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**ECONOMIC GROWTH AND FINANCIAL DEPTH:
THE ROLE OF INSTITUTIONAL QUALITY**

**GAZDASÁGI NÖVEKEDÉS ÉS PÉNZÜGYI MÉLYSÉG:
AZ INTÉZMÉNYI MINŐSÉG SZEREPE**

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ABSTRACT

In this paper, we analyze the potential nonlinear impact of economic growth on financial depth. In particular, we argue that the nonlinearity is driven by a threshold effect of the institutional quality level which represents a novel approach in the literature. We utilize a panel data set from 2000 to 2007, covering 114 countries and employ a panel FD-GMM threshold model (Seo and Shin (2016)) which allows for simultaneity between the two variables. We find that there is some, although not overwhelming, evidence of the posited nonlinearity. In high regimes, the coefficients of Real GDP growth are, in most cases, markedly different from their coefficients in low regimes which signifies that institutional quality can determine the nature of the relationship between economic growth and financial depth.

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1. INTRODUCTION

Financial markets have become the cornerstone of the modern economy. They contribute immensely to the economy by allocating capital for firms, providing risk management opportunities and boosting innovation (Cihak, 2012, Levin (2005)). It is no wonder, therefore, that previously, there had been a wide consensus concerning the positive relationship between financial depth and economic growth. This was also corroborated by most of the empirical studies written on the subject – even up to the point of widespread publication bias (e.g., Bijlsma et al., 2018). But in the wake of the Great Financial Crisis in 2008, as financial markets swiftly collapsed, it became increasingly clear that excessive financial depth can, in fact, be burdensome to the economy if not regulated appropriately (Bijlsma et al., 2018). No matter what their conclusions are, it is adequate to say that numerous studies investigate the (potentially nonlinear) effect of financial depth on economic growth. However, despite convincing economic arguments, barely any studies focus on the reverse relationship: what is the effect of economic growth on financial depth, and is it nonlinear?

This paper fills the gap in the literature by analyzing the potential nonlinear impact of economic growth on financial depth. In particular, we argue that the nonlinearity is driven by a threshold effect of the institutional quality level. Our hypothesis is that countries with stronger institutions can better regulate and protect the rights of the financial intermediaries, and therefore, economic growth promotes financial depth more if countries have stronger institutional quality (Chick, 1983 and Chick, 1992).

To examine our hypothesis, we use a panel data set from 2000 to 2007, covering 114 countries and employ a panel threshold model. To allow for endogeneity, we use the GMM method proposed by Seo and Shin (1996) to estimate our model. We find that there is some, although not overwhelming, evidence as to the posited nonlinearity of the relationship.

The rest of the paper is organized as follows. Section 2 provides a literature review on the economic growth and financial depth relationship, focused on causality and nonlinearity. Section 3 presents the data and the empirical methodology. Section 4 discusses the empirical results, and Section 5 concludes the paper and provides policy implications.

2. LITERATURE REVIEW

As previously stated, this paper intends to estimate the effect of economic growth on financial depth, but the number of studies examining this direction are scarce. Instead, the effect of financial depth on growth is most often discussed. Of course, many authors recognize the potential endogeneity and control for it using e.g. 2SLS or GMM estimation. However, the regressions still estimate the effect of financial depth on growth, not vice versa. Nevertheless, some conclusions can be drawn, even from these studies, especially with respect to nonlinearity and the directionality of the two variables.

2.1. The definition and measurement of the main variables

The functioning of the financial system (or financial depth/development) is one of the focal points of this research, along with economic growth. Ultimately, the aim of this study is to estimate the effect of economic growth on the functioning of the financial system. Ideally, this would entail finding a variable which contains information about the quality, stability and efficiency of financial markets simultaneously. Such a variable is difficult if not impossible to find; as such, one needs to use a proxy variable instead, such as one measuring the size of the financial system (Cihak et al., 2012).

The size of the financial system is also called financial depth (or financial development¹). More precisely, financial depth is the size of financial institutions and markets in a given economy. Conceptually, financial markets deepen when markets and financial intermediaries alleviate imperfect information and transaction costs (Cihak et al., 2012).

Determining the proxy for financial depth (or financial development, as sometimes denoted) is not fully agreed upon in the literature. Such a proxy needs to fulfil certain criteria, such as:

1. Capturing the capacity of the financial sector to provide financial services.
2. Being available for a wide array of countries for a long horizon so as to be appropriate for panel data analysis.

The most used metric for financial depth is domestic credit for the non-financial private sector as a ratio of GDP. There are also some other candidate variables proposed by Cihak et al. (2012) such as stock market capitalization or stocks traded to GDP. Nevertheless, the bulk of the studies

¹ The terminology is not always clear. In some studies, financial depth and financial development are used interchangeably, while other authors emphasize their distinct meanings. In this study, they will be used synonymously. Financial deepening will denote the change / growth of financial depth from now on.

utilize the ratio of domestic credit to GDP (Bijlsma et al., 2018) whereas economic growth is mainly measured by the real GDP per capita growth rate (Cihak et al., 2012).

2.2. Causality and nonlinearity of the relationship

One of the first proponents of the „economic growth causes financial development” view is Robinson (1952) who argues that „where enterprise leads finance follows”. According to this view, financial depth is not a prerequisite but rather a consequence of economic growth. This is based on economic grounds: for instance, greater economic growth leads to a higher demand for financial services (Chick, 1983). This also leads to larger financial markets, as the firms in dire need of credit and households with excess capital turn to the stock market. In economies with a greater growth, there is also likely more excess capital of households. Zang and Kim (2007) also find and argue that economic growth precedes financial deepening, not vice versa and advocate for a more balanced approach to be taken with respect to the direction of the relationship.

There are multiple studies recognizing the bidirectional nature of the relationship (e.g., Rachdi & Mbarek (2011)). Greenwood and Jovanovic (1990) create a theoretical model based on the assumption that while financial depth encourages economic growth by allowing a higher rate of return to be earned on capital, growth also motivates financial deepening because „it provides the means to implement costly financial structures”. The causal relationship between the two variables is examined by Aretsis & Demetriades (1997) using time series methods but no conclusive results are reached. Their models show bidirectional or unidirectional relationships based on the country examined and these results also depend on the type of financial variable used for measuring depth.

The assumption of nonlinearity between the two variables is based on the arguments of Chick (1983, 1992) who argues that in more sophisticated financial systems, finance is potentially viewed as endogenous, as a consequence of demand pressures resulting from economic growth. This implies that the more developed the financial system is, the more economic growth causes financial deepening. This also results in a nonlinearity in the effects.

Recently, the nonlinear treatment of the relationship between financial depth and economic growth has been getting increasingly more common (e.g., Botev et al. (2019)). In fact, recent evidence suggests that the exclusion of nonlinearity could cause some of the ambiguous empirical results (Bucci et al., 2020). Nevertheless, more than half of the relevant studies have a linear specification (Bijlsma et al., 2018).

A great deal of papers include nonlinearity as a logarithmic specification of the financial proxy, thereby implying decreasing returns to financial development. A limited number of studies employ a quadratic specification, therefore allowing the relationship to be U-shaped (Bijlsma et al., 2018). More nuanced approaches include nonlinearity by explicitly estimating threshold effects (Masten et al., 2008), or utilizing nonparametric methods (Stengos et al., 2007), among others.

