Thresholds in the Finance-Growth Nexus: A Cross-Country Analysis

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Thresholds of inflation, government size, trade openness, and per capita income for the finance-growth nexus are investigated using five-year averages of standard variables for 84 countries from 1965 to 2004. The results suggest that (i) high inflation crowds out positive effects of financial depth on long-run growth, (ii) small government sizes hurt the finance-growth nexus in low-income countries, while large government sizes hurt high-income countries, (iii) low levels of trade openness are sufficient for finance-growth nexus in high-income countries, but low-income countries need higher levels of trade openness for similar magnitudes of the finance-growth nexus, (iv) catch-up effects through the finance-growth nexus are higher for moderate per capita income levels. Financial development, Economic growth, Thresholds3Cross-country analysis JEL Classification: E31, E44, F36, O16, O47

In a seminal study, Lucas (1985) argues that the benefits obtained by individuals from eliminating the whole macroeconomic instability in a given economy are almost certain to be negligibly small, when compared with those that can be obtained with more growth.[1] Therefore, even the global financial crisis that has started at the end of 2007, considered to be the biggest one since the Great Depression by most economists, should not matter from a welfare analysis point of view, and countries, especially the developing ones, should still focus on the long-run growth. In this context, the impact of financial development on the long-run growth is of particular interest: A healthy financial system not only encourages savings, but also improves the allocation of such savings to efficient investment projects; this, in turn, encourages an efficient and high level of capital formation to promote growth. However, what are the necessary economic conditions and/or environments to achieve such a healthy finance-growth nexus? Does high inflation lead financial depth to show its negative impacts on growth or does it only eliminate the positive effects? Is there any

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1. See Imrohoroglu (2008) and the discussion therein.

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optimal level of trade openness or government size for the development of finance-growth nexus in low-income and high-income countries? Who benefits most from the catch-up (convergence) effects through the finance-growth nexus? Is the finance-growth nexus stable through time? All these questions are sought to be answered here by investigating the historical experiences of 84 countries from 1965 to 2004 and considering the nonlinearities in the finance-growth nexus through a continuous threshold analysis.

The effect of inflation on growth is found to be negative, especially in the literature on empirical growth. This is attributed to increasing uncertainties, mostly because of increasing relative price variability, increasing difficulties in planning, or increasing expectations of disinflation (see Fischer, 1993, Barro, 1996, Temple, 2000, for various arguments and surveys of empirical literature). While measuring such effects, Bruno and Easterly (1998) show that growth falls sharply when the inflation rate crosses the threshold of 40 percent per year. In the context of finance-growth nexus, uncertainty due to high inflation can be through the flow of information about the investment projects and returns, used by intermediaries. Rousseau and Wachtel (2002) show that the impact of financial depth on growth disappears for inflation rates above 6.5 or 13.4 percent, depending on the financial-depth measure used. In the very same context, by using a slightly different method, this study finds that high inflation crowds out the positive effects of financial depth on long-run growth; however, the threshold inflation rate estimated by this study is about 8 percent, independent of the financial-depth measure used.

The government expenditure can promote growth through the provision of public goods, such as property rights, national defense, legal system, and police protection; however, large public expenditures would tend to crowd out potentially productive private investments. The empirical evidence is in line with this claim suggesting that the effects of government size on growth are mixed: Landau (1983) claims that the growth of government size hurts growth, while Kormendi and Meguire (1985) find no connection between government size and growth. Furthermore, Ram (1986) finds that government size has positive effect on growth, while Levine and Renelt (1992) show that there is a fragile statistical relationship between growth and the growth of government size. Karras (1996) reports that there is an optimal government size, and, on an average, it is about 23 percent of the GDP. Demetriades and Rousseau (2010) contend that government expenditure has positive effect on financial development of countries that are in the midrange of economic development, and a strongly negative effect on the wealthiest countries, but little effect on poor countries. In the context of the finance-growth nexus, this study shows that small government sizes hurt low-income countries (e.g., owing to the lack of sufficient public goods, such as infrastructure or property rights, to have an effective financial system), while large government sizes hurt high-income countries (e.g., owing to the crowding-out effect described earlier); thus, the optimal government size, on an average, is found to be between 11 and 19 percent, which is lower than that suggested by Karras (1996).

Trade openness can endorse growth through providing access to large and high-income markets, together with low-cost intermediate inputs and technologies; however, it can also lead to more vulnerability through international shocks (either trade or finance). Such effects of trade openness on growth have been studied extensively (see Yanikkaya, 2003, for a comprehensive survey). Although relatively recent works by Dollar (1992), Sachs and Warner (1995), Edwards (1998), Frankel and Romer (1999), and Dufrenot et al. (2010) assign an important role for trade openness in economic growth, considerable skepticism does exist about this relationship, as summarized by Rodriguez and Rodrik (2000). They show that low levels of trade openness are sufficient for the finance-growth nexus in high-income countries, because they already have their high-income (and mostly large) national markets and financial intermediaries who can help in this process. On the contrary, low-income countries need higher levels of trade openness for similar magnitudes of finance-growth nexus, because they can benefit from larger, high-technology and high-income markets only through high levels of openness.

