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Abstract

This paper offers a re-assessment of the finance-growth nexus in a framework that allows to distinguish between short-run versus long-run effects. Our dataset contains information on 45 developed and developing countries over the period 1995-2011. We make use of the integration and cointegration properties of the data, establish a cointegrating relation and derive the long-run elasticities of per capita GDP with respect to employment, the physical capital stock, and financial development. We employ these results to specify an error correction model and assess whether the years of crisis have changed the relationship between finance and growth.

JEL classification: E44, F43, F65
Keywords: Finance-Growth Nexus, Panel Cointegration, Error Correction Model, Threshold Model, End-of-sample instability

1 Introduction

The financial crisis changed substantially the perception of how financial markets impact on the real economy. While the work of King and Levine (1993a) motivated an avenue of research, which by and large shared the view that banks and financial markets provide important services to the economy and thereby foster growth (Levine, 2005), this perception has to be reconsidered in face of recent developments. Even though a few studies find a weak or even negative relationship between financial development and growth, the bulk of the evidence supports the finding of a positive finance growth nexus. With the spillover of the financial turmoil to the real economy in the second half of 2008, the public, political and academic discussion on this subject matter changed substantially. Obviously, though finance provides important services for the economy, the growth of the financial sector contributed to the most severe financial crisis since the great depression, and this was most certainly not beneficial for long-run economic growth. As Beck (2013) points out, "the financial sector can be both a growth engine and a source of economy-wide fragility and crisis" (p. 49). The nexus between finance and growth hence needs a renewed assessment that takes into account what we learned from the crisis.

One question crucial for this reassessment is the distinction between short- and long-run effects. The objectives of this paper are therefore to assess whether the years of crisis have changed the relationship between finance and growth and to do so in a setting that distinguishes short-run from long-run effects. Making use of the integration and cointegration properties of data on per capita GDP, employment, the capital stock, and financial depth for a sample of 45 developed and developing countries over the time period 1995-2011, we employ panel cointegration techniques, which at the same time address a number of critical issues that have been brought up in the empirical finance-growth literature such as omitted variables and endogeneity. We examine the long-run relationship which is supposed to represent equilibrium conditions in the economy and allow for nonlinearities using a threshold model. In the next step, we set up an error correction model to address the differential impact of finance on growth in the short- and in the long-run. Finally, we assess whether the parameters of the model have changed in response to the crisis.

The questions we raise are highly topical and of great political importance for various reasons. First of all, it is important to have an in-depth understanding of the link of financial intermediation and economic growth. As short run and long run effects might work in the opposite direction, it is important to disentangle them in the empirical analysis. Second, in order to have an understanding of the implications of financial stress, one has to be aware of the interplay of short-run effects with longer term equilibrium-enforcing relationships and the speed of adjustment across different countries, regions, and time periods. Based on this assessment, well designed policy measures can strengthen those links, that promote long-run growth, while at the same time implementing appropriate regulatory policies to avoid short run instabilities.

This paper differs from other papers as we employ an empirical strategy that distinguishes between short-run and long-run effects while at the same time accounting for possible nonlinearities in the the finance-growth nexus and potential parameter instability. We find, that while there seems to be a positive long-run relationship of finance and per capita GDP when assuming a homogeneous relationship, this positive relationship can not hold for countries with a high level of financial depth, where credit to the private sector exceeds a level of 68.5% of GDP. For these countries with a high level of financial depth, there is a significantly negative relationship of finance and economic output. Furthermore, we find that there is no impact of finance on growth in the short-run. Finally, the application of an end-of -sample instability test shows that there is evidence for a structural break at the end of the sample, indicating that the financial crisis has changed the parameters of the finance growth nexus.

The paper is structured as follows: Section 2 provides a short overview over important contributions on the finance-growth nexus. In section 3 we present the data and the empirical strategy. In section 4 we identify the long-run relationship of finance and per capita GDP based on both linear and nonlinear models. In section 5 we set up a panel error correction model, using the estimates of the long-run relationship to construct homogeneous and regime-specific error correction terms. In section 6 we examine whether the parameters in the error correction model have changed at the and of the sample relying on Andrews (2003) end-of-sample instability test. Section 7 offers robustness checks with respect to different measures of financial depth and section 8 concludes.

2 Literature

The question to which extent financial markets contribute to economic growth, was addressed in numerous studies from the theoretical as well as the empirical side. One of the first contributions originates in Schumpeter (1911) who put forward the idea that the banking system has a key role in enabling innovative entrepreneurs to finance and market their products. The supposedly positive role of finance for growth was however challenged ever since.

Roughly clustered, economic theory offers two main explanations concerning how finance can affect growth. Through the quantitative channel increased financial deepening leads to a mobilization of savings and hence, faster accumulation of capital. Through the qualitative channel, financial intermediation facilitates the financing of innovation projects and thereby increases total factor productivity (Ang, 2008).

Levine (2005) discusses the literature along five main channels by which finance has an impact on growth. First, financial systems allocate capital more efficiently than private savers by their advantage in gathering relevant information on possible investments. As the acquisition and use of information is difficult and comes at a high cost, financial intermediaries facilitate the process of judging potential investment projects and thereby allow capital to be used most efficiently. Second, financial markets improve the monitoring of investments and the exertion of corporate governance - be it in a bank based system or via financial markets. Third, financial markets have an important role in the trading and diversification of risk and risk management, since financial markets make possible to pool, trade, resell, and diversify the risk associated with certain projects and allow intertemporal risk sharing. The fourth channel captures the above mentioned mobilization of savings and finally, the role of financial services in easing exchange by lowering transaction costs and lower transaction costs might foster growth.

There is an extensive empirical literature studying the relationship of finance and growth. In their seminal paper, King and Levine (1993a) show that financial indicators are significantly and positively correlated with growth. Furthermore the financial indicators at the beginning of the period are a good predictor of the average rate of real per capita GDP growth, which indicates that the results are not driven by finance simply following growth. In King and Levine (1993b), the authors develop a growth model in which productivity growth is determined endogenously and extend the King and Levine (1993a) results by instrumenting for financial development.They confirm the King and Levine (1993a) finding that finance predicts growth.

Levine and Zervos (1998) construct a series of stock market indicators and assess the relationship with economic growth, capital accumulation, and productivity growth. They show that while the initial level of stock market liquidity and the initial level of banking development (bank credit) have a positive impact on economic growth over the following 18 years, the pure size of the stock market, volatility, and integration in world capital markets do not determine economic growth.

Beck et al. (1999) re-examine the King and Levine (1993a) results by improving upon the methodology using an instrumental variable approach as well as dynamic panel techniques. Beck et al. (2000) assess the finance growth nexus with a focus on the sources of growth. Their results confirm the finding that financial deepening affects total factor productivity growth, but the link of financial development with capital accumulation or the private savings rate is not robust to altering estimation methods or different financial deepening indicators.

