financial system, where close long-term relationships are preferred to "arms' length finance" and shareholders' rights at times have to stand behind those of stakeholders is contrasted to a "market-based" financial system. These categories are frequently discussed in a narrative fashion, however, they are notoriously difficult to be identified empirically. Fortunately, we now can refer to first results of the efforts of Ross Levine and collaborators who recently made accessible to the research community a set of dummy variable for "market-based" and "bank-based" financial systems (DEMIRGUÇ-KUNT/LEVINE, 1999). On this basis, we define two additional dummy variables:

- $MB = 1$  if a financial system is classified as "market-based",  $MB = 0$  otherwise,
- $BB = 1$  if a financial system is classified as "bank-based",  $BB = 0$  otherwise.<sup>20</sup>

Now, we re-run regression (27) with an additional parameter, allowing for two different coefficients  $\beta_4'$  and  $\beta_4$  in the two subgroups. For the *PIQ* versus *HIQ* split the results are unambiguous: As expected,  $\beta_4$  is significantly higher ( $p < .05$ ) when the institutional framework is better developed. In addition, while it is significantly positive for the *HIQ* group ( $t = 2.90$ ), the point estimate for the *PIQ* group is *negative*, though not significantly different from zero ( $t = -.12$ ). In other words, while financial activity is indeed growth promoting in an environment with "good institutions",<sup>21</sup> it does not seem to matter for overall economic performance when institutions are of low quality. Moreover, this difference between the two *PIQ* and *HIQ* subgroups with respect to the financial activity regressor does not show up when we test for a similar structural break with respect to physical and human capital accumulation:  $\beta_1$  – referring to  $g(K/L)$  – shows a somewhat higher *HIQ* point estimate, but is far from being significantly different between the subgroups ( $p = .28$ ) and  $\beta_2$  – referring to  $g(H/L)$  – is not affected in any conclusive way at all ( $p = .96$ ).

Turning to the "bank-based" versus "market-based" financial system distinction, our analysis does not reveal any conclusive results. Specifically,  $\beta_4$  scores slightly higher (but not statistically significantly:  $t = .71$ ) in the *MB* subgroup, but the same is true for the *BB* subgroup ( $t = .27$ ). Since, as noted above, the subgroups are not complementary, this is probably due to the fact that 36 countries in our sample are neither classified as *MB* nor as *BB* and had to be coded as Zero in either case, where it is not implausible to assume that these countries - apart from missing data - share common characteristics that drive the estimates down in either case. Apart from self-immunization stating that the influence is in terms of adjustment behavior only, it is fair to conclude that – like other studies – this investigation rather discourages any attempt to discriminate among the possible set-ups for financial systems. Moreover, if missing classifications are caused by significant fragmentation so that clear-cut identification is not available, our result above supports the view that financial fragmentation hampers long-run growth (*proposition 4*).

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<sup>20</sup> Note that Demirguç-Kunt/Levine's "market-based" versus "bank-based" classification applies for 54 of our 90 countries. Since the missing values can only be labelled as either "non market-based" or "non bank-based", this "market-based" and "bank-based" distinction is not complementary but rather amounts to two different sample splits.

<sup>21</sup> At least, to put it more modestly, our results do not contradict this conjecture.

Finally, we turn to those of our control variables which allow for ordering the entire pooled data set.<sup>22</sup> In this context, recall that pooling data implies to regard them as independent observations, so our splitting procedure allows for  $N-1 = 719$  alternative critical values. In order to keep the computing and evaluation effort manageable, we restrict the analysis to a one-by-one procedure. Accordingly, these tests are conducted as follows (see also HANSEN, 1999):

1. select a control variable which is susceptible to be a cause or a signal for structural shifts or breaks in the finance-growth nexus,
2. order the 720 observations of the panel by this control variable,
3. perform 719 repeated sample splits where the total is divided into a group that scores low with respect to the control variable, and a corresponding high scoring group,
4. re-run the base regression with modification 719 times and record the deviation of  $\beta_4$  in the low-scoring group from the high-scoring group as shown below in equation (28),
5. select the next control variable and go back to number 2.

