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

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

(REVISED VERSION - SEPTEMBER 2003)

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*Dresden Discussion Paper in Economics No. 15/03*

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

(REVISED VERSION – SEPTEMBER 2003)

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## Abstract:

An endogenous growth model with a financial sector is formulated, and empirical analyses are conducted. The model exhibits structural shifts and breaks caused by institutional change, 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-linearity that is consistent with the model. Most importantly, we find signs for excessive financial activity.

JEL-Classification: O16, O42, O57

Keywords: Financial Development, Endogenous Growth, Institutions, Non-linearities

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## Abstract:

An endogenous growth model with a financial sector is formulated, and empirical analyses are conducted. The model exhibits structural shifts and breaks caused by institutional change, 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-linearity that is consistent with the model. Most importantly, we find signs for excessive financial activity.

## 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 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 follow 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

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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/VAROUDAKIS (1996) and RAJAN/ZINGALES (1998). For a recent study see BENHABIB/SPIEGEL (2001).

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 activity; 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. 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, as many observers have noted,<sup>5</sup> financial dualism is the rule outside the developed part of the world: enclaves of modern finance 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, 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.

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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/DYBVIK (1983), SINGH (1997), and CHANCELLOR (1999).

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.

Hence, in poor countries, the potential benefits from financial activity might be more than outweighed by their disadvantageous starting point. In addition to this, the benefits of finance with respect to growth and development could be contingent on the economic and institutional environment with various 'poverty-traps'.<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 financial activity is strongly embedded in the socio-economic and political environment in which it is supposed to perform its tasks.<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 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 employed in the financial system add to efficient capital allocation by gathering and processing information and channeling society's savings into the most promising investment projects. Hence, when human capital is highly specialized, it may support both the production of output and add to sophistication in the financial sector.<sup>10</sup> Accordingly, we model financial engineering as specialized work which can improve the level of technological efficiency.

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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) analyze the financial activity-real development interaction. An inflation threshold is highlighted by ROUSSEAU/WACHTEL (2002).

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

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

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

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

## 2.1 What constitutes the finance growth-nexus

The possibility of a causal relationship between financial activity ( $F$ ) 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:

- 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  $F$  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. On the other hand, 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). Hence, if financial activity is supposed to nowadays play a decisive role in growth and development, the major line of causation should be through improvement of capital accumulation.

Now, from a macro perspective, this allocation 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 paper will take a closer look at this conjecture.

## 2.2 An endogenous growth model with financial activity-human capital interaction

In this section, a growth model is formulated where financial development is based on human capital in two different ways: firstly, one part of human capital in the financial sector serves as a direct input factor in the production technology; secondly, another part of human capital which is employed in financial business to process information for innovative use adds to technological efficiency of the economy. Our starting point is the human capital story in (LUCAS, 1988) and its extensions by FUNKE/STRULIK (2000). However, while FUNKE/STRULIK are modeling human capital as homogeneous, we let it simultaneously enter in

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<sup>11</sup> For a detailed exposition of this, see KINDLEBERGER (1993).

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



- final-good production,
- real-production technology development,
- financial-intermediation process knowledge.

The benevolent social planner is faced with an economy characterized by a Cobb-Douglas technology producing a single homogenous final good  $Y$

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

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 final production,  $H_n$  is accumulated knowledge on financial intermediation which boosts the level  $D$  of intermediation by

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

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

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  $i$ . 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.

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

where  $\xi > 0$  is an efficiency parameter of the society's ability to enforce the development of working skills. An economy is characterized by *sophisticated financial intermediation* if  $H$  breaks up according to equation (2).