Benhabib and Spiegel (2000) estimate a Solow (1956) model with human capital and an endogenous growth model based on Benhabib and Spiegel (1994), extending the specifications with the King and Levine (1993a) measures of financial deepening. Their results indicate that financial development is an important factor determining GDP growth and that an increase in total factor productivity is the main channel by which a higher level of financial development translates to higher growth. Based on industry-level data, Rajan and Zingales (1998) show that industries which depend to a higher degree on external finance do better in countries with a higher level of financial depth.

A number of time series studies address the issue of causality (see for example Neusser and Kugler, 1998; Choe and Moosa, 1999; Luintel and Khan, 1999; Bell and Rousseau, 2001; Rousseau and Vuthipadadorn, 2005; Arestis and Demetriades, 1997). Well in line with cross country studies, these analyses mostly conclude that causality runs from financial development to growth. Arestis and Demetriades (1997) however point out that the findings vary considerably from country to country. Christopoulos and Tsionas (2004) address the issue of causality in a panel cointegration framework. They show that long-run causality runs from financial development to growth and find no support for a short-run effect of finance on growth. Similarly, Wu et al. (2010) apply a cointegrated panel to assess the impact of financial institutions on growth in the European Union. They find that there is a long run relationship between credit markets, stock markets and economic development.

Several recent studies investigate whether there is a threshold, above which the effect of financial development might turn insignificant or even negative. Arcand et al. (2012) find that finance has a negative impact on economic growth when private credit exceeds a threshold of 100% of GDP. There are a number of explanations why there might be a negative relationship of finance and growth at high levels of financial depth. One likely explanation is that a high degree of financial depth increases the probability of banking crisis. Arcand et al. (2012) however show that this is only one factor which can not fully explain a negative nexus at high levels of financial depth. Other factors contain the importance of a well functioning regulatory framework and hence country heterogeneity, an adverse allocation of resources, and the quality and type of credit (see Beck, 2013, for a discussion on the opposed effect of firm credit and household credit).

Using a semiparametric approach, Herwartz and Walle (2014) confirm the finding that the effect of finance on growth depends on the set of countries and show that the impact of financial development on growth varies with income, where there is a stronger impact in richer economies. This finding is confirmed by Henderson et al. (2013) who base their analysis on kernel methods that allow for heterogeneity in partial effects and conclude that while rich countries benefit from more finance, there is no beneficial effect of financial development on growth for poor countries.

The large number of studies devoted to reassess the finance-growth nexus in recent years shows that the crisis has changed the perception of a supposedly positive relationship of finance and growth and that research is needed that examines the subject matter on a differentiated level, that disentangles short-run from long-run effects and addresses potential non-linearities and structural breaks.

3 Data

We employ domestic credit to the private sector as % of GDP as a measure of financial development as this allows us to compare our results to previous studies and delivers a comparatively long time series dimension. It is however not straightforward to find an appropriate overall measure for financial depth (Ang, 2008). We therefore conduct a series of robustness checks using the following measures of financial depth suggested by the literature: credit provided by banking sector as (% of GDP) and liquid liabilities (M3) (as % of GDP) to capture the role of financial institutions and listed domestic companies, market capitalization (as % of GDP), financial market depth (as % of GDP), and stock market turnover ratio (% of GDP) to investigate the role of financial markets for per capita GDP growth (see section 7) .

We apply a similar econometric framework as in Christopoulos and Tsionas (2004), but base the empirical model on a production function with total income of country i in period t, (Y_{it}), being a function of the physical capital stock (K_t), labor input (N_{it}), and a measure of financial development (FD_{it}), which is a determinant of total factor productivity.

$$Y_{it} = K_{it}^{\alpha} N_{it}^{\tilde{\beta}} FD_{it}^{\gamma} \tag{1}$$

For total income Y_{it}, we use GDP at constant 2005 USD, for labor N_{it} total employment, and we employ data on the physical capital stock provided by Berlemann and Wesselhoeft (2012). All variables expect the physical capital stock stem from the World Development Indicators (WDI) Database. As we wish to evaluate the impact of financial depth on GDP per capita, we transform the relationship in (1) by dividing by N_{it} and taking the natural logarithm. Hence, the basic empirical model for the long-run relationship reads

$$\ln y_{it} = \alpha \ln K_{it} + \beta \ln N_{it} + \gamma \ln FD_{it} + \epsilon_{it}, \tag{2}$$

where we use per capita GDP, y_{it}, as measure of output per effective labor, such that α is the elasticity of per capita GDP with respect to the capital stock, γ is the elasticity of per capita GDP with respect to the financial depth indicator (here private credit over GDP) and the elasticity of per capita GDP with respect to total employment, β is given by $(\tilde{\beta} - 1)$.

We employ a broad sample of 45 developed and developing countries (see list of countries in the Appendix) over the period 1995-2011, which yields a high degree of variation in the data. The GDP per capita series covers countries with very low levels of economic development such as Sri Lanka, which reports an average per capita GDP of 967.4 USD as well as rich countries such as Switzerland which has an average per capita GDP of 51938.8 USD. The same is true for *private credit*, where our sample contains countries with very

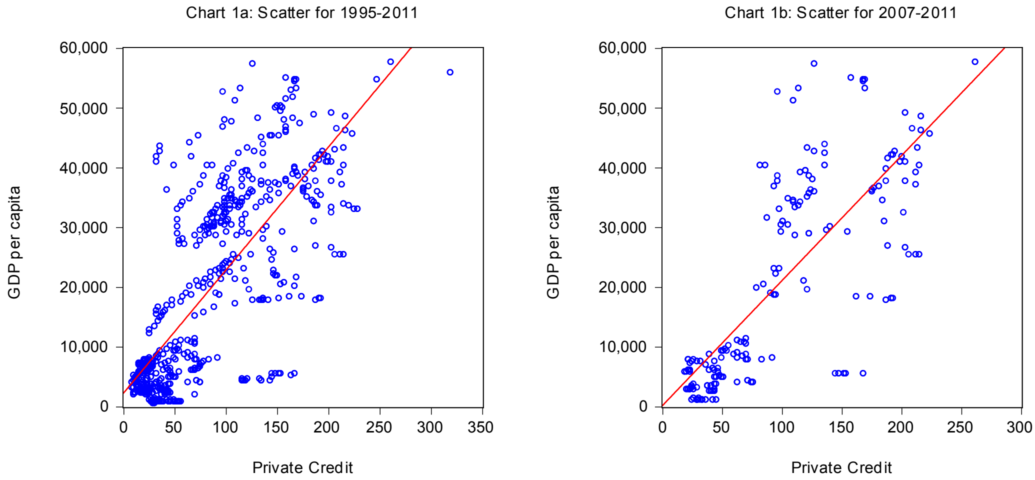

Figure 1: Correlation of GDP per capita and private credit

high average values of private credit to GDP such as 319.5% of GDP in Iceland and countries with very low average levels of private credit such as 8.8% of GDP in Venezuela. The median of the sample is 80.6 % of GDP and the mean 85.9% of GDP.