Starting with Gerschenkron (1952), the argument that low-income countries can grow faster than high-income countries has been studied extensively. According to Gerschenkron, the so-called "catch-up effect" is due to the low costs of industrialization in low-income countries through imitating already-developed technologies in high-income countries. Barro and Sala-i-Martin (1995) connect this story to the neoclassical theory of diminishing returns to physical capital, which should cause more advanced countries to grow more slowly than the less advanced countries. However, in empirical terms, the evidence is mixed: Besides many others, Baumol (1986) finds evidence for the catch-up effect in some OECD countries, while DeLong (1988) could find no evidence in the historical data of over a century. In the context of finance-growth nexus, using *ad hoc* measures of development, Rousseau and Yilmazkuday (2009) claim that financial depth has higher effects on low-income countries than on high-income countries. However, as financial development is costly and difficult, one would expect that catch-up effects would start manifesting only after the income crosses a certain threshold value. Considering all possible income levels, this study shows that the catch-up effect, through the finance-growth nexus, does not start until a country reaches the threshold per capita income level of about $665 (in constant 1995 U.S. dollars), and that it would not work effectively until that income level reaches about $1,636 (in constant 1995 U.S. dollars).

The finance-growth nexus has been studied extensively, especially after the classic studies by Hildebrand (1864), Schumpeter (1911), and Sombart (1916, 1927), among others, who emphasized the proactive role of financial services in promoting growth and development. Goldsmith (1969), McKinnon (1973), and Shaw (1973) carried out theoretical studies stressing the connection between a country's financial superstructure and its real infrastructure. While Goldsmith focuses on the effect of economy's financial superstructure on the

acceleration of economic growth to the extent of relating economic performance to migration of funds to the best projects available, McKinnon and Shaw emphasize that government restrictions, such as interest-rate ceilings, high reserve requirements, and directed credit programs encumber financial development and ultimately reduce growth. Similar conclusions were drawn by other economists who developed models of endogenous growth theories in which growth and financial structure are explicitly defined. In particular, the works by Durlauf et al. (2005), Levine (2005), and Khan et al. (2006) provide useful survey of literature on this aspect.

Recent literature on empirical growth analysis, following Barro (1991) and Levine and Renelt (1992), focuses on growth equations, including a standard set of explanatory variables that provide robust and widely accepted proxies for growth determinants. King and Levine (1993) extend this empirical framework by including measures of financial development. Most of the recent studies have moved toward threshold analysis to capture possible nonlinearities in these growth equations. They split the cross-country data based on the countries' financial development levels (e.g., low, intermediate, and high financial development of Rioja and Valev, 2004, and Rousseau and Wachtel, 2011, or deviations from optimal financial development as reported by Graff and Karmann, 2006), inflation rates (e.g., below or above optimal threshold inflation as reported by Fischer, 1993, Bruno and Easterly, 1998, Khan and Senhadji, 2001, Khan et al., 2006, and Rousseau and Yilmazkuday, 2009), or development status (e.g., 'developed' vs. 'developing' status as reported by Rousseau and Yilmazkuday, 2009, and Rousseau and Wachtel, 2011). The split-up was achieved mostly through *discrete* measures that may suppress the actual nonlinear relation between growth and other variables.[2] An exception here is the study by Rousseau and Wachtel (2002), who use a rolling-regression framework by ordering the data according to 5-year inflation rate averages, which can be thought as a *continuous* (rather than a discrete) analysis. However, they could not obtain any information from rolling-regression by ranking countries according to other variables, such as the initial per capita income, openness, or government size, among many others. Another drawback of rolling-regression technique is that sequential regressions have different sample sizes: Rousseau and Wachtel (2002) used 50 observations to start with, and then added one observation at a time until the full sample was included. A potential problem with this technique was that the estimated coefficients might not be comparable owing to the changes in the power of the estimation through the Law of large numbers. Another exception is the study by Rousseau and Wachtel (2011), who also employed the rolling-regression framework by ordering the data according to financial development of countries. Nevertheless, their study also lacked any information that can be obtained from rolling-regression by ranking countries according to other threshold

2. See Hansen (1999, 2000) for recent econometric techniques to determine discrete thresholds.

variables mentioned earlier. Another drawback of the rolling-regression technique in their study is that they used 20-country windows in each regression, which may be problematic owing to small sample size (i.e., the significance of the coefficient estimates may not be reliable because of the Law of large numbers). In contrast, this study considers the thresholds in several possible explanatory variables in the finance-growth nexus through rolling-window two-stage least squares regressions with constant and large sample sizes, to capture all possible nonlinearities. Technically speaking, this approach generalizes the threshold frameworks used in earlier studies (mentioned above) to figure out how nonlinear growth estimates and their significance change if all the observations are ordered by a variable of interest (e.g., inflation, government size, trade openness, or initial per capita income).