There are also theoretical models created which motivate the potential nonlinearity such as that of Bucci et al. (2020). This model is a finance-extended AK type model where financial development influences both total factor productivity and capital accumulation in a linear fashion. According to this model, in the initial stages of financial development, deepening financial markets facilitate Research & Development activities, resulting in higher productivity. Adversely, at higher levels of financial depth, the so-called crowding out effect dominates, which stems from the excessive costs of financial intermediation.

However, there are some authors who oppose nonlinearity and find contradicting evidence. For instance, Ketteni et al. (2007) investigate the potential nonlinearity using nonparametric techniques and conclude that with the inclusion of the appropriate control variables, linearity between the two variables holds.

Overall, there are theoretical and empirical grounds to base our analysis off of, both in terms of bidirectionality and nonlinearity. There are more than a few studies recognizing the simultaneity and nonlinearity of the variables.

3. EMPIRICAL MODEL AND DATA

In this section, we will derive our empirical model and show the data information.

3.1. Empirical model

As previously mentioned, most of the studies only discuss the effect of financial depth on economic growth. Among them, theoretical models are rare. The first author to provide a wide overview and a theoretical model of this exact relationship is Pagano (1993) who argues that financial depth has an effect not only on the level of the output of the economy but the growth of the economy itself. Pagano's simple model is an „AK model” where output is a linear function of the aggregate capital stock:

$$y_t = AK_t \quad (1)$$

Further, he assumes investment depreciates at a rate of δ :

$$I_t = K_{t+1} - (1 - \delta)K_t \quad (2)$$

Finally, he makes the crucial assumption that household savings are not equal to investments because a proportion $(1 - \varphi)$ of the savings is „lost” during financial intermediation:

$$\varphi S_t = I_t \quad (3)$$

After some manipulation of the equations above, the steady-state growth rate of the economy is characterized by the following equation:

$$g = A\varphi \frac{S}{Y} - \delta \quad (4)$$

where g is a function of φ , the ratio of savings funnelled into investments. Financial deepening increases φ , thereby also resulting in an increase in the steady-state growth rate.

Other than this model, there are very few theoretical models to be found which explicitly link financial depth to economic growth, such as that of Bucci et al. (2020, see below). Rather, most of the authors investigate the effect of financial intermediation on technological progress (Trew, 2008) or human capital (Bucci and Marsiglio, 2018).

Based on the arguments above, measuring the relationship between economic growth and financial depth is not trivial, as many factors need to be controlled for. Other than nonlinearity, endogeneity is also a major concern (Polemis et al., 2020): it is fair to assume that the two variables have simultaneous effects, as well as unobserved heterogeneity, which need to be

addressed using panel data analysis. Furthermore, if one allows the relationship between the variables to be possibly U-shaped, a threshold-based approach is inevitable.

Nonetheless, most of the studies do not control for a great deal of these factors (Bijlsma et al., 2018). Panel methods, such as fixed or random effects, are frequently employed among the studies, along with dynamic panel data methods, such as GMM (e.g. Leita0, 2010). Motivation for a threshold extension is given by Bijlsma et al. (2018) whose meta-analysis concludes that even after including nonlinearity in the form of a logarithmic specification, the effect of financial development is still smaller in developed countries than in developing ones, therefore only partially correcting for nonlinearity.

To derive our exact model specification, let us assume that the growth of financial markets is given by the following equation:

$$G_{F_{it}} = f(G_{Y_{it}}, Inf_{it}, G_{Exr_{it}}) \quad (5)$$

where subscripts $i = 1, \dots, N$ represent the different countries and $t = 1, \dots, T$ are time indices. In this equation, $G_{F_{it}}$ denotes financial depth growth, $G_{Y_{it}}$ denotes economic growth, Inf_{it} is inflation and $G_{Exr_{it}}$ represents the change of the exchange rate in a given country. This specification is similar to that of Hajilee et al. (2017)'s seminal paper. Hence, the long-run equilibrium takes the following form:

$$G_{F_{it}} = \rho_{0i} + \rho_{1i}G_{Y_{it}} + \rho_{2i}Inf_{it} + \rho_{3i}G_{Exr_{it}} + \varepsilon_{it} \quad (6)$$

where ρ_{0i} is an unobserved country fixed effect and ε_{it} is an error term.

If there is also simultaneity present in the model, such as between financial deepening and economic growth (as noted by e.g. Polemis et al., 2020) as well as unobserved country heterogeneity then this can be treated by using a first difference GMM model. Hence, the Arellano-Bond FD-GMM model (Arellano-Bond, 1991) with an AR(1) specification takes the following form:

$$\Delta G_{F_{it}} = \alpha_i + \beta_{1,i}\Delta G_{F_{it-1}} + \beta_{2,i}\Delta G_{Y_{it}} + \beta_{3,i}\Delta Inf_{it} + \beta_{4,i}\Delta G_{Exr_{it}} + \varepsilon_{it} \quad (7)$$

where Δ means the first difference of the given variable and ε_{it} is white noise. Note that this model is linear contrary to some findings.

An econometric approach that contains all the necessary extensions, including nonlinearity, is that of Seo and Shin (2016). They devise a dynamic panel model with a threshold effect

accounting for endogeneity. It is a first difference GMM estimator, allowing both the regressors and even the threshold variable to be endogenous.

The motivation behind employing a threshold model, specifically, is that it allows the two regimes to be interpreted in a simple manner by being linear in the two respective thresholds. This, of course, also restricts how well one can capture the true nonlinearity in the data (if it exists). However, the fact that the two types of endogeneity can also be controlled for makes this a valuable tool for us in this analysis.

Their model takes the following form:

$$G_{it} = (1, x'_{it})\varphi_1 \mathbf{1}\{q_{it} \leq \gamma\} + (1, x'_{it})\varphi_2 \mathbf{1}\{q_{it} > \gamma\} + \varepsilon_{it} \quad (8)$$

where y_{it} denotes financial depth growth, x'_{it} economic growth (among others) as a time-varying variable, $\mathbf{1}\{.\}$ the indicator function, q_{it} the transition variable, and γ the threshold parameter. Furthermore, they assume the error contains unobserved individual fixed effects:

$$\varepsilon_{it} = \alpha_i + v_{it} \quad (9)$$

where α_i denotes the unobserved fixed effects and v_{it} is a martingale difference sequence.

Due to the downward bias of the fixed effects estimates in a dynamic panel data context (Nickell, 1981), first differences of the data are taken as in Arellano and Bond (1991):

$$\Delta G_{it} = \beta' \Delta x_{it} + \delta' X'_{it} \mathbf{1}_{it}(\gamma) + \Delta \varepsilon_{it} \quad (10)$$

where

$$X_{it} = \begin{pmatrix} (1, x'_{it}) \\ (1, x'_{it-1}) \end{pmatrix} \text{ and } \mathbf{1}_{it}(\gamma) = \begin{pmatrix} \mathbf{1}\{q_{it} > \gamma\} \\ -\mathbf{1}\{q_{it-1} > \gamma\} \end{pmatrix} \quad (11)$$

The moment conditions according to which the model is estimated are:

$$g_i(\theta) = \begin{pmatrix} z_{it_0} \Delta \varepsilon_{it_0} \\ \vdots \\ z_{iT} \Delta \varepsilon_{iT} \end{pmatrix} = \begin{pmatrix} z_{it_0} (\Delta y_{it_0} - \beta' \Delta x_{it_0} - \delta' X'_{it_0} \mathbf{1}_{it_0}(\gamma)) \\ \vdots \\ z_{iT} (\Delta y_{iT} - \beta' \Delta x_{iT} - \delta' X'_{iT} \mathbf{1}_{iT}(\gamma)) \end{pmatrix} \quad (12)$$

where z_{it} denote different instruments, such as lagged variables. For further details, refer to Seo and Shin (2016).