Table 1: Descriptive Statistics

	GDP per capita	Capital Stock	Employment	Private Credit
Mean	20299.100	2.14E+12	17176008.000	85.887
Median	18461.600	4.36E+11	5553718.000	80.555
Maximum	58009.800	3.10E+13	149000000.000	319.461
Minimum	1028.540	2.04E+10	153851.900	7.824
Std. Dev.	16273.920	5.15E+12	26230615.000	58.739
Observations	542	542	542	542

Figure 1 shows the scatter plot of GDP per capita and private credit for the time period 1995-2011 and 2007-2011. We see that, as suggested by the recent literature on the topic, the relationship seems to have weakened in recent years. The positive correlation among the two main indicators used in this study, does however remain. Table 1 shows the descriptive statistics on per capita GDP, the capital stock, employment and private credit.

Unit Root and Cointegration Tests

We suppose that equation (2) represents a long-run economic relationship between per capita income, total employment, the capital stock of the economy and the level of financial depth. Even though there may be deviations from this relationship in the short run, they should not have a permanent impact but lead to an adjustment process that maintains the economy close to this relationship in the longer term. Such a relationship that extracts the stationary and equilibrium enforcing component of by themselves nonstationary processes is generally known as cointegrating relation.

In order to evaluate the integration and cointegration properties of the variables, we conduct a series of panel unit root and cointegration tests. We employ the Levin et al. (2002) (LLC), Breitung (2005) and Im et al. (2003) (IPS) panel unit root tests to test for unit roots in the data. All three tests are performed on the basis of Augmented Dickey

Fuller regressions, where LLC and Breitung (2005) test against the null hypothesis of a common unit root while the IPS test runs the regression for each cross-section and uses the mean of the individual specific t-statistics to test against the null hypothesis of individual unit root processes. The results of the tests indicate that per capita GDP, employment, and private credit are all integrated of order one, even though the LLC test rejects the null hypothesis of a common unit root in all series due to the considerable heterogeneity in the data. For the physical capital stock, the LLC tests rejects the null hypothesis of a common unit root in levels and first differences, while the IPS test cannot reject the null hypothesis of individual unit root processes in levels but rejects for the first differences.

To examine whether the variables given in equation (2) are cointegrated, we rely on the Pedroni (1999, 2004) residual based cointegration test. Pedroni (1999) suggests seven tests statistics to test for panel cointegration: the panel v-statistic, panel rho-statistic, panel PP-statistic, panel ADF-statistic, group rho-statistic, group PP-statistic, and group ADF-statistic. The tests are conducted in two steps, where the first step is to run the regression $\ln y_{it} = \alpha \ln K_{it} + \beta \ln N_{it} + \gamma \ln FD_{it} + \epsilon_{it}$ for each cross section and the second step is to test whether the ϵ_{it} are stationary. The results support the hypothesis of a long-run equilibrium cointegrating relationship among per capita GDP, the physical capital stock, employment, and private credit. (Table 12 and Table 13 in the Appendix report the results for the unit root and cointegration tests).

The implementation of our empirical strategy involves proceeding in two separate steps, where in the first step (section 4), we estimate the cointegrating relation (based on a linear and on a nonlinear model) and in the second step, we set up the error correction model, where we use the estimates of the first step to construct the error correction term (section 5).

4 Identifying the long-run relationship

We employ the dynamic ordinary least squares (DOLS) estimator put forward by Saikkonen (1995) for estimating the cointegrating relation in a panel as it delivers unbiased and asymptotically efficient estimates of the coefficients in (12) when confronted with possible endogeneity among the variables. Therefore, the basic equation is augmented by lags and leads of the included variables, such that we estimate with OLS the following equation:

$$\begin{aligned} \ln y_{it} &= a + \alpha \ln K_{it} + \beta \ln N_{it} + \gamma \ln FD_{it} \\ &+ \sum_{j=-k}^{k} \phi_{1,ij} \Delta \ln K_{it-j} + \sum_{j=-k}^{k} \phi_{2,ij} \Delta \ln N_{it-j} + \sum_{j=-k}^{k} \phi_{3,ij} \Delta \ln FD_{it-j} + u_{it} \end{aligned} \tag{3}$$

As was shown by Wagner and Hlouskova (2010), this estimator outperforms the other estimators such as the fully modified OLS estimator in panels where the time series dimension is relatively short. In the first model, we include only country fixed effects and in the second model we include country and period fixed effects in the estimation and we set $k = 1$ because of the short time series dimension. We estimate equation (3) with the White method for coefficient variances that yields robust standard errors under cross-sectionally correlated errors.

The estimated long-run elasticities are presented in Table 2. In model 1, where we include only country fixed effects, the elasticities of per capita GDP with respect to employment and the capital stock are 37% and 30%, both highly significant. The elasticity

Table 2: Long-run relationship of per capita GDP with employment, capital stock and private credit

	ln N	ln K	ln FD	Obs
1) DOLS estimator	0.3660***	0.3041***	0.1611***	490
Country FE	(0.0685)	(0.0386)	(0.0111)	
2) DOLS estimator	0.0191	0.1170***	0.0856***	490
Country and Period FE	(0.0719)	(0.0405)	(0.0127)	

Dependent variable is $\ln y$
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

of financial depth is also positive and estimated to be 16%, which is also highly significant. When we include also period fixed effects, the effect of employment on per capita GDP is estimated to be close to zero, while the elasticities of the capital stock and financial depth are now estimated to be half as strong but still significantly positive at 12% and 9%. From this first look at the long-run relationship, where we assume a homogeneous relationship for all countries, one would conclude that there is a positive and significant effect of financial depth on GDP, when measured with private credit. This simple regression hence seems to confirm previous results of a positive finance growth nexus.

4.1 Nonlinear Model with Exogenously Determined Regimes

As demonstrated in recent empirical work, the nexus of financial depth and growth might come from a nonlinear relationship, where the effect of finance on growth depends on the achieved level of financial depth or income (see for instance Arcand et al., 2012). In this section, we suggest a set of models that incorporate nonlinearities in the long-run relationship between financial depth and growth. In so doing, we allow for different long-run parameters for financial depth in the cointegration vector for different regimes depending on the average financial depth of each country. We first distinguish between low, medium, and high levels of financial depth where the three regimes are given by countries with an average credit to GDP ratio below the 33th quantile (regime 1), above the 33th quantile but below the 66th quantile (regime 2) and above the 66th quantile (regime 3). In the next step, we do not chose the thresholds arbitrarily but we estimate a threshold model, where the indicator function clusters the countries in three regimes. The thresholds are chosen by estimating all possible models that ensure a minimum of 10% of observations in each regime and choosing the model with the lowest sum of squared residuals (SSR).