II. DATA AND BASELINE GROWTH REGRESSIONS

The data set was constructed for 84 countries covering the period 1965–2004 as a panel of country observations from the World Bank's *World Development Indicators*.[3] The list of countries is given in the note under Table 1. Following Barro (1991) and Levine and Renelt (1992), the baseline growth equations included a standard set of explanatory variables that provide robust and widely accepted proxies for growth determinants. The dependent variable was the growth rate of real per capita output averaged over 5-year periods from 1965 to 2004.

The regression analysis included standard explanatory variables, such as log initial per capita GDP, log initial secondary enrollment rate (SEC), the ratio of liquid liabilities (i.e., M3) to GDP, the ratio of M3 less M1 to GDP, inflation rate, openness, and government size. The log of initial per capita GDP for each 5-year period in constant 1995 U.S. dollars is expected to have a negative coefficient because of convergence (i.e., the tendency for countries with lower starting levels of GDP to "catch up" with countries of higher GDP). The log of the initial secondary school enrollment rate for each 5-year period (i.e., the percentage of the high school aged population actually enrolled) is expected to have a positive coefficient to reflect a country's commitment to the development of human capital; school enrollment rates are more widely available than other more precise measures of human capital. Two measures of financial sector depth, each averaged for individual 5-year periods, were used: (i) the ratio of liquid liabilities (i.e., M3) to GDP and (ii) the ratio of M3 − M1 to GDP. The broad money supply M3 included all deposit-type assets and was presumed to relate to the extent and intensity of intermediary activity; M3 − M1 took the pure transactions assets out of the ratio to reflect more closely the

3. Original raw data set covers the period 1960–2004. But, considering that the missing observations in all possible variables will have a consistent analysis across different model specifications, the data set was reduced to cover only the period of 1965–2004.

TABLE 1. Descriptive Statistics, 1965–2004, 84 Countries

Variable	Per capita income growth (%)	Per capita initial GDP	Initial SEC (%)	Government (% GDP)	Trade Openness	Inflation (%)	M3 (% GDP)	M3-M1 (% GDP)
Mean	1.77	5961	50.33	14.69	60.80	15.25	45.48	28.49
Maximum	11.66	45888	146.32	40.59	212.49	351.97	184.03	156.44
Minimum	−9.27	145	1.00	4.36	8.92	0.49	4.15	−13.14
Standard deviation	2.67	8498	30.43	5.52	31.73	26.37	28.21	24.28
Coefficient of variation	1.50	1.43	0.61	0.38	0.52	1.73	0.62	0.85
Correlations								
Per capita income growth (%)	1.00							
Per capita initial GDP	0.11	1.00						
Initial SEC (%)	0.16	0.75	1.00					
Government (% GDP)	−0.02	0.45	0.41	1.00				
Trade openness	0.11	−0.06	0.11	0.33	1.00			
Inflation (%)	−0.18	−0.12	−0.06	−0.04	−0.13	1.00		
M3 (% GDP)	0.25	0.50	0.55	0.33	0.29	−0.16	1.00	
M3-M1 (% GDP)	0.26	0.49	0.54	0.26	0.22	−0.12	0.83	1.00

Note: The list of 84 countries is as follows: Algeria, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Fiji, Finland, France, Gambia, The, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Uruguay, Venezuela, RB, Zimbabwe.

Source: Author's analysis based on data sources discussed in the text.

intermediation activities of the depository institutions. The inflation rate was measured as the average annual growth rate of the consumer price index (CPI) in each 5-year period, where deflationary episodes were filtered. This allowed explicit examination of the direct effects of price inflation on growth, and a negative coefficient is expected. The total government expenditure, in terms of the percentage of GDP, and the international trade openness averaged for each 5-year period served as additional control variables. Although the role of government expenditure is weak, large public expenditures would tend to crowd out potentially more productive private investments, especially in higher-income countries. To control for any country-size and income-level effects on openness, international trade openness was measured as residuals from a regression of international trade (the sum of exports and imports) as a percentage of GDP on country size (measured by log GDP) and income level (measured by log per capita GDP). To control for scale effects in the interpretation of the empirical results, minimum international trade openness (measured by residuals) was scaled up to the minimum value of the international trade as a percentage of GDP, because that minimum value was least affected by the country size and income level. In a growth regression, this adjustment will have no effect on the coefficient estimates, because it will be captured by the intercept. This adjusted trade openness is expected to have a positive effect on growth.