In order to investigate the effect of economic growth on financial depth, we used the World Bank's Databank. This is a collection of 85 datasets each with a different focus. For our analysis,

we utilized the World Development Indicators and the Global Financial Development datasets. These are country-level datasets with a yearly frequency.

3.2. Data

For the analysis, a total of four variables were utilized, as per Hajilee and Al Nasser (2017):

- Financial depth: Private credit by deposit money banks and other financial institutions to GDP (%)
- Real GDP per capita (2015 US\$)
- Exchange rate (local currency in US\$)
- Inflation, consumer prices (%)

Hajilee and Al Nasser also mention political stability as an important factor. However, this is not a widely available variable in most of the countries and as such, we omitted it. We conducted a cross-country analysis, similar to most of the studies (Bijlsma et al., 2018). In general, we opt to include as many countries in our analysis as possible relative to the amount of time periods. This is due to the fact that Seo and Shin (2019) themselves admit that if in an asymptotic sense, when using the model we employ, $\frac{T}{N}$ converges to a constant other than zero when N goes to infinity, the econometric model is biased. Therefore, the inclusion of as many countries relative to the amount of time periods is pivotal. This is why we chose to include a relatively short period of time (2000-2007) and only a few widely available variables in our analysis. The time period we select is motivated by choosing a period devoid of great economic and financial turmoil. Overall, there are 114 countries in the dataset.

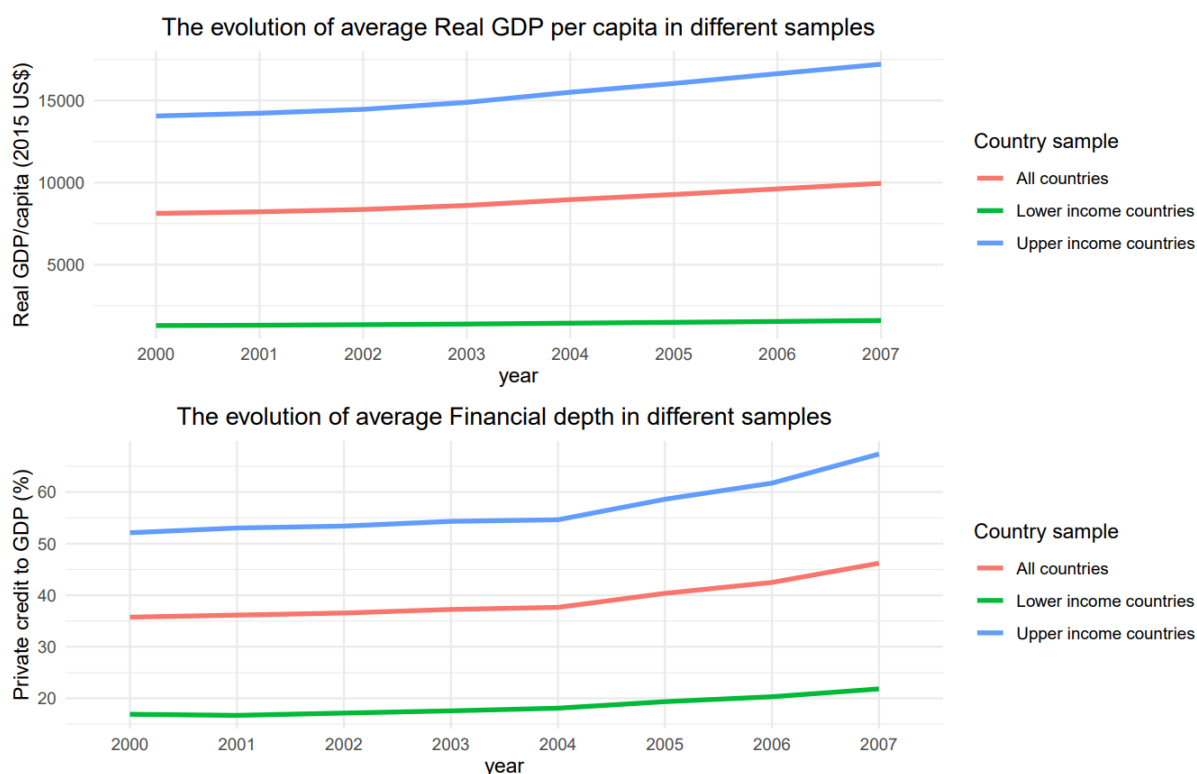
We only include those countries in the dataset for which all the data were available for all the chosen time periods. This is because Seo and Shin (2016)'s model requires a balanced panel dataset.

We also split the dataset into two subsamples: lower income countries and upper income countries. Usually, this split is made based on OECD membership (such as in Chen et al., 2020). However, our OECD subsample would have included only a handful of countries, thereby certainly resulting in biased estimates due to the relatively larger number of T compared to N. We made the income classification based on the World Bank's own classification: the lower income group we introduce consists of low income and lower middle income countries, whereas the upper income group includes those countries classified by the World Bank as upper middle

income and high income. The resulting subsamples contain 53 countries for the lower income group and 61 countries for the upper income group, respectively.

4. RESULTS

Figure 1: The evolution of the main variables by subsamples, in levels.



4.1. Graphical analysis

Figures 1-2 provide the visual examinations of the economic growth – financial depth relationship. Specifically, figure 1 shows the averaged series of the two main variables as a function of time. As is the case *ad definitionem*, Real GDP/capita is a lot higher in the upper income countries, reaching an average of about 17.500 USD by the end of the sample, before the Great Financial Crisis. In contrast, lower income countries have an average GDP/capita barely exceeding a thousand USD in the sample.

It is also not surprising that financial depth (measured by private credit as a percent of GDP) in lower income countries is a lot smaller compared to upper income countries. Lower income countries hover around 20 percent, whereas upper income countries exceed 60 percent, on average, by the end of the sample period.

Figure 2: The evolution of growth rates of the main variables by subsamples, in levels.