Table 3 depicts the estimated long-run coefficients if we estimate the model separately for countries with low, middle or high levels of financial depth. The results are remarkable as they confirm the hypothesis of the recent literature, which suggests that at high levels of financial depth, the impact on growth is likely to diminish or even become negative. While in countries with a low level of financial depth, finance has a positive and strong effect on GDP, which is significant at the 1% significance level, this effect diminishes as the level of credit to GDP increases and eventually becomes significantly negative for countries with

Table 3: Long-run relationship of per capita GDP with employment, capital stock and private credit

ln N	ln K	ln FD Regime 1	ln FD Regime 2	ln FD Regime 3	ln FD Regime 4	R^2	Obs
With Country Fixed Effects							
0.1651	0.3233***	0.2546***				0.986	155
(0.1095)	(0.0768)	(0.0221)					
0.4812***	0.3295***		0.0897***			0.986	154
(0.1296)	(0.0732)		(0.0290)				
						0.991	181
0.0721	0.6682***			-0.0304*			
(0.1065)	(0.0720)			(0.0156)			
With Country and Period Fixed Effects							
-0.5764***	0.0847	0.1043***				0.992	155
(0.1318)	(0.0776)	(0.0210)					
-0.0436	0.4340***		-0.0078			0.999	154
(0.1586)	(0.0671)		(0.0311)				
0.1041	0.4976***			-0.0356**		0.992	181
(0.1048)	(0.0972)			(0.0147)			
With Country Fixed Effects							
0.3237**	0.2929***	0.2486***				0.987	116
(0.1400)	(0.1111)	(0.0227)					
0.2419	0.5752***		0.0578***			0.999	128
(0.1664)	(0.0987)		(0.0196)				
0.3350**	0.3982***			-0.0047		0.998	130
(0.1378)	(0.0830)			(0.0149)			
0.0640	0.7428***				-0.0907**	0.993	116
(0.1514)	(0.0937)				(0.0377)		
With Country and Period Fixed Effects							
-0.4752**	0.0458	0.0990***				0.991	116
(0.1894)	(0.1263)	(0.0297)					
-0.0483	0.3991***		0.0154			1.000	128
(0.1082)	(0.0832)		(0.0176)				
0.1581	0.4120***			-0.0486**		0.999	130
(0.1717)	(0.0935)			(0.0219)			
0.0632	0.6707***				-0.0687	0.994	116
(0.1514)	(0.1245)				(0.0477)		

Dependent variable is $\ln y$.Heteroskedasticity robust standard errors in parenthesis
***(**)[*] indicates significance at the 1% (5%)

a very high level of credit to GDP. The lower part of Table 3 shows the results for the model with country and period fixed effects.

If we divide the sample into four subsamples, the estimation yields very similar results with an insignificant or negative impact of finance on GDP as financial depth becomes higher. For the model with country and period fixed effects, the impact of finance on growth becomes negligible in the second regime and is negative in the third and fourth regime. The lower panel in Table 3 summarizes the results of applying four regimes.

4.2 Threshold Model

The regime-specific estimations indicate that country heterogeneity has indeed a substantial role in how finance impacts on GDP and their results make obvious that it is important to distinguish between different levels of financial depth. We therefore estimate the following threshold model, where the thresholds are chosen by rolling estimation windows with a minimum of 10% of observations in each regime and according to the model with the lowest sum of squared residuals (SSR). More specifically, we estimate the model

$$\begin{aligned}\ln y_{it} &= a + \alpha \ln K_{it} + \beta \ln N_{it} \\ &\quad + \gamma_{\tau_1} \ln FD_{it} * I_{\tau_1} + \gamma_{\tau_2} \ln FD_{it} * I_{\tau_2} + \gamma_{\tau_3} \ln FD_{it} * I_{\tau_3} \\ &\quad + \sum_{j=-k}^{k} \phi_{1,ij} \Delta \ln K_{it-j} + \sum_{j=-k}^{k} \phi_{2,ij} \Delta \ln N_{it-j} + \sum_{j=-k}^{k} \phi_{3,ij} \Delta \ln FD_{it-j} + u_{it}, \qquad (4)\end{aligned}$$

where I_{τ_1} defines the regime covering all countries with an average credit to GDP level below the τ_1^{th}-quantile and $\tau_1 = 10, \ldots, 89$. The second regime is defined accordingly with the average credit to GDP being above the τ_1^{th}-quantile and below the τ_2^{th}-quantile which runs from $\tau_2 = \tau_1 + 10, \ldots, 99$. The third regime covers all countries with the average credit to GDP above the τ_2^{th}-quantile. We estimate the model with country fixed effects and with country and period fixed effects and choose the best model according to the SSR - and thereby the thresholds which determine the regimes. For the model with country fixed effects, we end up with a model, where the first regime is defined by a threshold covering all observations below the 12th quantile, the second regime by the following 37% of observations and the third regime applying to countries with an average financial depth indicator above the 49th quantile.

The results of the threshold model underpin the general direction of the previous model with exogenously chosen regimes. Credit to GDP becomes less beneficial for per capita GDP at higher levels of financial depth and the effect of private credit on GDP eventually becomes negative. This is also the case for the threshold model which is displayed in Table 4. While the impact of credit on GDP is large in the lowest regime - a 1% higher credit to GDP share is associated with 30% increase in per capita GDP, this effect is not even half as strong in the second regime and insignificant in third. When country and period fixed effects are included, the effect is strong in the first regime, decreases to one third of the initial effect for higher levels of credit and becomes negative in the third regime.

As a robustness check, we also include education (average years of total schooling above the age of 25 from the Barro-Lee dataset given in the Education Statistics of the World Bank) in our model. The inclusion of education (EDUC) does not alter our estimates for the coefficients of financial development in the cointegrating regression and only slightly changes the size of the effect of the capital stock or employment when comparing the

Table 4: Threshold model

	ln N	ln K	ln FD Regime 1	ln FD Regime 2	ln FD Regime 3	R^2	Obs
With Country Fixed Effects							
	0.1732**	0.4857***	0.2982***	0.1150***	0.0000	0.999	490
	(0.0848)	(0.0522)	(0.0207)	(0.0175)	(0.0156)		
With Country and Period Fixed Effects							
	-0.0844	0.3133***	0.2189***	0.0700***	-0.0698***	0.999	490
	(0.0788)	(0.0609)	(0.0192)	(0.0145)	(0.0147)		

Dependent variable is $\ln y$
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

estimation results for the same sample (the sample contains fewer countries when education is included). The coefficient of education itself does not show up to be significant, so we conclude that education does not play a major role in our model and we can use our main specification as given in equation (3).