The descriptive statistics of the data set (averaged over 5-year periods from 1965 to 2004) are provided in Table 1. It is evident from these statistics that the annual per capita income growth rates ranged between −9 and 12 percent, the per capita initial GDP levels between \$145 and \$46,000, the initial SEC between 1 and 146 percent, the government expenditure between 4 and 41 percent, the adjusted trade openness between 9 and 212 percent, the inflation rate between 0 and 352 percent, M3 (% of GDP) between 4 and 184 percent, and M3 − M1 (% of GDP) between −13 and 156 percent. These wide ranges warrant a threshold analysis *per se*. The coefficients of variation (a normalized measure of dispersion of a probability distribution, calculated as the standard error over the mean) show that the dispersions of per capita income growth, per capita initial GDP, and inflation rate are high across the countries, while those of the government expenditure and trade are low. Therefore, one might expect to have relatively higher threshold effects from per capita income growth, per capita initial GDP, and inflation rate. The correlations across variables are also depicted in the lower part of Table 1. The expected signs of correlation coefficients between growth and explanatory variables are consistent with the foregoing discussion. Almost all variables are positively correlated with each other, except for inflation, which is negatively correlated with all the variables, implying possible distortionary effects of positive price changes in all the transmission channels in the economy.

Estimation was carried out by instrumental variables (i.e., two-stage least squares) with initial values of financial depth, inflation, government

expenditure, and trade for each 5-year period serving as instruments in the first stage. Fixed effects for the 5-year periods were also included, because global business cycle conditions often involved shocks with common growth effects across the countries.[4] Table 2 presents the results that replicate the linear regression analysis of Rousseau and Yilmazkuday (2009); the only difference is that this study has employed an *adjusted trade openness* measure for openness, as described earlier. Column 1 contains the baseline growth model where the coefficient for initial GDP is negative and is thus consistent with the theory of conditional convergence but is not statistically significant, while the coefficient on the initial SEC is positive and significant at 1-percent level. As the baseline specification is expanded in the remaining columns of the Table, the coefficient on the initial GDP remains negative throughout and is statistically significant in 6 of the 12 regressions. The initial secondary enrollment retains its positive and statistically significant coefficient throughout.

Column 2 of Table 2 includes trade openness and government expenditure as controls to form an extended baseline. Openness is positively and significantly related to growth in this specification and all others in which it appears, while the coefficients on government expenditure are negative and statistically significant throughout. These findings are consistent with the priors for these controls.

When inflation is included to the baseline model in Column 3 and to the extended baseline in Column 4, the coefficients on inflation become negative, but statistically significant at the 5-percent level only in Column 4; this finding is consistent with that of earlier studies. When any of the two financial variables are included to the baseline and extended baseline in Columns 5–8, both the measures become positively and significantly related to the growth at 1-percent level.[5] Finally, when both financial depth and inflation are included in the remaining columns of Table 2, although the effects of the financial variables remain, the statistical significance of the inflation coefficients falls to 10-percent level without additional controls (Columns 9 and 11) and when the full conditioning set was included (Columns 10 and 12), the inflation coefficients are no longer significant.

The dampening of the effect of log initial GDP and inflation on growth, combined with financial development, calls for an explanation. Why does the effect of log initial GDP disappear when it is combined with log initial SEC,

4. For robustness, country-fixed effects were also included in the regressions, but the results were not at all affected by this inclusion; the only effect was on the explanatory power of the regression, which shifted up when the country-fixed effects were included. These results of additional sensitivity analysis can be obtained using the published Matlab codes.

5. The ratio of total domestic credit to GDP was also experimented as a measure of financial development that would bring non-depository intermediaries into the analysis; however, it was found that this variable was not statistically significant in any of the specifications. This echoes the results (i.e., covering the period 1960 to 2004) recently obtained by Rousseau and Wachtel (2011). Therefore, the analysis is limited to the two financial measures as described earlier.

TABLE 2. Instrumental variables growth regressions, 1965–2004, 84 Countries

	Dependent Variable: Growth of Per Capita Income (%)											
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log of initial GDP	−0.124	−0.023	−0.154	−0.031	−0.277*	−0.143	−0.299*	−0.169	−0.284*	−0.153	−0.309**	−0.181
	(0.107)	(0.119)	(0.106)	(0.119)	(0.110)	(0.121)	(0.110)	(0.123)	(0.111)	(0.121)	(0.110)	(0.123)
Log of initial SEC (%)	1.101**	1.033**	1.154**	1.082**	0.912**	0.883**	0.923**	0.896**	0.951**	0.917**	0.971**	0.940**
	(0.251)	(0.212)	(0.252)	(0.213)	(0.248)	(0.211)	(0.252)	(0.210)	(0.250)	(0.215)	(0.253)	(0.213)
Government (% GDP)		−0.062**		−0.061*		−0.068**		−0.059*		−0.067**		−0.058*
		(0.025)		(0.024)		(0.024)		(0.024)		(0.024)		(0.024)
Trade openness		0.014**		0.013**		0.010**		0.011**		0.009**		0.010**
		(0.004)		(0.004)		(0.004)		(0.004)		(0.004)		(0.004)
Inflation (%)			−0.012*	−0.010					−0.006†	−0.005	−0.008†	−0.007
			(0.005)	(0.007)					(0.004)	(0.007)	(0.004)	(0.007)
M3 (% GDP)					0.023**	0.021**			0.022**	0.020**		
					(0.005)	(0.005)			(0.005)	(0.005)		
M3 − M1 (% GDP)							0.029**	0.025**			0.027**	0.024**
							(0.006)	(0.006)			(0.005)	(0.006)
R-bar sqd.	0.18	0.21	0.20	0.23	0.22	0.24	0.22	0.24	0.23	0.25	0.24	0.25

Note: †, * and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively. Standard errors are in parentheses. Growth rates are five-year averages. Estimation is by two-stage least squares. The initial values of government, trade, inflation, M3, and M3-M1 in each five-year period are used as instruments for the corresponding five-year averages. All equations include fixed effects for time periods that are not shown. The sample size in each equation is 485.