The first three control variables,  $(Y/L)$ ,  $FD$  and  $(H/L)$ , are self-explaining and taken from the panel as described so far. The fourth deserves some comments: The theoretical model implies that there might be appropriate levels of  $FD$  with respect to development in general, and particularly with respect to highly qualified human capital ( $TER$ ) (see *proposition 2 (iii)*). Hence, there could be a correspondence between  $FD$  and  $TER$ , where every level of  $TER$  implies a corresponding level of  $FD$  to make the latter most efficient in promoting economic growth. In this context, the propositions from the theoretical model imply the concept of a "balanced growth path" for  $FD$ , where the optimum level of  $FD$  is contingent on the realization of a set of variables. For a first try, let us assume that the main dimensions of this contingency can empirically be captured by two variables, overall development and highly qualified human. Then, a regression of  $FD$  on  $(Y/L)$  and  $TER$  will result in predicted values of "balanced" financial development  $FD^*$  and residuals, which we can interpret as the degree of deviation of the empirical level of  $FD$  from balanced  $FD^*$ . In other words, negative (positive) residuals, which constitute our fourth control variable, tell us how much an observation is under- or over-scoring with respect to what we would expect given its levels of  $(Y/L)$  and  $TER$ .<sup>23</sup> Accordingly, our selected control variables are:

- initial real development  $(Y/L)_{i,t-1}$ ,
- initial financial development  $FD_{i,t-1}$ ,
- initial general human capital  $(H/L)_{i,t-1}$ ,
- deviation of  $FD_{i,t-1}$  from  $FD_{i,t-1}^*$ , given  $(Y/L)_{i,t-1}$  and  $TER_{i,t-1}$ .

Before presenting the results, a methodological remark is in order. What we are doing is to run "threshold regressions" for the coefficient of lagged  $FD$ , which are based on  $N-1 = 719$  single regressions for every control variable. Practically, we realize the sample splits by defining a vector of dummy variables  $D(C)_n$  that equals zero if an observation belongs to the high-scoring subgroup with respect to the control variable  $C$ , and one if otherwise, and  $n$  denotes the rank position of the split ( $n = 1, 2, \dots, 719$ ). Finally, we compute  $D \times FD_{i,t-1}$  and include this product as an additional regressor in (23) to get

<sup>22</sup> Recall that the preceding tests for structural breaks refer to different groups of *countries* ( $n = 90$ ) rather than to different groups of *observations* ( $n = 720$ )

<sup>23</sup> The regression  $FD_{i,t-1} = \beta_0 + \beta_1 (Y/L)_{i,t-1} + \beta_2 TER_{i,t-1}$  results in significantly positive coefficients for both regressors, and a fairly high  $R^2$  of 72% ( $N = 720$ ).

$$g(Y/L)_{i,t} = \beta_0 + \beta_i + \beta_t + \beta_1 g(K/L)_{i,t} + \beta_2 g(H/L)_{i,t} + \beta_3 \ln(Y/L)_{i,t-1} + \beta_4 FD_{i,t-1} + \beta_5 D \times FD_{i,t-1} + \varepsilon_{i,t}, \quad (28)$$

which we run 719 times for every  $C$ . Now, in a standard regression set-up,  $\beta_5$  is the point estimate of the difference of  $\beta_4$  for the two groups with  $D = 0$  and  $D = 1$ , and the t-statistics informs about its significance. Specifically, in equation (28),  $\beta_5$  and its t-statistics show if and in how far the growth promoting effect of lagged  $FD$ , which is quantified by  $\beta_4$ , deviates in the low-scoring sub-sample. However, since we do not impose a certain sample split by a fixed  $D$ , but refer to  $D(C)_n$ , we cannot interpret the t-values as test-statistics against any well specified null-hypothesis.<sup>24</sup>

We present the results, control variable by control variable, as charts of the t-statistics of  $\beta_5$  for all 719 sample splits. To facilitate the interpretation, we add a zero line and – with the reservations made above in mind – mark the  $\pm 1.961$  limits of 5%-significance which would apply for a two-tailed test.

Before looking at graphs 1–5, note that in the absence of systematic shifts or breaks in the finance-growth nexus with respect to a given control variable, the t-statistic plots should show white noise only.