Table 5: Threshold model with education

ln N	ln K	ln EDUC	ln FD Regime 1	ln FD Regime 1	ln FD Regime 1	R^2	Obs
With Country and Period Fixed Effects							
-0.0846	0.1697**	0.0561	0.1970***	0.0967***	-0.0688***	0.999	396
(0.0912)	(0.0689)	(0.0870)	(0.0364)	(0.0168)	(0.0161)		

Dependent variable is log GDP per capita.Heteroskedasticity robust Standard errors in parenthesis
***(**)[*] indicates significance at the 1% (5%)

5 Error-Correction Model

To examine the short-run and long-run effect of finance on growth, we make use of the integration and cointegration properties of the data and specify an error-correction model. We construct the error correction term using the long-run elasticities of per capita GDP with respect to employment, the physical capital stock, and financial development which we have gained in the previous section. The basic error correction model reads

$$\Delta \ln y_{it} = b_0 + b_1 \Delta \ln y_{it-1} + b_2 \Delta \ln N_{it-1} + b_3 \Delta \ln K_{it-1} + b_4 \Delta \ln FD_{it-1} + \phi EC_{t-1} + \epsilon_{it} \quad (5)$$

where the error correction term EC_t reflects the deviations from equilibrium such that $EC_t = \ln y_{it} - [\hat{\alpha} \ln K_{it} + \hat{\beta} \ln N_{it} + \hat{\gamma} \ln FD_{it}]$. A significant (negative) error-correction coefficient, ϕ, implies long-run causality, which is equilibrium enforcing in the sense that a deviation from the long-run equilibrium triggers an automatic adjustment back to equilibrium and ϕ measures the speed of adjustment to the long-run equilibrium. If we can reject the null hypothesis that $\phi = 0$, then this is a strong indication of a long-run causal effect of finance (private credit) on growth.

In order to use the estimates from equation (2) for the construction of the error correction term, we have to ensure that the error correction term (which reflects the deviations from equilibrium) is stationary. Testing the error correction term in the linear model for unit roots yields however mixed results. For the whole sample period, both the LLC test and the IPS test cannot reject the null hypothesis of a common unit root when no trend is included in the Dickey Fuller equation. If a trend is included, the LLC test rejects, while the IPS test does not. We can however reject the unit root hypothesis in both tests when we cut off the sample at the start of the global crisis and run the test for the sample 1995-2009 and include a trend. For the error correction term including country and period fixed effects, only the LLC test rejects. Looking at the error correction term based on the nonlinear model, the LLC test rejects in the model with trend as well as in the model without a trend, when the years of crisis are excluded. Also, for the error correction term based on the model with country and period fixed effects, both tests now reject, if we exclude the crisis. The unit root tests on the error correction terms therefore support the use of a nonlinear model rather than a linear model. Further, the results indicate that the years of crisis might have had an impact on the long-run equilibrium relationship. We address this issue in section 6.

The results of the basic error correction model are presented in Table 6. We find that, while the DOLS estimation showed the positive long-run relationship of per capita GDP and financial depth, this positive relationship does not hold for the short run. First, there is no statistically significant short-run effect of financial depth on GDP. This is to be expected, as the channels through which finance enhances productivity growth and a more efficient allocation of capital will take time and cannot materialize within short time periods. Second, an increase in the capital stock leads to a decrease in per capita output in the short-term. This result reflects the short-run nature of the estimated parameters - where an increase in the capital stock reflects higher savings and hence a cut in consumption.

One central result of our the error correction model is however the highly significant coefficient of the error correction term. We estimate a speed of adjustment parameter of $\phi^{ce} = 0.054$ and $\phi^{cpe} = 0.047$, depending on whether period fixed effects are included or not. The speed of adjustment parameter implies that a deviation from equilibrium today triggers a 5% adjustment of the original deviation each period.

Together with the results of the long-run specification, the results of the error correction model demonstrate the importance of disentangling short-run from long-run effects in the analysis of the finance-growth nexus. Financial depth does have a long-term but no short-term impact on the economy. The results show that the benefits of financial services in enabling and facilitating economic activity do not arise from a financial sector being a growth sector in itself (see Beck, 2013). The positive impact realizes in the long-run, and whenever there is a deviation from equilibrium, e.g. whenever per capita GDP is *too high* given a certain level of capital stock, employment and financial depth, there is an automatic adjustment to a predetermined long-term equilibrium level.

In an attempt to allow for short-run heterogeneity in the speed of adjustment parameter, we include an interaction dummy for various groupings of countries interacted with the error correction term in the model

$$\begin{aligned}\Delta \ln y_{it} = b_0 + b_1 \Delta \ln y_{it-1} + b_2 \Delta \ln N_{it-1} + b_3 \Delta \ln K_{it-1} + b_4 \Delta \ln FD_{it-1} \\ + \phi EC_{t-1} + I_G * \phi_G EC_{t-1} + \epsilon_{it}, \qquad (6)\end{aligned}$$

where I_G and ϕ_G denote the interaction dummy and speed of adjustment parameter of group i. We tested for possible group specific speed of adjustment parameters in the CEE region, emerging markets, rich and poor economies and countries with low and high levels of financial depth. For none of these groupings we find a statistically significant group-specific error-correction estimate. Furthermore, we include dummies for different average levels of financial depth to allow for group-specific short-run coefficients of financial depth. This model reads

$$\begin{aligned}\Delta \ln y_{it} &= b_0 + b_1 \Delta \ln y_{it-1} + b_2 \Delta \ln N_{it-1} + b_3 \Delta \ln K_{it-1} \\ +I_{G_L} * b_L \Delta \ln FD_{it-1} &+ I_{G_M} * b_M \Delta \ln FD_{it-1} + I_{G_H} * b_H \Delta \ln FD_{it-1} + \\ &\phi EC_{t-1} + \epsilon_{it}, \end{aligned} \tag{7}$$

where the interaction dummies are chosen to capture low, medium, and high levels of financial depth. We do not find strong evidence for group-specific short-run coefficients of financial depth, even though in the model with country and period fixed effects, the short-run coefficient is positive and significant at the 1% level indicating that for high financial depth countries, there might be a negative long-run but a positive short-run impact of financial depth on GDP growth.