Source: Author's analysis based on data sources discussed in the text.

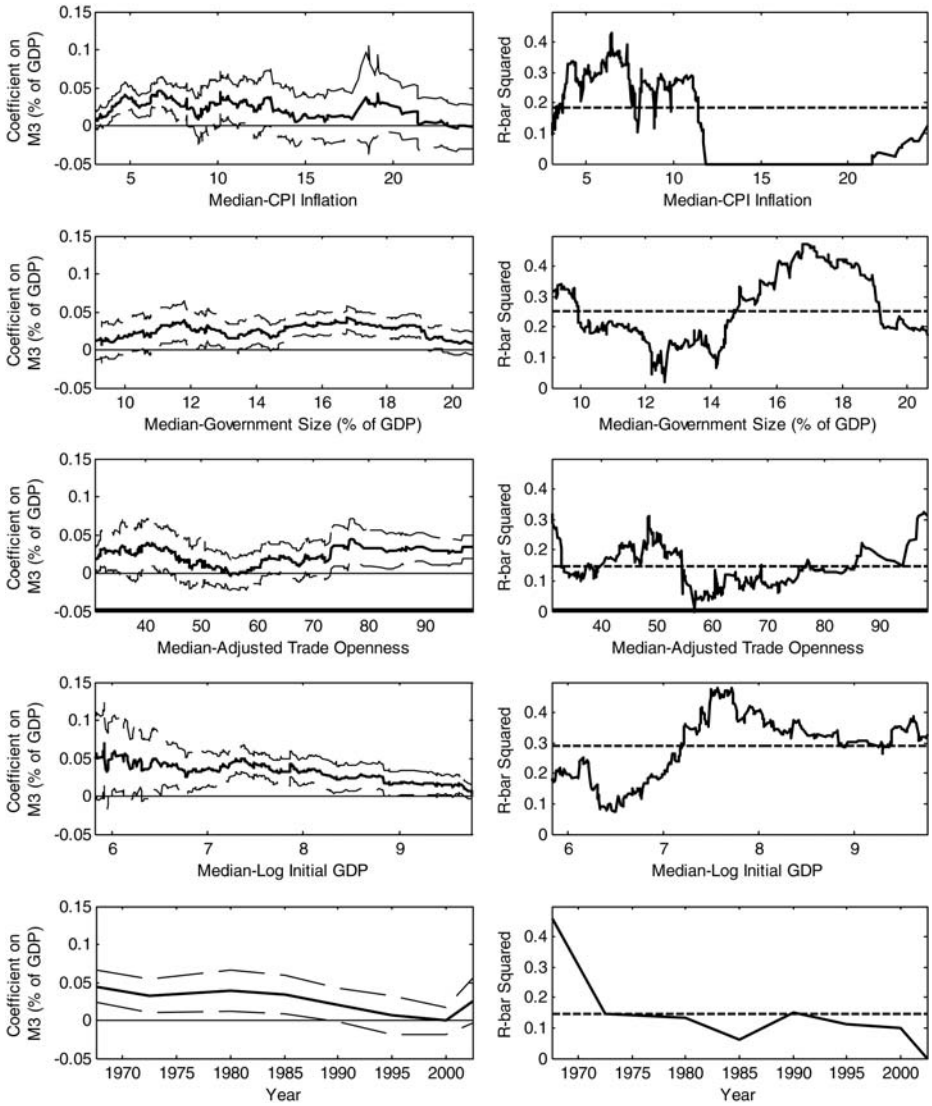
government expenditure, or trade? Is the direct effect of inflation on growth as important as the one suggested by the regressions in Columns 3 and 4 of Table 1? Or, does inflation inhibit growth primarily through its effects on the smooth operation of the financial sector, as indicated by the regressions in Columns 9–12 of Table 2? Is there a continuum of combinations of inflation rates and levels of financial development that are associated with a given rate of growth? If a continuum exists, linear regression analysis seems ineffective in showing it clearly, especially given the negative correlation between inflation and financial depth (-0.16 for M3 and -0.12 for M3 − M1 in Table 1); nevertheless, a continuous threshold analysis can shed more light on understanding nonlinearities in growth regressions.