The first control variable is initial per capita income. Graph 1 reveals a trough around the 50th observation, and an upper peak at observation No. 140. The rest is not exactly white noise, but there are no pronounced patterns except for the last roughly 100 observations, where the t-statistics show that the point estimates of  $\beta_5$  are positive throughout. Now, recall that a positive  $\beta_5$  implies that the observations on the left, i.e. the low-scorers with respect to the control variable – here:  $(Y/L)_{i,t-1}$  –, show a more pronounced finance-growth nexus – as reflected by the point estimate for the  $FD_{i,t-1}$  coefficient – than the rest of the sample.

Accordingly, the trough in Graph 1 indicates a poverty trap for a small group of about 50 observations with very low  $(Y/L)_{i,t-1}$ , but in general, there is no evidence that richer countries reap more benefits from  $FD$ . The peak at observation 140 would rather suggest that, taken together, all observation to the right hand of this are profiting less from a given level of financial activity.

Turning to graph 2, which plots the t-statistics with respect to  $FD$  itself, the picture looks slightly different. While – again – there are signs for a low level development trap, the plot does not greatly deviate from the zero line in the upper part. If anything, we would conclude that this adds some evidence to the "big push" story of MURPHY, SHLEIFER and VISHNY (1989) where the building-up phase of  $FD$  from very low levels induces losses due to high opportunity costs and low returns (see *proposition 2 (ii)*).

Graph 3 shows the results for general human capital  $(H/L)_{i,t-1}$  as control variable. Once again, we see evidence for a low level development trap. A peak around observation No. 300 means that the high general human capital observations to the right of this taken together get a lower  $FD$  coefficient than low scorers, which implies that a country needs a minimum level of general human capital in order to reap the benefits of  $FD$ , but this minimum level is comparatively low.<sup>25</sup>

Finally, graph 4 refers to our balance-imbalance indicator deviation of  $FD_{i,t-1}$  from  $FD_{i,t-1}^*$ , where high values signify that the level of financial activity as measured by  $FD$  is higher than

24 Here, we rather have 719 null-hypotheses. See HANSEN (1999) for a detailed discussion of this point.

25 The trough in graph 3 corresponds to a level of about 1.5 average years of schooling.

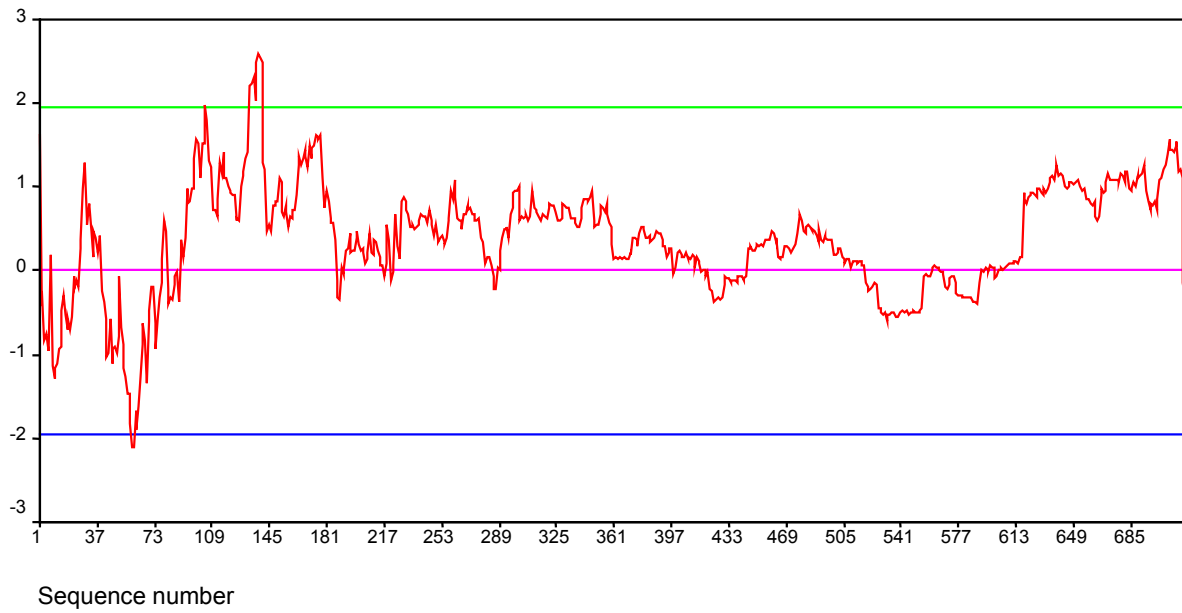
what we would expect, given the levels of per capita income and highly specialized human capital. Here, apart from a noisy domain covering the first 100 under-scorers, the picture shows a remarkably regular pattern, with a continuous rise of the t-statistics for  $\beta_5$  up to about observation No. 500, and a pronounced drop thereafter. This implies that the 200 or so most pronounced over-scorers<sup>26</sup> in  $FD_{i,t-1}$  from  $FD_{i,t-1}^*$  have indeed driven their financial development too far.