5.1 Error-Correction Model with Regime-Specific Long-Run Coefficients

Table 7 presents the results for the error-correction model when we use the regime-specific long-run estimates for the construction of the error-correction term. This implies that we compute the deviations to the regime-specific equilibrium and incorporate the resulting disequilibrium vector in the error-correction specification. As is to be expected, the use of regime-specific equilibrium yields higher estimated speed of adjustment parameter. As a result, also significance increases and the error correction term is now highly significant at the 1% level in all specifications.

Besides this, the short-run effects do not change very much when we use regime-specific estimates, regardless of whether we use country fixed effects only or country and period fixed effects. GDP per capita appears to be strongly persistent. If period fixed effects are included, the coefficient of employment on per capita GDP appears to be positive and significant suggesting that there is a positive impact of employment in the short run. There is a negative short-run impact of the capital stock in all models but the model with country and period fixed effects in the cointegrating and error-correction specification. Finally, we do not find a short-run effect of financial depth on growth. Overall, the results confirm the hypothesis of a differing impact of the capital stock, employment, and financial development on per capita GDP in the short- and in the long-run. They also underline the importance of accounting for cointegration in the analysis of financial depth on per capita GDP.

6 End-of-Sample Instability

In this section, we wish to account for the the possibility of a change in the parameters through the years of the global financial and economic crisis. The past years have left no doubt on the importance of financial stability and the risks associated with financial deepening. Obviously, even though finance provides important services for the economy, the growth of the financial sector contributed to a global financial crisis with tremendous negative effects on long-run economic growth. As is to be expected regarding the long-run

Table 6: Error-Correction Model

	Effects in Cointegrating Regression			
	Country FE		Country FE	
Δ ln y (-1)	0.1946***	0.2724***	0.1952***	0.2729***
	(0.0728)	(0.0730)	(0.0728)	(0.0728)
Δ ln N(-1)	0.0678	0.1577	0.0639	0.1549
	(0.0850)	(0.0755)	(0.0853)	(0.0766)
Δ ln K (-1)	-0.6071***	-0.3860***	-0.6170***	-0.3951***
	(0.1467)	(0.1261)	(0.1470)	(0.1267)
Δ ln FD(-1)	0.0055	0.0026	0.0041	0.0016
	(0.0080)	(0.0063)	(0.0086)	(0.0068)
EC Term	-0.0549*	-0.0467*	-0.0584*	-0.0489*
	(0.0319)	(0.0247)	(0.0337)	(0.0257)
EC Term CEE			0.0471	0.0320
			(0.0776)	(0.0622)
Effects in EC Model				
Country FE	Y	Y	Y	Y
Period FE	N	Y	N	Y

Dependent variable is $\Delta \ln y$
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

Table 7: Error-Correction Model with Regime Specific Long-run elasticities

	Effects in Cointegrating Regression			
	C FE in Coint	C FE in Coint	CP FE in Coint	CP FE in Coint
Δ ln y (-1)	0.2327***	0.2897***	0.2161***	0.3073***
	(0.0741)	(0.0749)	(0.0707)	(0.0717)
Δ ln N(-1)	0.0986	0.1520*	0.0974	0.1666**
	(0.0833)	(0.0749)	(0.0839)	(0.0742)
Δ ln K (-1)	-0.3952***	-0.3074**	-0.3752***	-0.1981
	(0.1523)	(0.1359)	(0.1416)	(0.1454)
Δ ln FD(-1)	0.0106	0.0057	0.0100	0.0065
	(0.0082)	(0.0064)	(0.0081)	(0.0066)
EC Term	-0.0825***	-0.0817***	-0.0756***	-0.1103***
	(0.0317)	(0.0297)	(0.0206)	(0.0318)
Country Fixed Effects	Y	Y	Y	Y
Period Fixed Effects	N	Y	N	Y

Dependent variable is $\Delta \ln y$.
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

Table 8: Error-Correction Model for Full Sample and Pre-Crisis Sample

	Linear Model 1998-2011	Linear Model 1998-2007	Nonlinear Model 1998-2011	Nonlinear Model 1998-2007
Δ ln y (-1)	0.2724***	0.2280**	0.3073***	0.2899***
	(0.0730)	(0.1015)	(0.0717)	(0.0891)
Δ ln N(-1)	0.1577**	0.0232	0.1666**	0.0427
	(0.0755)	(0.0923)	(0.0742)	(0.0918)
Δ ln K (-1)	-0.3860***	-0.7010***	-0.1981	-0.3658**
	(0.1261)	(0.1637)	(0.1454)	(0.1662)
Δ ln FD(-1)	0.0026	-0.0017	0.0065	0.0031
	(0.0063)	(0.0068)	(0.0066)	(0.0069)
EC Term	-0.0467*	-0.0457	-0.1103***	-0.1744***
	(0.0247)	(0.0301)	(0.0318)	(0.0406)

All models contain country and period fixed effects in cointegrating regression and error correction model, Dependent variable is $\Delta \ln y$.
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

elasticities for the whole sample period in comparison to the sample which excludes the years 2008-2010, the positive impact of finance on growth is estimated to be stronger, when we exclude the years of the crisis (11% instead of 8% for the model with country and period fixed effects). . Looking at the error-correction model for the whole sample and the pre-crisis sample (see Table 8), we find for both samples that while the adjustment to equilibrium plays an essential role when including regime-specific equilibria, we do not find significant error correction when assuming a homogeneous long-run relationship. Besides this, we find that the speed of adjustment is much faster in the years 1998-2007 than for the whole sample, which is a sign of a change in the way the economy reacts to deviations from equilibrium and which might also indicate the formation of a new equilibrium relationship between per capita GDP and financial depth.

In order to make a qualified assessment of a possible change in the short-run parameters, we would like to employ a statistical test on parameter instability. Andrews (2003) proposes a test for parameter instability at the end of the sample. For the error correction model in (8) with the number of regressors $d = 5$, n observations before the changepoint and m observations after the changepoint

$$
\Delta \ln y_{it} = \begin{cases} b_0 + b_1 \Delta \ln y_{it-1} + b_2 \Delta \ln N_{it-1} \\ + b_3 \Delta \ln K_{it-1} + b_4 \Delta \ln FD_{it-1} + \\ \phi EC_{t-1} + \epsilon_{it} \\ & \text{for } i = 1, \dots, n, \\ \\ b_0^{1i} + b_1^{1i} \Delta \ln y_{it-1} + b_2^{1i} \Delta \ln N_{it-1} \\ + b_3^{1i} \Delta \ln K_{it-1} + b_4^{1i} \Delta \ln FDit - 1 \\ + \phi^{1i} EC_{t-1} + \epsilon_{it} \\ & \text{for } i = n+1, \dots, n+m \end{cases} \tag{8}
$$