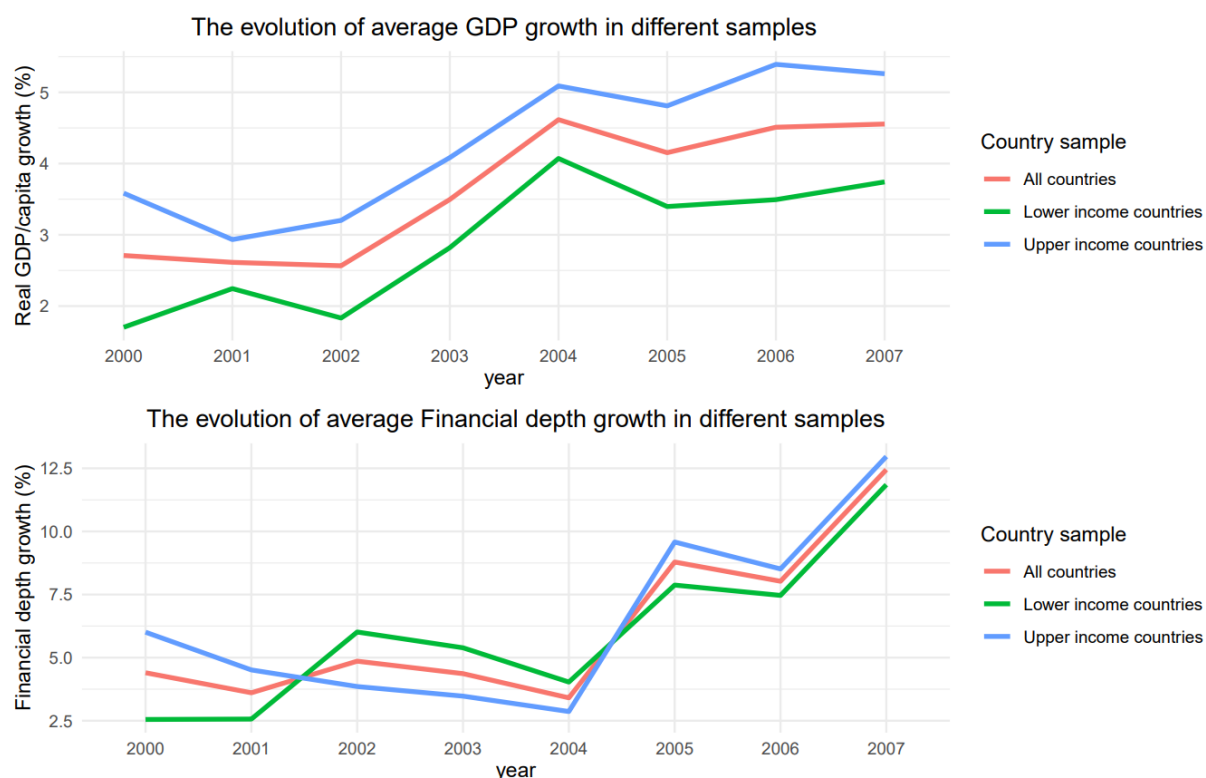


Figure 2 presents the growth rates of the two main variables. In upper income countries, real GDP growth is higher than in lower income countries, but financial depth growth is not so clear cut in this regard. Both economic growth rates and financial depth growth rates increase steadily from 2000 to 2007.

Overall, the results of the both figures show clear asymmetries and motivate us to explore the nonlinear effect of the economic growth on financial depth.

Table 1: Panel unit root tests.

Harris-Tzavalis panel unit root test results.

	All		Upper Income		Lower Income	
	Statistic	p-value	Statistic	p-value	Statistic	p-value
$\Delta \text{FinDepth}_{it-1}$	0.035***	0.000	0.105***	0.000	-0.028***	0.000
$\Delta \text{realGDP}$	0.133***	0.000	0.253***	0.000	0.031***	0.000
Inflation_{it}	0.201***	0.000	0.402***	0.000	0.091***	0.000
$\Delta \text{Exchangerate}_{it}$ chan	0.390***	0.000	0.369***	0.000	0.417***	0.000

Note: *** implies significance at the 1% level.

4.2. Unit root tests and descriptive statistics

We next check whether all the variables satisfy the stationarity criterion required. For this, we choose the Harris-Tzavalis test (Harris and Tzavalis, 1999). This is a panel unit root test which allows large N and fixed T that fits for our dataset: namely, a balanced panel database with a small amount of time periods relative to the amount of cross sectional units. As the level of the exchange rate was non stationary at any significance level, we also calculate the growth rate of the series. This is also understandable because the exchange rates are given in local currency which differ by country and, if kept in the analysis as such, would have distorted the results. All of the variables are panel stationary at any significance level, in both the full sample and the two income-based subsamples.

Table 2: Descriptive statistics.

Descriptive statistics of the variables in the original dataset (before winsorization).					
All Countries					
Variables	Mean	Standard deviation	Maximum	Minimum	Observations
Real GDP growth	3.652	4.575	55.590	-14.964	912
Inflation	6.727	14.544	324.997	-9.616	912
Exchange rate change	1.727	18.702	293.791	-99.992	912
Financial depth growth	6.237	19.673	289.114	-66.342	912
Upper Income Countries					
Variables	Mean	Standard deviation	Maximum	Minimum	Observations
Real GDP growth	4.294	4.916	55.590	-7.886	488
Inflation	5.348	7.616	96.096	-1.409	488
Exchange rate change	-0.362	13.364	96.026	-99.992	488
Financial depth growth	6.472	21.028	289.114	-60.335	488
Lower Income Countries					
Variables	Mean	Standard deviation	Maximum	Minimum	Observations
Real GDP growth	2.913	4.027	27.831	-14.964	424
Inflation	8.313	19.598	324.997	-9.616	424
Exchange rate change	4.131	23.171	293.791	-28.233	424
Financial depth growth	5.968	18.010	91.033	-66.342	424

Table 2 presents the descriptive statistics of the used variables for the 114 countries, spanning from 2000 to 2007. Note that the positive sign of the exchange rate change in the full sample signifies, by large, that relative to the dollar, the average currency weakened by 1.73 percent per year. This is much more so in case of lower income countries, whereas upper income countries have the opposite tendency on average.

Also note the very high standard deviations of inflation, exchange rate change and financial depth growth. Even more notable are the maximum and minimum values corresponding to each of the variables, reaching maximum growths of real GDP per capita of 55 percent in a year, as well as about 300 percent changes in the other three variables. Similar astounding values are found in the „minimum” column where one country’s currency lost almost 100 percent of its value relative to the U.S. dollar in a year.

In order to mitigate these outlier distortions, we chose to winsorize all the variables: for the highest and lowest 5 percent of all the variables we replace the values with their respective (5th and 95th) percentiles.²

Table 3 shows the correlation matrix of the winsorized dataset. In general, we can deduce that correlations between different variables are not too high, but, in most cases, significant. Of particular importance are the correlations between financial depth growth (the dependent variable in the models) and the other variables. Perhaps not too surprisingly, real GDP growth and financial depth growth exhibit a significantly positive correlation in all the samples, with the correlation being strongest in the upper income countries.

Table 3

Correlation matrix for different groups of countries in the final dataset (after winsorization).				
All Countries				
Variables	Real GDP growth	Inflation	Exchange rate change	Financial depth growth
Real GDP growth	1*** (0.000)			
Inflation	0.059* (0.07)	1*** (0.000)		
Exchange rate change	-0.172*** (0.000)	0.376*** (0.000)	1*** (0.000)	
Financial depth growth	0.203*** (0.000)	-0.001 (0.979)	-0.111*** (0.000)	1*** (0.000)
Upper Income Countries				
Variables	Real GDP growth	Inflation	Exchange rate change	Financial depth growth
Real GDP growth	1*** (0.000)			
Inflation	0.049 (0.278)	1*** (0.000)		
Exchange rate change	-0.203*** (0.000)	0.366*** (0.000)	1*** (0.000)	
Financial depth growth	0.273*** (0.000)	0.045 (0.322)	-0.167*** (0.000)	1*** (0.000)
Lower Income Countries				
Variables	Real GDP growth	Inflation	Exchange rate change	Financial depth growth
Real GDP growth	1*** (0.000)			
Inflation	0.129*** (0.007)	1*** (0.000)		
Exchange rate change	-0.099** (0.041)	0.359*** (0.000)	1*** (0.000)	
Financial depth growth	0.130*** (0.007)	-0.039 (0.426)	-0.053 (0.278)	1*** (0.000)

*** means significantly different from zero at the 1% level. This table provides a correlation matrix within different groups of countries.