The social planner's problem is to maximize 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 this model can be reduced to one where only the total amount  $H_Y := H_R + H_F$  of human capital matters to capture this 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  $J$  with respect to  $H_R$  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, re-scaling factor of technological efficiency from  $A$  to  $A_1$  appropriately, where  $A_1 < A$ , our model of an economy with sophisticated financial intermediation reduces to an innovative economy with exactly one human capital input factor  $H_Y$  of magnitude  $H_R + H_F$ . 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

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

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

Let us now look at different stages of financial intermediation. First, consider the case where no innovation takes place, i.e.  $\dot{n} = 0$ , so that equation (1') 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 with respect to  $\bar{x}$ . Inserting equation (14) into  $D = n^{1/\alpha} \bar{x}$  and rearranging for  $Y$  yields

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

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 find that an economy with sophisticated financial intermediation grows at a higher steady-state rate than an economy with advanced financial intermediation because

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

Note that at the very early stage of development, a country's human capital might be so scarce that a continuous accumulation of knowledge in financial services cannot be sustained. Formally, in an economy with *rudimentary financial intermediation* ('stage I') there will be only one type of knowledge,  $H_R$ , and this will be used as a flexible input in production.  $H_F$  is either kept at some constant level  $\bar{H}_F$  causing an imbalance effect, or, more restrictively, output elasticity of  $H_F$  does not differ significantly from zero ( $\gamma_F = 0$ ). 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 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

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

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 of 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 at 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 if  $\gamma_F > 0$ . 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 a part of the disposable human skills  $H_Y$  to 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.

Thus, in this model, an economy passing from rudimentary to sophisticated financial intermediation can suffer a negative level effect when entering advanced intermediation. However, advancing to sophisticated intermediation will definitively increase the steady-state growth rates and this overcompensates the earlier detrimental effect of financial development.

### 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 *ceteris paribus* from rudimentary to advanced and further 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 if working skills 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 characteristics, 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 institutions always favor long-run growth rates, i.e.  $dg_Y^*/d\xi > 0$ .

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

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

While the above results characterize shifts in steady-state behavior, the following is on short-term aspects and the adjustment behavior only, as the parameter  $\delta$  does not influence the steady-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  $dY^*/d\delta > 0$ . Moreover, the output level is a positive function of the innovation rate  $\delta$  for any given level of endowments  $K$  and  $H$ .

### 3 Empirical analyses

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 and the availability of international data sets as well as the computational resources to handle them have led to 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) 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 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 evaluation of some of the hypotheses derived above. To this end, a three-stage research design is adopted.

The first step is a new multi-indicator measurement of financial activity ( $F$ ). 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 the share of resources a society devotes to run its financial system. The common variance of these indicators is identified and corresponding principal component score is computed for every observation. We regard the resulting encompassing indicator as more adequate for investigations into the sources of economic growth than the standard  $F$  proxies.

The second step is to fit a standard cross-country growth equation. 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 is regressed on its presumed determinants, which follow from an extended version of the aggregate production function. This set-up allows for the inclusion of country-specific and period-specific (country invariant) 'fixed effects' to reduce the inevitable omitted-variable bias. Our analysis so far mainly departs from the standard approach by introducing a new  $F$  variable.

In the third and final step, we relax the equality restriction for the structural parameters and screen 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, to identify potential thresholds we order the sample by metric control variables which follow from the theoretical model as potential causes of – or signals for – structural shifts or breaks and run a number of threshold regressions.

### 3.1 A new proxy for financial activity

The construction of our new variable for financial activity aims at getting a reasonably reliable and comparable quantification of 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.<sup>15</sup> While this intention bears resemblance to the core argument of New Institutional Economics (NORTH 1990, WILLIAMSON 1985), namely that aggregate transaction costs are 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 services rendered by the financial system to mitigate frictions and market failure due to informational asymmetry.

Specifically, our 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, complete and valid measure for the intended notion of financial activity:

- The share of the labor force employed in the financial system,
- the share of the financial system in GDP,
- the traditional *F* 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 channeled 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, recall that the usual indicators of financial repression/liberalization and financial depth 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.

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 indicator variables were screened for obvious errors and incompatibilities. Then, operational rules were 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 first principal component was extracted.