the null hypothesis of no structural break is given by $H_0 : b_j = b_j^{1i}$ and $\phi = \phi^{1i}$ for all $j = 1, \dots, 4$ and $i = n+1, \dots, n+m$ while the alternative is $H_1 : b_j \neq b_j^{1i}$ for at least one j or $\phi \neq \phi^{1i}$, for some $i = n+1, \dots, n+m$. The S test statistic is similar to the F test but uses a transformation of the model by the square root of the inverse of the covariance matrix of the errors. This allows less restrictive assumptions on the residuals. For the case where $m \leq d$, S is equal to the transformed residual sum of squares. Andrews (2003) suggests a *parametric subsampling* method to gain critical values, where the observations before the changepoint are used to obtain the distribution of the S statistic by computing S based on the full sample estimators for all $n - m + 1$ windows of length m before the changepoint. The relatively short time dimension of the sample in this paper, does however not allow to compute critical values with asymptotic validity for hypothesis testing. We nevertheless report the best possible implementation of the test, which uses the full sample coefficient estimates of the error correction model to gain a set of test statistics, given by the residual sum of squares, for overlapping three year windows starting in 1998 to the period of instability 2008-2010. We then calculate the 95th quantile of the pre-crisis statistics as critical values for a comparison to the S test statistic for the period 2008-2010 where we apply as well the full sample coefficient estimates. We obtain p-value below 0.05 for the error correction model based on the linear and the nonlinear cointegrating regression, indicating that we do face parameter instability at the end of the sample and that the years of the global financial crisis have changed the relationship of financial depth and economic growth.

7 Robustness Checks

As laid out in section 2, different parts of a well functioning financial system provide different services to the economy. It is difficult to find an ideal measure of all these services altogether. We use credit to the private sector as a main variable as it allows us to do the analysis for a broad set of countries and the results can be compared easily to other studies. The literature on the finance growth nexus suggests a couple of further indicators that each captures a different role of finance having an impact on economic growth.

We first include domestic credit provided by the banking sector as % of GDP in the analysis, which is a similar but a broader indicator than credit to the private sector. In the adjusted sample, that ensures a balanced panel structure, both indicators have equally many observations. The panel unit root and cointegration tests suggest that domestic credit by the banking sector is $I(1)$ and cointegrated with per capita GDP, employment, and the capital stock. Table 10 shows the estimated long-run elasticities of different financial depth indicators. Using the broader measure of domestic credit provided by banking sector does not change the coefficients substantially, even though the results for model 2 with country and period fixed effects are not significant for employment and the capital stock and financial depth is significant only at the 10% significance level. Looking at the error correction model (see Table 11), we find that the central results keep unchanged. There is a negative short-run impact of the capital stock, no short-run impact of financial depth and high persistence in GDP. The error correction term points in the same direction, but for the broader measure, the correction is no more significant in model 2. Overall, the long-run and short-run impact of finance on growth decreased when we use the broader measure instead of credit to the private sector, which to some degree supports the finding of Beck (2013), that for growth it matters "who gets the credit".

King and Levine (1993a) suggest to use liquid liabilities (M3) as % of GDP as a proxy for financial depth. Even though this is a measure that captures the pure size of the financial system and none of the various services provided by either financial institutions or financial markets, we estimate the long-run elasticities as well as the error correction model with liquid liabilities as the financial depth measure. The data on liquid liabilities covers 38 countries from 1996 to 2011, which yields 579 observations that include countries with very low values (such as Slovenia in 2011 with 5.4%) to countries with very high values (such as Hong Kong with 313.63%). The unit root and cointegration tests allow us to use liquid liabilities as an alternative financial depth indicator. Compared to our baseline estimation with private credit, we obtain a lower elasticity of per capita GDP with respect to employment but a higher elasticity with respect to the capital stock, while the long-run effect of financial depth stays the same - no matter if it is measured with private credit or liquid liabilities. For the error correction model, we see that using liquid liabilities does no lead to an automatic adjustment mechanism to their long run equilibrium in both models.

Table 9 lists a set of other potential measures of financial depth, which do however not fulfill the unit root precondition and can therefore not be used as an alternative indicator for financial depth in our analysis.

Table 9: Descriptive Statistics for Different Financial Depth Indicators

Indicator	Mean	Median	Max	Min	SD	Obs	Source	IPS
Private Credit [1)]	83.59	71.89	319.46	8.33	58.63	608	WDI	**I(1)**
Bank credit [2)]	98.50	83.27	337.47	10.51	67.49	608	WDI	**I(1)**
Liquid liabilities [3)]	71.81	56.77	313.69	4.26	52.32	579	GFDD	**I(1)**
DMB assets [4)]	83.15	68.42	275.39	4.17	57.42	575	GFDD	**I(1)**
Financial Depth [5)]	125.51	104.77	620.51	7.85	96.39	430	GFDD	I(0)
SM turnover [6)]	66.65	53.20	393.30	0.12	56.31	571	GFDD	I(0)
DMBA/ DMCBA [7)]	93.94	97.53	100.00	46.20	8.56	549	GFDD	I(0)
Listed Dom. Companies [8)]	635.19	239.00	8851.00	7.00	1181.3	608	WDI	I(0)
SM capitalization [9)]	72.47	46.73	606.00	0.02	79.12	606	GFDD	I(0)
NPL [10)]	4.86	2.90	42.00	0.10	5.64	436	WDI	I(0)
Value traded [11)]	58.90	27.51	726.54	0.00	84.08	569	GFDD	I(0)

[1)] Private Credit is Domestic credit to the private sector (% of GDP)
[2)] Domestic credit provided by banking sector (% of GDP)
[3)] Liquid liabilities to GDP (%)
[4)] Deposit money bank assets to GDP (%)
[5)] Sum of Market capitaltization and Outstanding domestic private debt securities to GDP (%)
[6)] Stock market turnover ratio (value traded/capitalization) (%)
[7)] Deposit money bank assets to deposit money bank assets and central bank assets (%)
[8)] Listed Domestic Companies, total
[9)] Stock market capitalization to GDP (%)
[10)] Bank nonperforming loans to total gross loans (%)
[11)] Stock market total value traded to GDP (%)

8 Conclusions

In this paper, we make use of the integration and cointegration properties of per capita GDP with employment, the capital stock and financial depth and set up a model that allows to distinguish between short-run and long-run effects of financial depth on growth. Specifically, we estimate a panel error correction model in a two-step procedure, where the first steps involves the estimation of the cointegrating vector, yielding the long-run elasticities of per capita GDP with employment, the capital stock and the financial depth indicator. We find that in the long-run there appears to be a positive impact of finance on growth as long as we assume a homogeneous long-run equilibrium for all countries in the sample. Allowing for a heterogeneous long-run relationship and estimating the cointegrated regression with thresholds in financial depth, reveals that the assumption of a homogeneous long-run relationship can not hold. In all models which allow for a group-specific effect of finance on GDP, we find that while low levels of financial depth are beneficial for GDP, at higher levels of financial depth, finance loses its positive impact on GDP and the effect eventually becomes significantly negative for countries with a financial depth level above a threshold of private credit to GDP of 68.5%.