III. TECHNICAL ANALYSIS

For a continuous threshold analysis, rolling-window two-stage least squares regressions were employed with a constant window size of 120 after ordering the data according to the threshold variable. For instance, if the inflation thresholds were of interest, all the observations (i.e., the pooled sample of 5-year average data from all the countries) were sorted in the order of the lowest to the highest inflation rates; the first regression was run with the first 120 observations of the sorted data set, the second regression by moving the 120 window toward higher inflation rates by one observation, and so on. The selection of a constant window size was important for comparison of coefficient estimates across the windows, while the selection of a window size of 120 was important to ensure a fair distribution across the power of the regressions and the degree of nonlinearity. Nevertheless, the results of this study are robust to the selection of the window size; the results obtained under different possible window sizes are almost the same as those that will be discussed below.[6] For a consistent inference across linear and nonlinear frameworks, the rolling-window regressions used the specifications in Columns 10 and 12 of Table 2, depending on the financial-depth measure used. The corresponding results are given in Figs 1–2, where the x-axes show the median of the threshold variable in 120 sample windows (i.e., the variable according to which all the observations have been sorted). The y-axes of the figures in the left panel of Figs 1–2 show the coefficient estimates of the finance variable (either M3 or M3 − M1 as a percentage of GDP). The bold solid lines show the coefficient estimates and the dashed lines the 10-percent confidence intervals. For the sake of robustness, Fig. 1 considers the finance variable of M3 as a percentage of GDP, and Fig. 2 M3 − M1. The results are similar in terms of the significance of the estimated parameters, but slightly different in terms of the coefficient estimates.

6. Although these sensitivity analyses were skipped to save space, they can easily be obtained using the published Matlab codes.

FIGURE 1. Thresholds (with M3 as the finance variable)

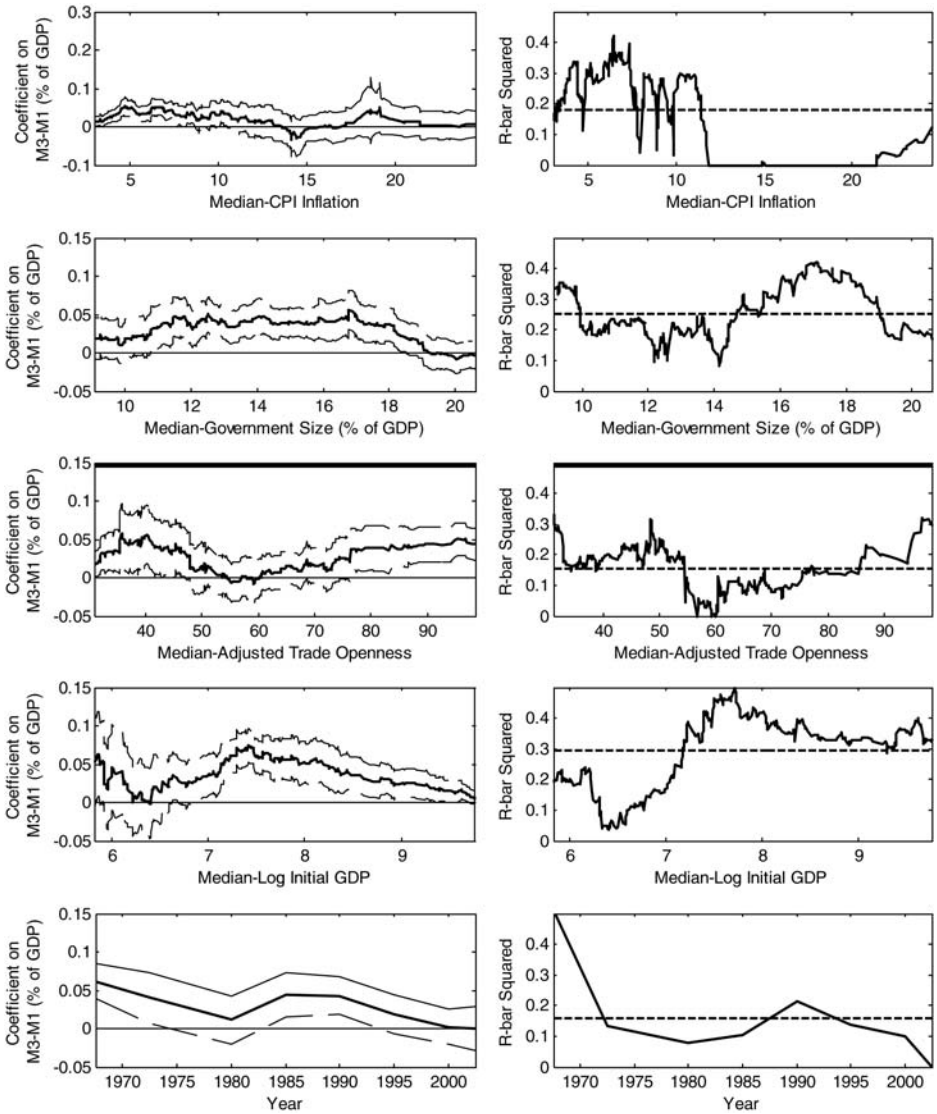


Note: The dashed lines in the figures of left panel show the 10 percent confidence intervals, while the dashed lines in the figures of right panel show the mean of R-bar squared values.