The results are unambiguous: the first component already accounts for 75% of total variance, and all communalities are .69 or higher, which clearly implies a one-dimensional data space. Accordingly, in what follows, we shall take the factor values of the first component as our numerical estimates for  $F$ .

### 3.2 Derivation of reduced form for estimation

The present empirical literature on economic growth commonly starts from an aggregate production function with the traditional 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

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha} L_{i,t}^{\beta} H_{i,t}^{\gamma}, \quad (21)$$

where  $Y$  is GDP, total factor productivity ( $TFP$ ),  $K$  physical capital,  $L$  labor and  $H$  human capital. Dividing through  $L$ , taking logs and time derivatives 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

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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  $F$  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.

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 ( $\alpha + \beta + \gamma = 1$ ).



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

where  $\ln (Y/L)_{i,t-1}$  captures the 'catching-up' potential, and  $X$  is a variable matrix containing a 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  $H_R$ . However, a distinction of  $D^\eta$  and  $A'$  is feasible, if we take  $F$  as a proxy for  $g(D)$ . Accordingly, the reduced form to be estimated is

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

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

### 3.3 Data

The sample consists of 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, our 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. Real GDP is in 'international \$', with 1996 as the common base. Labor refers to the number of people aged 15–64. Capital stock growth rates are computed on the basis of investment rates and a perpetual inventory calculus. Human capital accumulation is represented by the rate of change of educational attainment (mean years of schooling).

### 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 referred to in the reduced form (25). 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  $F$ :

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

The results are as follows: The fixed effects – country as well as period (not reproduced below) – are jointly highly significant, so that – while no specific interpretation of the estimates is intended – they must indeed be included in order to reduce missing variable bias. The coefficients  $\beta_1$  to  $\beta_4$  are given in equation (27):

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

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

This first result is obviously in line with the broad theoretical reasoning behind (26). All point estimates are significantly different from zero, given their expected signs, in one-tailed tests (t-statistics in brackets,  $p \leq 5\%$ ). Moreover, the magnitudes of the coefficients are compatible with a priori reasoning:  $\beta_1$  of roughly 1/3 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 expected magnitude of human capital (in addition to 'raw' labor, to which the estimation equation is normalized), to growth a positive elasticity of more than 6% ( $\beta_2$ ) does not contradict standard calculations of the social rate of return to human capital. The catching-up variable  $\beta_3$  enters negatively, as expected. Last but not least, the financial activity coefficient  $\beta_4$  is significantly positive which is in line with the basic prediction of our theoretical model. The overall fit of our model ( $R^2 = .50$ ), however, shows that much remains to be explained.<sup>20</sup>

### 3.5 Looking for structural shifts

We now proceed to the third and final step of our empirical analysis. Recall that the theoretical model 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), the level of financial development and – as follows from the model – characteristic deviations of financial activity from its appropriate intensity, given its state of development.

To address these hypotheses empirically, we relax the restriction  $\beta_4 = .009$  implied by the point estimate in (27) and let it take different values for two complementary subgroups that result from sample splits by dichotomous control variables. In this way, we firstly address *proposition 3* which states that good institutions are a prerequisite for the growth enhancing properties of financial activity, and secondly *proposition 5* according to which a financial system favoring long-term commitment might be superior to an 'arm's length' type financial system. To capture a broad concept of institutional quality we refer jointly to

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20 Yet a coefficient of determination around 50% is not quite unusual in cross-country growth regressions, and we are 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 explicit regressors, so one should expect a considerable share of residual variance.

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

and identify their common variance, i.e. the first principal component, by which we order our 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, researchers now can refer to first results of the efforts of Ross Levine and his 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>21</sup>

Now, regression (27) is re-run with two different coefficients  $\beta_4'$  and  $\beta_4''$  for the subgroups.

For the institutional quality split the results are unambiguous: as one would expect,  $\beta_4$  is significantly higher ( $p < .05$ ) when the institutional framework is better. 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>22</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 similar breaks 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 at all ( $p = .96$ ).