We use the estimates of the long-run elasticities to obtain the error correction term for both the homogeneous and regime-specific cointegrating vector, where for the latter case the error-correction term captures deviations to the regime specific long-run equilibrium. The results demonstrate the relevance of long-run stationary equilibria between per capita GDP, employment, the capital stock and financial depth. Further, they confirm the application of a model that allows to distinguish between long-run and short-run effects. While there is as strong long-run relationship between financial depth and GDP, in the short run, changes in financial depth do not have substantial impact on economic growth. Finally, we find that the years at the end of the sample - the years of financial and economic crisis - do alter the parameters of the model.

Table 10: Long-run relationship of per capita GDP with employment, capital stock and different financial depth indicators

	ln N	ln K	ln FD	R^2	Obs
LFD = Private Credit					
1) DOLS estimator	0.3660***	0.3041***	0.1611***	0.998	490
Country FE	(0.0685)	(0.0386)	(0.0111)		
2) DOLS estimator	0.0191	0.1170***	0.0856***	0.998	490
Country and period FE	(0.0719)	(0.0405)	(0.0127)		
LFD = Bank Credit					
1) DOLS estimator	0.3618***	0.3475***	0.1288***	0.997	503
Country FE	(0.1119)	(0.0762)	(0.0338)		
2) DOLS estimator	-0.0885	0.1129	0.0427*	0.998	503
Country and period FE	(0.0849)	(0.0763)	(0.0239)		
LFD = Liquid Liabilities					
1) DOLS estimator	0.2106*	0.4419***	0.1553***	0.998	410
Country FE	(0.1131)	(0.0833)	(0.0434)		
2) DOLS estimator	0.0164	0.1814*	0.0848***	0.998	410
Country and period FE	(0.0886)	(0.0936)	(0.0324)		
LFD = DMB Assets					
1) DOLS estimator	0.2029	0.5798***	0.0154	0.998	402
Country FE	(0.1334)	(0.0768)	(0.0172)		
2) DOLS estimator	-0.0331	0.1897*	0.0000	0.998	402
Country and period FE	(0.0937)	(0.1036)	(0.0143)		

Dependent variable is $\ln y$.
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

Table 11: Error-Correction Model for different financial depth indicators

	Effects in Cointegrating Regression					
	Country FE		Country FE		Country FE	
	Bank Credit		Liquid Liabilities		DMB Assets	
Δ ln y (-1	0.2824***	0.2025***	0.1739**	0.2518***	0.1505**	0.2365***
	(0.0741)	(0.0753)	(0.0825)	(0.0682)	(0.0831)	(0.0698)
Δ ln N(-1)	0.1633**	0.0713	0.1131	0.2158***	0.1111	0.2041**
	(0.0754)	(0.0845)	(0.0909)	(0.0798)	(0.0930)	(0.0816)
Δ ln K (-1)	-0.3204**	-0.5572***	-0.6180***	-0.3993**	-0.6027***	-0.3815**
	(0.1311)	(0.1498)	(0.2114)	(0.1761)	(0.2184)	(0.1855)
Δ ln FD(-1)	0.0010	0.0058	0.0025	0.0130	0.0028	0.0183
	(0.0088)	(0.0108)	(0.0141)	(0.0120)	(0.0162)	(0.0120)
EC Term	-0.0502**	-0.0528	-0.0532	-0.0410	-0.0437	-0.0395
	(0.0252)	(0.0329)	(0.0435)	(0.0293)	(0.0462)	(0.0332)
Country Fixed Effects	Y	Y	N	Y	N	Y
Period Fixed Effects	N	Y	Y	Y	Y	Y

Dependent variable is $\Delta \ln y$.
Heteroskedasticity robust standard errors in parenthesis,
***(**)[*] indicates significance at the 1% (5%)

Appendix

9 Countries Included in the Dataset

Australia, Austria, Bulgaria, Chile, Colombia, Costa Rica, Denmark, Dominican Republic Ecuador, Egypt, El Salvador, Finland, France, Germany, Greece, Hong Kong, China, Hungary, Iceland, Israel, Italy, Japan, Lithuania, Mexico, Netherlands, New Zealand, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Russian Federation, Singapore,, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States, Venezuela

10 Tables

Table 12: Panel unit root tests

	Levels		First Differences	
	Statistic	p-value.	Statistic	p-value
GDP				
Levin, Lin & Chu t*	-3.9141***	0.0000	-9.4416***	0.0000
Breitung t-stat	3.2404	0.9994	-3.1502***	0.0008
Im, Pesaran and Shin W-stat	0.9234	0.8221	-4.7744***	0.0000
Employment				
Levin, Lin & Chu t*	-3.6278***	0.0001	-9.4528***	0.0000
Breitung t-stat	2.5980	0.9953	-3.7687***	0.0001
Im, Pesaran and Shin W-stat	0.8013	0.7885	-4.3185***	0.0000
Capital Stock				
Levin, Lin & Chu t*	-4.51368***	0.0000	-7.83753***	0.0000
Im, Pesaran and Shin W-stat	1.00403	0.8423	-3.20018***	0.0007
Private Credit				
Levin, Lin & Chu t*	-4.7863***	0.0000	-11.7689***	0.0000
Breitung t-stat	4.2570	1.0000	-1.6862**	0.0459
Im, Pesaran and Shin W-stat	0.3394	0.6328	-6.0924***	0.0000

The Augmented Dickey Fuller regressions of the above tests include a constant and a trend for GDP, employment and private credit. We include 1 lag to account for autocorrelation. The regressions of the test for the capital stock include a constant and country specific number of lags.

Table 13: Pedroni Residual Cointegration Test

	Statistic	Prob.	Weighted Statistic	Prob.
Alternative hypothesis: common AR coefs. (within-dimension)				
Panel v-Statistic	0.5683	0.2849	-0.9622	0.8320
Panel rho-Statistic	2.6156	0.9955	2.7986	0.9974
Panel PP-Statistic	-2.6313	0.0043	-2.5904	0.0048
Panel ADF-Statistic	-4.9730	0.0000	-5.3367	0.0000
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	5.2920	1.0000		
Group PP-Statistic	-5.8811	0.0000		
Group ADF-Statistic	-11.2658	0.0000		

Trend assumption: No deterministic trend

Included observations: 532

Automatic lag length selection based on SIC with a max lag of 3

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