Hence, following the results from graphs (2) to (4), the imbalance effect stated in *proposition 2* does indeed seem to have empirical correlates.

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26 The deviation of predicted ("balanced") and empirical  $FD$  is closest to Zero for observations 406 and 407. Note that the peak of the t-statistics plot (observation No. 493) lies to the right hand of the point, i.e. in the domain of the over-scorers.

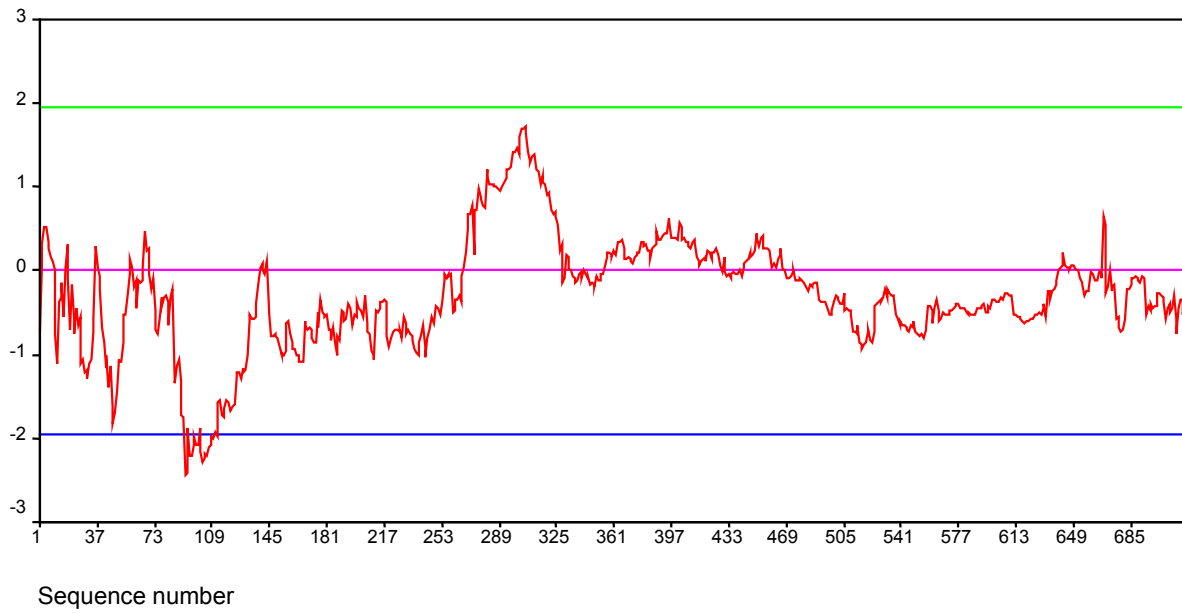
Graph 1. Control variable:  $(Y/L)_{i,t-1}$