4.3. The threshold variable

Deciding how to introduce nonlinearity (which variable to choose as a threshold variable) we had no theoretical grounds to stand on due to the less researched nature of this direction of the relationship, except a vague note by Chick (1983) that the given relationship differs based on the level of the development of the financial system. However, based on Chen et al. (2020)'s model, we posited that potential nonlinearity can arise from different institutional backgrounds in various countries. This would make sense because along with more refined institutions,

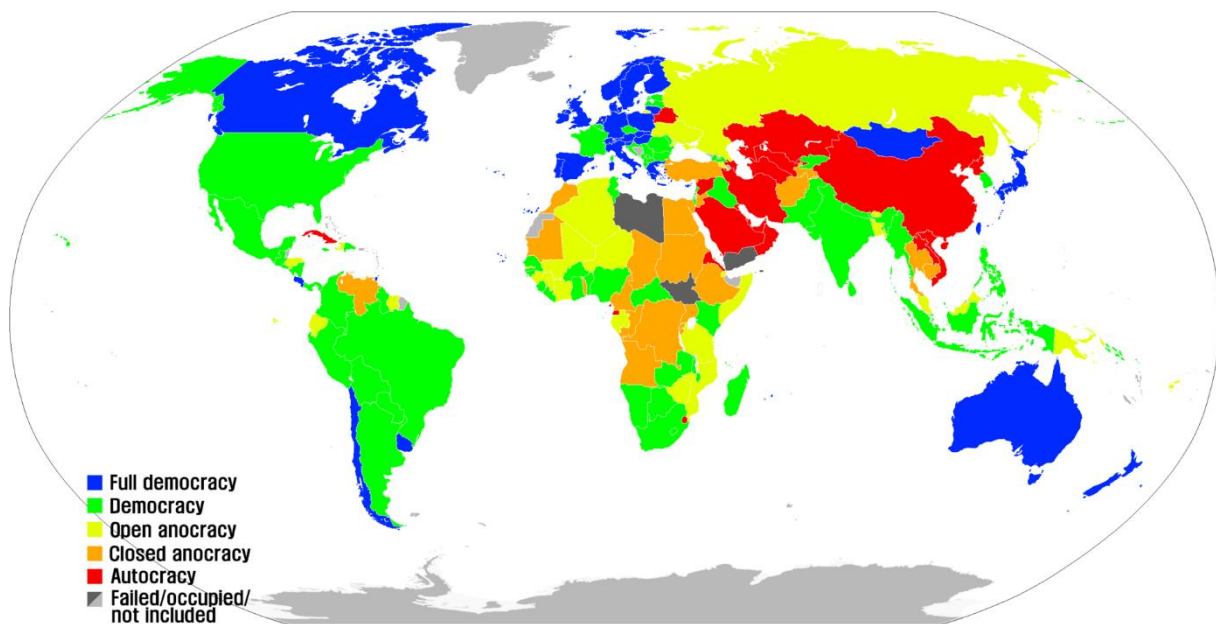
² We could have also chosen to omit countries which exhibit great volatility but chose not to. That would have entailed imposing an arbitrary threshold for the maximum and minimum values acceptable for each variable which would have brought great subjectivity into our analysis and would have reduced our sample size by a big margin.

excess capital resulting from economic growth is better funneled to the financial sector. Therefore, our hypothesis is the following:

There is a nonlinear relationship between economic growth and financial deepening: a better institutional background positively increases the effect of economic growth on financial deepening.

To capture institutional development, we include as the threshold variable an index which measures how democratic a country is. For this purpose, we use the so-called „Polity IV” which is an index measuring on a scale ranging from -10 to +10 how democratic a country is, with -10 indicating a hereditary monarchy/a full autocracy and +10 a stable democracy.

Figure 3. Classification of different countries by their Polity IV score³.



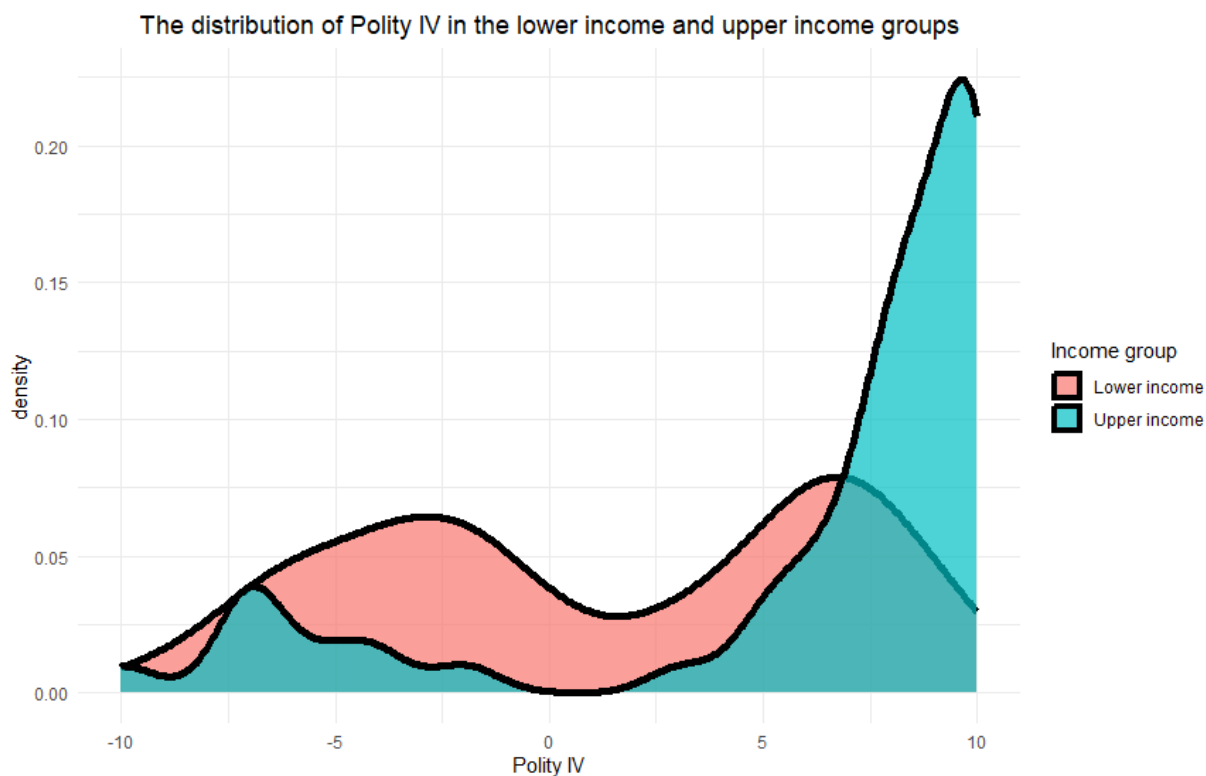
Note that as seen in Figure 3, most of Europe and the Americas are democracies according to this measure, while the bulk of Asian and African countries are anocracies (meaning a semi-democratic and semi-autocratic state) or autocracies.