Source: Author's analysis based on data sources discussed in the text.

The top rows of Figs 1–2 replicate the inflation-threshold analysis of Rousseau and Wachtel (2002), this time by using a rolling-window regression with a constant window size of 120 (Rousseau and Wachtel [2002] used a rolling-regression analysis, where they started with 50 observations and included one more observation for each additional estimation). The purpose of this exercise is to investigate the effects of inflation on the finance-growth

FIGURE 2. Thresholds (with M3-M1 as the finance variable)



Note: The dashed lines in the figures of left panel show the 10 percent confidence intervals, while the dashed lines in the figures of right panel show the mean of R-bar squared values.

Source: Author's analysis based on data sources discussed in the text.

nexus. It is evident that the coefficient estimates of financial depth are significant only when the inflation rate is below approximately 8 percent, independent of the financial-depth measure used. Financial depth appears to need a reasonably low inflation environment to promote long-run growth effectively; otherwise, as shown in Figs 1–2, the financial-depth effects on growth approach zero as inflation increases. This threshold value is in line with the

values suggested by Rousseau and Wachtel (2002), which vary between 6.5 and 13.4 percent, depending on the financial-depth measure used. Within this picture, the significance may not be an indisputable guidance, because with a high number of observations in a panel framework and a large number of regressions, the significance at conventional levels may imply 5 or 10 percent of type-1 errors (rejecting the null when it should be maintained). At the same time, failure to meet conventional significance levels does not imply the certainty that the null is true (type-2 error).[7] Therefore, it is also worth focusing on the coefficient estimates without considering their significance. The coefficient estimates of financial depth are non-negative for almost any level of inflation. This contrasts with the result reported by Rousseau and Wachtel (2002), who show that financial depth has a negative coefficient estimate for inflation rates above 13.4 or 15.9 percent, depending on the financial-depth measure used. In sum, according to the present study, the worst-case scenario with high inflation rates is to have an ineffective financial-depth effect on the long-run growth.

Besides Rousseau and Wachtel (2002), this study considered the thresholds in variables other than inflation. First, the second rows of Figs 1–2 analyze the effects of government-expenditure thresholds on the finance-growth nexus. Independent of the financial-depth measure used, the coefficient estimates of the financial depth were found to be significant for countries with government expenditures of approximately between 11 and 19 percent of their GDPs. Although the finance-coefficient estimates were found to be non-negative for almost any government size, consistent with their significance levels, their effects on growth were found to be lower for government sizes lower than 11 percent or higher than 19 percent. Thus, the historical cross-country data shows that the government size must be optimal for significant and positive effects of financial depth on the long-run growth. This may be in line with the expectations of stimulus effects of government expenditures on low-income countries in promoting productive private investments through the financial system, and distortionary effects of government expenditures in high-income countries through crowding out potentially more productive private investments. To test this claim, the income levels of countries were checked with government sizes below 11 percent, between 11 and 19 percent, and above 19 percent. The results supported the claim by showing that, on an average, countries with government sizes below 11 percent have per capita income levels of about $1,053, those between 11 and 19 percent about $2,148, and those above 19 percent about $6,628.

Second, the third rows of Figs 1–2 analyze the effects of trade-openness thresholds on the finance-growth nexus. It is evident that the coefficient estimates of financial depth become significant for countries that have adjusted

7. The author would like to thank the anonymous referee for pointing out this issue for the significance of the parameters.

trade openness lower than about 35 percent or higher than about 75 percent of their GDPs. Coefficient estimates of financial depth are found to be non-negative for almost any degree of trade openness. Therefore, according to historical cross-country data, there is also evidence that optimal trade openness has significant and positive effects of financial depth on the long-run growth. While investigating the possible economic reasons behind this result, it was observed that countries with trade openness between 35 and 75 percent have an average per capita income level of about $1,481, those with lower than 35 percent openness about $2,945 and those with higher than 75 percent openness about $2,143. This suggests that higher-income countries benefit from financial depth mostly through their national markets. However, for lower-income countries, the story is different: to benefit from financial depth, lower-income countries should have a trade openness of at least about 75 percent, failing which the effect of financial depth on the long-run growth is almost none. This can be linked to the market shares of the countries: if a country has access to high-income markets, through their national markets or international trade, then financial depth helps growth; otherwise, financial depth remains ineffective, and the country suffers from a disconnected finance-growth nexus.