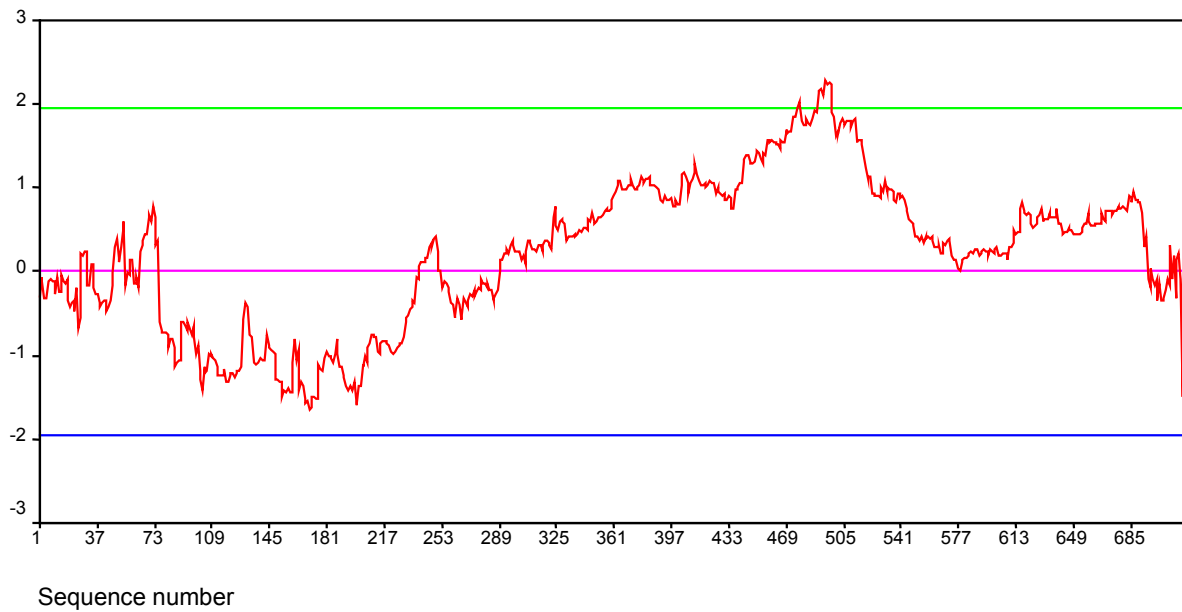
Graph 2. Control variable:  $FD_{i,t-1}$



Graph 3. Control variable:  $(H/L)_{i,t-1}$



Graph 4. Control variable: deviation of  $FD_{i,t-1}$  from  $FD_{i,t-1}^*$ , given  $(Y/L)_{i,t-1}$  and  $TER_{i,t-1}$



## 4 Summary and Conclusions

To highlight the causal links between financial activity and economic growth, a theoretical endogenous growth model is discussed, and an empirical cross-country growth analysis is conducted.

In the modeling part, we find various breaks, poverty traps, imbalance effects and structural shifts in the finance-growth nexus, suggesting that the linear approach, which dominates empirical studies on the effect of financial activity and growth, may not be appropriate.

We therefore present an empirical framework to address this point directly. To this end, we first fit our data (referring to a panel of 90 countries from 1960–2000) to a standard growth equation which – apart from our focal variable: a proxy for financial activity – includes the usual growth regressors as well as fixed country and period effects. Then, we order the sample by control variables which follow from our model as potential causes or signals for structural shifts or breaks. Finally, a number of threshold regressions indeed reveal signs for structural shifts or breaks that are consistent with the model. Most importantly, countries seem to gain less from a given level of financial activity, if it exceeds what would follow from a well balanced expansion path given its overall state of development.

We hurry to emphasize that, given the level of abstraction in both the theoretical model and the data based analyses, our results cannot be interpreted as a validation of any particular model. However, we are able to present theoretical as well as empirical evidence for the suspicion that the finance-growth nexus is characterized by various non-linearities, which should cast some doubt on much of the existing empirical results in the recent literature on finance and growth.

## 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 countries that are very small (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).

If not mentioned otherwise, data are from the Penn World Table 6.1, October 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 latest version of the BARRO/LEE web-data base referring to mean years of schooling in the population aged 15–65.

*Financial development* ( $FD$ ) 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 World Development Indicators online access data base), (2) the share of labor 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)  $M2/GDP$  (source: World Development Indicators online access 2003).

*Rule of law index (Political Risk Services)*, source: EASTERLY/LEVINE (1997).

*Corruption index (Political Risk Services)*, source: EASTERLY/LEVINE (1997).

*Institutional quality index (Political Risk Services)* source: SACHS/WARNER (1997).

*Black market premium*, source: EASTERLY/LEVINE (1997).

*Market-based/bank-based financial system classification*, source: DEMIRGUÇ-KUNT/LEVINE (1999).

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