It is also important to check the distribution of the Polity IV in the two income-based subsamples (Figure 4). The upper income and lower income distributions are vastly different in the samples. The distribution of the threshold variable is greatly skewed to the right in upper income countries with the mode of the distribution being 9 (which signifies a very strong democracy) and very few countries (especially rich Gulf monarchies) being at the left side of

³ Source: https://en.wikipedia.org/wiki/Polity_data_series#/media/File:Polity_IV_2017.png

the distribution. Contrary to this, the distribution for the lower income sample is bimodal with the two modes being at -2 (closed anocracy) and +4 (open anocracy).

Figure 4



4.4. Estimation results

This subsection reports the estimation results. In the following text, we will first specify the Arellano – Bond FD-GMM model which is linear in its parameters and then introduce nonlinearity with Seo and Shin's (2016) model. Note that we assume a simultaneous relationship between economic growth and the growth of financial depth as per Bijlsma (2018) and use heteroskedasticity consistent robust standard errors.

Table 4: Arellano – Bond model results.

Arellano-Bond linear FD-GMM model results.

Countries	All	Upper Income	Lower Income
$\Delta \text{FinDepth}_{it-1}$	0.109 (0.243)	0.463 (0.254)	-0.128 (0.232)
$\Delta \text{realGDP}$	1.414 (0.967)	1.256 (1.135)	-0.178 (1.244)
Inflation_{it}	0.884 (0.822)	0.751 (1.171)	0.041 (0.953)
$\Delta \text{Exchangerate}_{it}$	-0.96 (0.250)	-0.199 (0.331)	-0.164 (0.408)
Observations	684	318	366

Note: Real GDP growth is considered endogenous in the model.

Table 4 reports the estimation results of the linear panel model using the Arellano and Bond estimator (Arellano & Bond, 1991) along with the respective standard errors. We observe that none of the variables are significant in any sample. Only judging by these results, one would determine that these variables bear no explanatory power when attempting to explain the growth of financial depth – not even the lag of the dependent variable itself. This is either because there really is no linear relationship between the variables, or because the sample size is not big enough to serve identification properly.

Now, turning to the threshold model, Table 5 reports the estimation results of the dynamic panel threshold model using the GMM method of Seo and Shin (2016). Table 5 also presents the results of the nonlinearity testing, where we employ the bootstrapped Sup-Wald test (e.g., see Hansen (1996) and Seo and Shin (2016)). We observe some very interesting findings from Table 5 and summarize them as follows.

First, it needs to be stated that the bootstrap linearity test was not rejected at any significance level for the whole sample and for the upper income sample at any normal significance level, thereby implying that the relationship is linear. However, plenty of the coefficients are significant and significantly different in the two regimes which implies at least some nonlinearity.

In the whole sample, it is notable that real GDP growth has a positive effect on financial depth growth in both regimes, with the effect being greater in the upper regime (3.48 % against 1.24 %), supporting our hypothesis. The regime switch is when the polity IV has a value of 9: when

below this threshold, in the lower regime, a percent increase in real GDP per capita growth results in a 1.24 percent increase in financial depth growth, but above that (in the most stable democracies) this effect increases to 3.84 percent.⁴

The same effect (a significantly positive effect of economic growth on financial depth growth in the upper regime) is also the case in the upper income subsample. However, in this case, curiously, the effect of economic growth on financial deepening in the lower regime is negative. This most likely implies not an explicitly negative relationship between the two variables but the fact that financial depth growth most likely lags behind economic growth in the low threshold. In the high regime, a percentage economic growth results in a 3.74 % growth of financial depth. Therefore, once again, our original hypothesis is corroborated.

Table 5

Non-linear endogenous panel model when Polity IV is used as a threshold variable (2000-2007).

Countries	All		Upper Income		Lower Income	
Threshold	9		7		4***	
	Low	High	Low	High	Low	High
$\Delta \text{FinDepth}_{it-1}$	-0.2464** (0.112)	1.571*** (0.455)	0.347*** (0.044)	0.104 (0.088)	0.174* (0.100)	-0.961*** (0.176)
$\Delta \text{realGDP}$	1.254 *** (0.46)	3.484* (1.803)	-2.509*** (0.285)	3.740*** (0.846)	4.262*** (0.693)	0.488 (0.809)
Inflation_{it}	-1.637*** (0.216)	2.653 (1.638)	-1.016 (0.334)	-1.435** (0.594)	-0.459*** (0.161)	-0.402*** (0.354)
$\Delta \text{Exchangerate}_{it}$	0.139 (0.111)	-0.653 (0.477)	0.126 (0.109)	0.074 (0.172)	0.522*** (0.074)	0.3806** (0.163)
Observations	912		488		424	

Note: Real GDP growth is considered endogenous in the model.

* = significant at 10%; ** = significant at 5%; ***=significant at 1%.

Nevertheless, in lower income countries, this effect does not seem to hold. In these countries, real GDP growth is positive in the lower threshold but not different from zero in the upper threshold at any significance level. This is a possible result of the bimodal, highly unorthodox shape of the threshold variable in this subsample (see Figure 4) and the fact that lower income

⁴ Note that financial depth is given as a % of GDP which implies that financial depth increases more than economic growth not just in the absolute level but also as a percentage of GDP. This implies that if, in a given year, economic growth increases by, for example, 10 percent, then for the effect of economic growth on financial growth not to be negative, there would need to be at least a 10 percent increase in financial depth growth (since financial depth is measured as a percentage of GDP).

countries are most likely a lot more heterogeneous than upper income countries. We believe the relationship between the two variables follow a very different nonlinear relationship if the given country's income is lower.

The coefficient estimate of the exchange rate change is only significant in case of the lower income subsample. In that case, a percentage change (depreciation) in the exchange rate can make exports more competitive and boost export-oriented industries, leading to increased demand for credit to finance expansion and investment. Also, a depreciation of the domestic currency can make assets cheaper for foreign investors, leading to an increase in FDI, and this effect is more prominent in countries with lower income levels.

The coefficient estimate of inflation is negative in most of the subsamples and regimes as well. This is consistent with the consensual view that financial deepening needs price stability as a prerequisite. High rates of inflation exacerbate the friction of financial markets, dampen the efficiency of the financial system and negatively effect long term growth. Additionally, high inflation can cause instabilities of financial variables such as equity returns. Furthermore, high inflation is associated with low real returns to saving (Boyd et al., 1996). Empirical studies conducted on this relationship generally show strong and negative coefficients of inflation on financial deepening (Abbey, 2012).

4.5. Robustness checks

As evidenced by Table 5, results differ significantly based on income and there is possibly an additional nonlinearity effect based on income. To examine the robustness of our findings, we carry out additional analysis in this subsection. Specifically, we conduct four types of robustness checks:

1. Omitting one or two of the control variables in the equations;
2. Checking graphically whether regimes differ significantly;
3. Testing the relationship for a different time period;
4. Further dividing the sample into smaller groups.