Third, the fourth rows of Figs 1–2 extend the analyses carried out by Rousseau and Yilmazkuday (2009) and Rousseau and Wachtel (2011) by considering the continuous log per capita initial GDP thresholds. They both considered *ad hoc* splits of countries in terms of their developments, simply by setting a threshold of a certain amount of per capita real income (e.g., countries with per capita income of less than US $3,000 a year in 1995 are 'developing' and those with higher income 'developed'). This approach suppresses changes in the development of countries through time, because the development of a country is measured based on its performance during the base year; moreover, there may be many other categories of development in a more continuous sense. The present study used a robust measure of development, namely the per capita initial income for the time period considered in the pooled sample. It is evident that the effect of financial development on growth was significant for countries with a per capita income of more than about $665 (=exp[6.5]). Although the significant effect of financial depth on growth was found to increase until the per capita income reached about $1,636 (=exp[7.4]), it started decreasing above this level. Yet, the coefficient estimates of financial depth were non-negative for almost any degree of initial GDP level. The decreasing effects of financial depth on growth for countries with per capita income levels higher than $1,636 were consistent with the catch-up effect, which suggest that low-income countries have the potential to grow at a faster rate than high-income countries, because the diminishing returns (in particular, to physical capital) are not as strong as those in countries with high levels of capital. Furthermore, low-income countries can replicate production methods, technologies, and institutions currently used in developed countries, and combine them with their cheap labor opportunities. Therefore,

on an average, as the income of the countries increases, the effect of financial depth on growth goes down.

Finally, the results for time thresholds are depicted at the bottom of Figs 1–2, where 120-sample-size windows were not used; instead, the 5-year periods were used as thresholds through which 5-year averages were taken. The *y*-axes of the figures in the left panels of Figs 1–2 again show the coefficient estimates of financial depth, while the *x*-axes show the median of each 5-year period considered. It is evident that, consistent with the findings of Rousseau and Wachtel (2011), the effects of financial development on growth are decreasing through time. Nevertheless, financial-depth effects on growth are found to be positive at almost all times. The economic reasoning behind this can be the diminishing returns to capital: as the countries get richer through time, because of diminishing returns, financial depth becomes less effective on growth. However, as all the countries were employed for each 5-year period, this may also reflect the effect of financial depth on growth for a subset of countries. Thus, according to the foregoing discussions, this does not rule out the scope for future finance-growth nexus.

Although the coefficient estimates in the left panels of Figs 1–2 depict the finance-growth nexus with the thresholds in inflation, government size, trade openness, and initial GDP, they do not provide any information on the relative importance of these thresholds. In particular, as each of these thresholds can substitute for the other, it is not clear which threshold is more important statistically. To answer this question, explanatory powers of the rolling regressions with each threshold (in terms of R-bar squared values) are provided in the right panels of Figs 1–2. While the *y*-axes of the figures in the right panel show the R-bar squared values, the dashed lines show the mean R-bar squared values. Using M3 (M3 − M1) as the percentage of GDP as the finance variable, the mean R-bar squared values are 0.18 (0.18), 0.25 (0.25), 0.15 (0.16), 0.29 (0.29), and 0.15 (0.16) for the threshold variables of inflation, government size, trade openness, initial GDP, and time, respectively. Hence, statistically, the initial GDP seems to be the most important threshold variable. This reconfirms the importance of the catch-up effects on the finance-growth nexus that start only after a country reaches a particular threshold value of income.

IV. CONCLUDING REMARKS AND DISCUSSION

This research paper has generalized the empirical studies on the finance-growth nexus by considering the thresholds in several explanatory variables. Following are the suggestions that emerged from this study: (i) Inflation rates above 8 percent eliminate the positive effects of financial depth on the long-run growth. (ii) Optimal government size (% GDP) for the finance-growth nexus is between 11 and 19 percent; government sizes below 11 percent hurt the low-income countries, and those above 19 percent hurt the high-income countries. (iii) Optimal trade openness for the finance-growth nexus is below about 35

percent for high-income countries, and above about 75 percent for low-income countries. (iv) The catch-up effect through finance-growth nexus starts when a country passes the threshold per capita income level of about $665; it has its highest impact when the per capita income is about $1,636; its impact decreases as the per capita income increases. (v) There is evidence to show that financial-depth effects on growth decrease through time. (vi) The thresholds in the initial per capita income seem to be more important than other thresholds.

However, this study is not without caveats. First, the financial-depth measures used here may not fully reflect the actual financial development, especially during crisis periods with high inflation rates or low levels of per capita income, although the averaging of the variables across 5-year periods amended some of these extreme cases. Second, despite strong evidence in favor of the nexus between finance and growth, the exact causality between finance and growth is still a subject of debate (see Demetriades and Hussein, 1996; Arestis and Demetriades, 1997; Andrianova and Demetriades, 2004, 2008); therefore, the results and policy implications of this paper should be qualified with respect to the certain causality assumptions and the estimation methodology employed. Third, the results reflect mostly the average historical experiences of the countries in the sample, rather than providing strong policy implications for future development of a country. Overall, in line with the suggestions of Durlauf and Johnson (1995), Liu and Stengos (1999), and Durlauf (2001), this study offers one important message: The typical cross-country growth regressions are inadequate, because the finance-growth nexus is shown to be nonlinear. Although this study has focused mostly on the finance-growth nexus, it can easily be extended to investigate other determinants/channels of growth, such as institutions, debt, law, private investment, foreign direct investment, inequality, volatility/uncertainty, culture, beliefs, financial aid, central bank independence, and so on. And, these could be the possible topics for future research.

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