Turning to the 'bank-based' versus 'market-based' financial system distinction, the 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

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<sup>21</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 labeled as either 'non market-based' or 'non bank-based', this distinction is not complementary but rather amounts to two different sample splits.

<sup>22</sup> At least, to put it more modestly, our results do not contradict this conjecture.

( $t = .27$ ). Since, as noted above, the subgroups are not complementary, this is probably due to the fact that 36 countries in our sample which DEMIRGUÇ-KUNT/LEVINE classify neither as *MB* nor as *BB* had to be coded as zero, and it is not implausible to assume that these countries – apart from missing data – share common characteristics that drive the estimates down in either case. If anything, this finding can be interpreted to support the view that financial fragmentation hampers long-run growth (*proposition 4*), but – like others before us (see LEVINE, 2002) – we were not able to find evidence in favor of any specific type of financial system.

Finally, we turn to the dimension that our model identified as central with respect to the possibilities of structural shifts or breaks within the finance-growth nexus: financial development proper. First, note that – unlike the previous control – this variable is measured on a continuous scale and therefore permits to order the entire pooled data set.<sup>23</sup> Furthermore, since pooling data implies to regard them as independent observations, a split by a continuous variable allows for  $N-1 = 719$  alternative critical values. Accordingly, we can refer to a considerably more flexible method than in the previous step and conduct *threshold regressions* (HANSEN, 1999) for the coefficient of lagged  $F$ . Specifically, we order the 720 observations of the panel by the control variable. Then, we perform 719 repeated sample split regression with  $\beta_4$  set free across subgroups, where the total is divided into a group that scores low with respect to the control variable and a corresponding high scoring group. Practically, we obtain 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 ( $n = 1, 2, \dots, 719$ ). Then,  $D \times F_{i,t-1}$  is included as an additional regressor in (23) to get

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

which we run 719 times for every  $C$ . Now, as in a standard regression set-up,  $\beta_5$  is the point estimate of the difference of  $\beta_4$  for the two groups  $D = 0$  and  $D = 1$  and the t-statistics informs about its significance. Specifically, in equation (28), the t-statistics of  $\beta_5$  shows if and in how far the growth promoting effect of lagged  $F$  in the low-scoring sub-sample deviates from the total sample.

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

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<sup>23</sup> Recall that the preceding tests for structural breaks refer to different groups of *countries* ( $n = 90$ ) rather than to different groups of *observations* ( $n = 720$ )

Graph 1 plots the t-statistics of lagged  $F$  with respect to  $F$  itself as control variable. Now, recall that a significantly negative  $\beta_5$  implies that the group of observations on the left, i.e. the low-scorers with respect to the control variable, are ceteris paribus characterized by a less pronounced finance-growth nexus – as reflected by the point estimate for the  $F_{i,t-1}$  coefficient – than the rest of the sample, and the opposite holds for positive t-statistics of  $\beta_5$ . Moreover, isolated spikes of the t-plots would rather be attributed to outliers with high leverage than to systematic shifts and breaks between groups of observations. On the other hand, by the same reasoning, t-statistics that stay above or below the zero-line for an extended number of splits would be more indicative of a systematic deviation from white noise, even if the conventional critical values of  $p$  are not met. Accordingly, the low initial domain in Graph 1 is indicating signs of a low- $F$  poverty trap.

**Graph 1: Control variable:  $F_{i,t-1}$  about here**

If anything, we would hence conclude that this adds some, albeit weak, evidence to the 'big push' story of proposition 2 (ii), where the building-up phase of  $F$  from very low levels induces losses due to high opportunity costs and low returns. However, taking the level of  $F$  as control variable does not wholly capture the spirit of our model, which postulates that financial over- or underdevelopment (rather than the level) might make financial activity less beneficial than it would be on a balanced development path. Specifically, the propositions from the theoretical model imply the concept of a 'balanced growth path' for  $F$ , where the optimum level of  $F$  is contingent on the realization of a set of variables, particularly development in general and the stock highly qualified human capital.