Table 6

Non-linear model for upper income countries (different specifications, 2000-2007)

Variables	All		w/o inflation		w/o exchange rate		only GDP growth	
Threshold	7		5		5		8	
	Low	High	Low	High	Low	High	Low	High
$\Delta \text{FinDepth}_{it-1}$	0.347*** (0.044)	0.104 (0.088)	0.399*** (0.067)	0.110 (0.133)	0.114** (0.049)	0.305*** (0.079)	0.691*** (0.113)	0.063 (0.293)
$\Delta \text{realGDP}$	-2.509*** (0.285)	3.740*** (0.846)	-0.924*** (0.296)	2.400*** (0.692)	-1.910*** (0.242)	0.549 (0.389)	-2.555*** (0.436)	4.415*** (1.267)
Inflation_{it}	-1.016 (0.334)	-1.435** (0.594)	-	-	0.759** (0.305)	-2.26*** (0.600)	-	-
$\Delta \text{Exchangerate}_{it}$	0.126 (0.109)	0.074 (0.172)	-1.278*** (0.367)	0.070 (0.433)	-	-	-	-
Observations	488		488		488		488	

Note: Real GDP growth is considered endogenous in the model.

* = significant at 10%; ** = significant at 5%; ***=significant at 1%.

Results of more model specifications are reported in Table 6. In none of the cases does the bootstrap linearity test confirm nonlinearity of the models. However, the results align with our main findings that the impact of the economic growth on financial depth is significantly positive in the high regime for the majority of cases. By contrast, we find that financial depth from countries with a low institutional quality level cannot benefit from the economic growth.

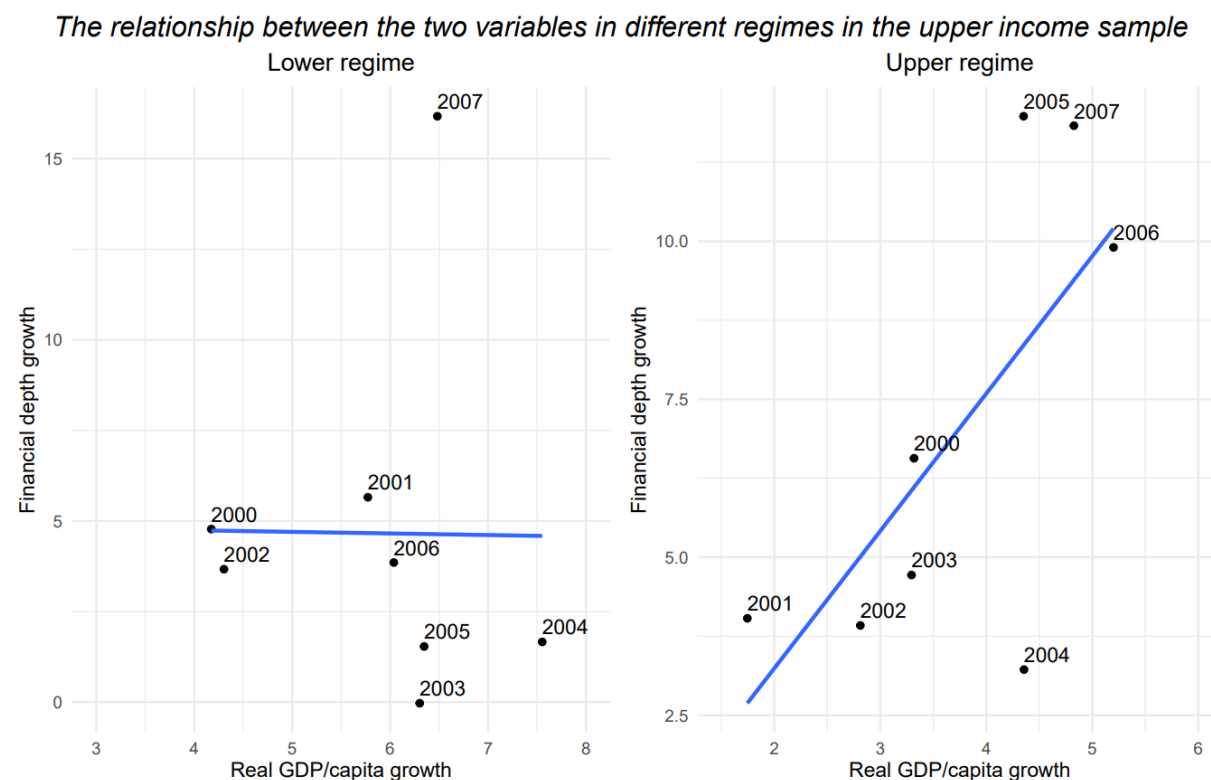
To graphically determine whether there really is some significant nonlinear relationship, we split the upper income sample into two parts based on the value of the threshold variable (the Polity IV): the low and high regime which denote countries with different institutionalization levels. Then, we calculated the average values of economic growth and financial depth growth for every year, and plotted the resulting points on two different plots (Figure 5).

There seems to be a different relationship between the two variables in the two thresholds: at lower institutional levels, financial growth seems to have no correlation with economic growth (or, if we omit the 2007 data point, one could argue that it is slightly negative). However, in the upper regime, the relationship appears significantly positive. This corroborates our previous findings.

The same applies to when we change the sample period from 2000 – 2007 to 1990 – 1997 (Appendix 1): in the high regime, particularly in the upper income countries, real GDP growth has a positive effect on financial deepening and a negative effect in the low regime. To be precise, in this sample, our findings are even more notable as the bootstrap linearity test signifies nonlinearity at all significance levels. If we divide the sample even further, into more

nuanced income groups (Appendix 2), the general result still stands (although the coefficients themselves are not significant anymore due to the amount of observations and the moderate number of countries relative to the time periods makes this result less impactful).

Figure 5



4.6. Limitations

There are some limitations to our findings which have to be taken into account. First, our hypothesis does not hold for lower income countries at all, only for wealthier ones. Even in these countries, the bootstrap linearity test did not confirm in all cases and samples the nonlinearity of our models, even though the coefficients themselves were mostly vastly different in the low and high regimes. Further, we only included a very limited number of control variables; the number of these should definitely be extended in any further analyses. Last but not least, actual nonlinearity could very well take a form much more complex than a threshold regime as discussed here. Nevertheless, our baseline results are promising and merit further research.

5. CONCLUSIONS

In this paper, we investigated the potentially nonlinear effect of economic growth on the growth of financial depth. We discovered some results indicating that this nonlinearity is, in fact, rooted in reality: the deeper the democratic institutions, the greater the effect of economic growth on financial depth. Our most important – and mostly robust – finding is that, at least in wealthier countries, better democratic institutions encourage financial deepening resulting from economic growth more. From a policy perspective, deeper financial markets are useful for a multitude of reasons. First, they allow for a lower cost of borrowing, both for firms and the government itself. Second, they allow governments to be more flexible when determining the specifics of their issued debt. Third, if we assume that the bidirectional relationship between the two variables holds, then that implies that greater financial depth also results in higher economic growth in the long run.

Due to all of these factors, it is most likely beneficial for policymakers to try raising the institutional quality in their respective countries in order to encourage financial deepening more.