Let us assume that for a first and tentative analysis, the main dimensions of this contingency can empirically be captured by two variables, overall development and highly qualified human (proxied by the share of the working age population with tertiary education  $TER$  from the latest BARRO/LEE web-database). Then, a regression of  $F$  on  $(Y/L)$  and  $TER$  will result in predicted values of 'balanced' financial activity  $F^*$  and in residuals, which we can interpret as the degree of deviation of the empirical level of  $F$  from balanced  $F^*$ .<sup>24</sup> In other words, negative (positive) residuals 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  $TER$ . The corresponding t-statistics threshold plot for the deviation of  $F_{i,t-1}$  from  $F_{i,t-1}^*$ , is shown in graph 2.

**Graph 2: Control variable: deviation of  $F_{i,t-1}$  from  $F_{i,t-1}^*$  about here**

Here, apart from a noisy domain at the far left, domain covering roughly the first 100 under-scorers, the graph shows a remarkably regular pattern: a continuous rise of the t-statistics for  $\beta_5$  up to about observation No. 500 (well exceeding what would be conventional levels of significance in a test for a structural break), and a pronounced drop thereafter. This finding

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<sup>24</sup> The regression  $F_{i,t-1} = \beta_0 + \beta_1 (Y/L)_{i,t-1} + \beta_2 TER_{i,t-1}$  results in significantly positive coefficients for both regressors, and a fairly high  $R^2$  of 72% ( $N = 720$ ).

implies that the 200 or so most pronounced over-scorers<sup>25</sup> in  $F_{i,t-1}$  from  $F_{i,t-1}^*$  have indeed driven their financial activity too far and reap significantly less macroeconomic benefits from a given input of financial activity than countries that keep on more balanced development path.<sup>26</sup>

#### 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 analyses are conducted.

In the modeling part, we find that plausible assumptions can generate 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 then develop an empirical framework to address this point. 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 concede that, given the level of abstraction in both the theoretical model and the data based analyses, these results cannot qualify as a strong validation of any particular model. However, we are presenting coherent theoretical as well as empirical evidence for the suspicion that the finance-growth nexus is characterized by various non-linearities, which might cast some doubt on some of the more generalizing conclusions in the recent literature on finance and growth.

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25 The deviation of predicted ('balanced') and empirical  $F$  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.

26 The same analyses were conducted with initial per capita income  $(Y/L)_{i,t-1}$  and initial human capital  $(H/L)_{i,t-1}$ . The resulting t-statistics plots, however, did not show any pattern that could be interpreted as substantially different from a white noise.

## 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%.

*Financial development (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 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).

*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.

*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 web-database.