6. REFERENCES

- Abbey, E. N. (2012). Inflation and financial development: Evidence. *American Journal of Economics and Business Administration*, 4(4), 227-236.
- Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Rev. Econom. Stud.* 58, 277–297.
- Arestis, P., & Demetriades, P. (1997). Finance and growth: institutional considerations and causality. Available at SSRN 35996.
- Beck, T. (2013) Finance, growth and fragility: The role of government. *International Journal of Banking, Accounting and Finance* 5, 49–77
- Bijlsma, M., Kool, C., & Non, M. (2018). The effect of financial development on economic growth: a meta-analysis. *Applied Economics*, 50(57), 6128-6148.
- Botev, J., Égert, B., & Jawadi, F. (2019). The nonlinear relationship between economic growth and financial development: Evidence from developing, emerging and advanced economies. *International Economics*, 160, 3-13.
- Boyd, J.H., B.D. Smith and R. Levine, 1996. Inflation and financial market performance. Pennsylvania State University.
- Bucci, A. and S. Marsiglio (2018) Financial Development and Economic Growth: Long Run Equilibrium and Transitional Dynamics, *Scottish Journal of Political Economy*, forthcoming, DOI: 10.1111/sjpe.12182
- Bucci, A., Marsiglio, S., & Prettnner, C. (2020). On the (nonmonotonic) relation between economic growth and finance. *Macroeconomic Dynamics*, 24(1), 93-112.
- Chen, C., Pinar, M., & Stengos, T. (2020). Renewable energy consumption and economic growth nexus: Evidence from a threshold model. *Energy Policy*, 139, 111295.
- Chick, V. (1983). *Macroeconomics after Keynes: a reconsideration of the general theory*. mit Press.
- Chick, V. (1983). The evolution of the banking system and the theory of saving, investment and interest (pp. 193-205). Palgrave Macmillan UK.
- Cihak, M., A. Demirguc–Kunt, E. Feyen, and R. Levine (2012) *Benchmarking Financial Systems Around the World*. Policy Research working paper 6175, Washington, DC: World Bank.
- Greenwood, J., & Jovanovic, B. (1990). Financial development, growth, and the distribution of income. *Journal of political Economy*, 98(5, Part 1), 1076-1107.
- Hajilee, M., & Al Nasser, O. M. (2017). Financial depth and exchange rate volatility: A Multicountry Analysis. *The American Economist*, 62(1), 19-30.
- Hansen, B. E. (1996). Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica: Journal of the econometric society*, 413-430.
- Harris, R. D., & Tzavalis, E. (1999). Inference for unit roots in dynamic panels where the time dimension is fixed. *Journal of econometrics*, 91(2), 201-226.

Leitao, N. C. (2010). Financial development and economic growth: A panel data approach. *Theoretical and Applied Economics*, 15-24.

Ross Levine. Finance and growth: Theory and evidence. In *Handbook of Economic Growth*, volume 1, chapter 12, pages 865-934. Elsevier, 2005.

Masten, A. B., Coricelli, F., & Masten, I. (2008). Non-linear growth effects of financial development: Does financial integration matter?. *Journal of international money and finance*, 27(2), 295-313.

Nickell, S., 1981. Biases in dynamic models with fixed effects. *Econometrica* 49, 1417–1426.

Polemis, M. L., Stengos, T., & Tzeremes, N. G. (2020). Revisiting the impact of financial depth on growth: A semi-parametric approach. *Finance Research Letters*, 36, 101322.

Rachdi, H., & Mbarek, H. B. (2011). The causality between financial development and economic growth: Panel data cointegration and GMM system approaches. *International Journal of Economics and Finance*, 3(1), 143-151.

Robinson, J. (1952). *The Interest Rate and Other Essays*, London: MacMillan.

Seo, M. H., & Shin, Y. (2016). Dynamic panels with threshold effect and endogeneity. *Journal of econometrics*, 195(2), 169-186.

Thanasis Stengos & Andreas Savvides & Theofanis Mamuneas & Elena Ketteni, 2007. "Is the Financial Development and Economic Growth Relationship Nonlinear?," *Economics Bulletin*, AccessEcon, vol. 15(14), pages 1-12.

Trew, A. (2008) Efficiency, depth and growth: Quantitative implications of finance and growth theory. *Journal of Macroeconomics* 30, 1550–1568

Zang, H., & Kim, Y. C. (2007). Does financial development precede growth? Robinson and Lucas might be right. *Applied Economics Letters*, 14(1), 15-19.

7. APPENDIX

Appendix 1

Non-linear endogenous panel model when Polity IV is used as a threshold variable (1990-1997).

Countries	All		Upper Income		Lower Income	
Threshold	4***		7***		-7***	
	Low	High	Low	High	Low	High
$\Delta \text{FinDepth}_{it-1}$	0.125*** (0.015)	0.214*** (0.036)	-0.028*** (0.009)	0.031** (0.014)	0.280*** (0.026)	-0.089*** (0.033)
$\Delta \text{realGDP}$	-0.497*** (0.109)	1.417*** (0.329)	0.131*** (0.008)	1.156*** (0.153)	-4.346*** (0.562)	0.376 (0.797)
Inflation_{it}	-0.731*** (0.057)	0.052 (0.108)	0.598*** (0.213)	-0.249*** (0.052)	-0.544*** (0.103)	-0.204 (0.151)
$\Delta \text{Exchangerate}_{it}$	0.005** (0.002)	-0.093*** (0.0187)	-0.607*** (0.011)	0.294*** (0.035)	0.009*** (0.003)	-0.027* (0.0147)
Observations	720		400		320	

Note: Real GDP growth is considered endogenous in the model.

* = significant at 10%; ** = significant at 5%; ***=significant at 1%. Stars at the threshold values represent the significance of the bootstrap linearity test.

Appendix 2

Non-linear endogenous panel model when Polity IV is used as a threshold variable (2000-2007, most detailed division of samples).

Countries	High Income		Upper Middle Income		Low Income		Lower Middle Income	
Threshold	8***		6***		-4***		-2.899***	
	Low	High	Low	High	Low	High	Low	High
$\Delta \text{FinDepth}_{it-1}$	-0.769* (0.436)	-0.041 (0.456)	-0.294*** (0.057)	-0.199 (0.134)	1.317 (0.889)	0.010 (1.225)	0.132** (0.054)	-0.167 (0.548)
$\Delta \text{realGDP}$	-1.224*** (0.355)	0.518 (0.924)	-0.961*** (0.214)	0.939 (1.382)	-12.801 (7.785)	2.573 (10.748)	-0.559** (0.270)	-0.503 (0.491)
Inflation_{it}	-2.166* (1.19)	-0.422 (1.333)	1.222*** (0.375)	-1.802* (0.955)	-2.541 (2.804)	2.874 (4.035)	-0.729*** (0.149)	-0.023 (0.219)
$\Delta \text{Exchangerate}_{it}$	0.899 (0.735)	-0.019 (0.799)	-2.349*** (0.455)	0.425 (0.724)	0.691 (2.661)	-0.363 (4.140)	0.929*** (0.207)	-0.097 (0.279)
Observations	248		240		136		288	

Note: Real GDP growth is considered endogenous in the model.

* = significant at 10%; ** = significant at 5%; ***=significant at 1%. Stars at the threshold values represent the significance of the bootstrap linearity test.