*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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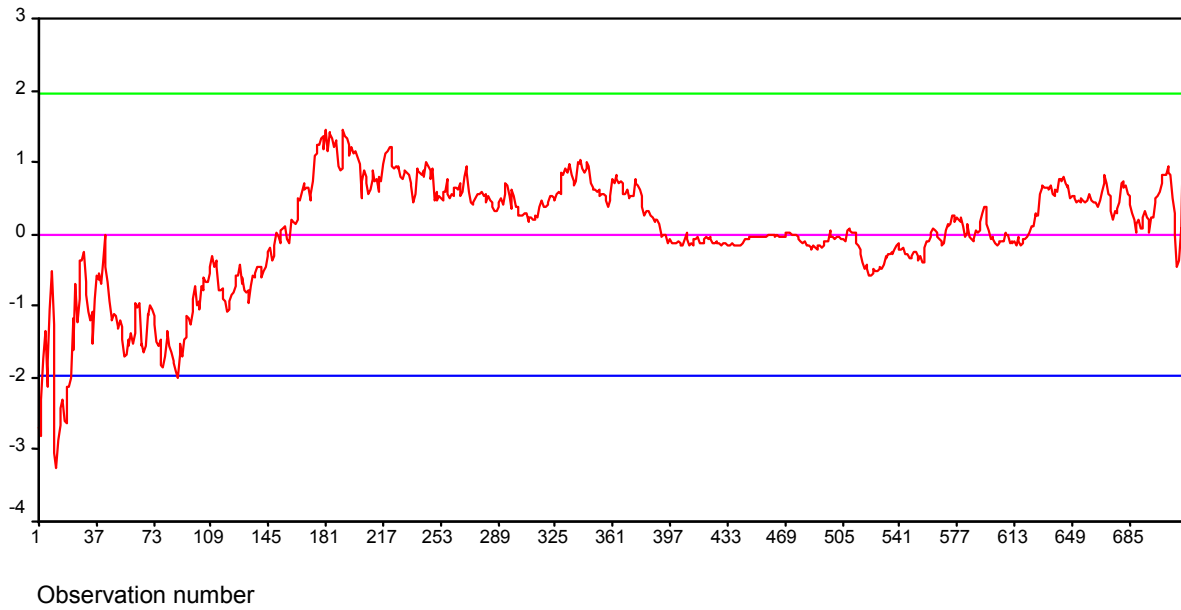
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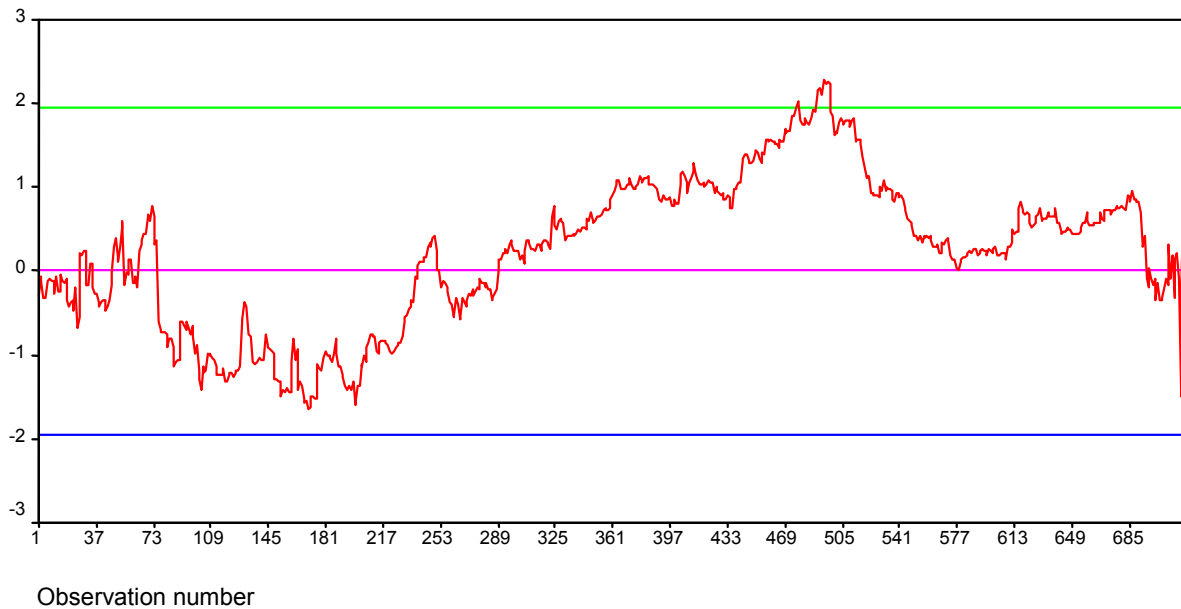
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Graph 1: t-statistics for  $\beta_5$ ,  
control variable:  $F_{i,t-1}$



Graph 2: t-statistics for  $\beta_5$ ,  
control variable: deviation of  $F_{i,t-1}$  from  $F_{i,t-1}^*$ , given  $(Y/L)_{i,t-1}$  and  $TER_{i,t-1}$



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