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Are small stock markets different?☆

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Abstract

Recent literature has established a positive correlation between financial development and economic growth. While papers such as Bencivenga et al. (J. Econom. Theory 67 (1995) 53) identify potential nonlinearities in this relationship, empirical research to date has allowed for only linear relationships. This paper uses regression tree techniques to investigate whether the partial correlation between growth and financial development differs based on countries' levels of financial and economic development. As in previous studies, growth and financial development are positively correlated in countries with high levels of market capitalization; however, this relationship does not appear to hold for countries with low levels of market capitalization.

JEL classification: O40; O16

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1. Introduction

There is a fairly large literature relating financial development to economic growth. Most research, both theoretical and empirical, has concentrated on the overall (partial) correlation between economic growth and the level of stock market development, using indicators such as stock market size (number of listings or capitalization) and liquidity (trading volume) to measure the level of financial development.

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For example, Greenwood and Jovanovic (1990) and Obstfeld (1994) construct theoretical models in which financial systems insure investors against risk, leading to a shift toward higher return, riskier investments. A second channel in Greenwood and Jovanovic (1990) is that a developed financial system causes more information about investment projects to be made available, allowing for a better allocation of resources. In Bencivenga et al. (1995) and Levine (1991), the allocation to higher-return projects occurs because more liquid stock markets enable investors to invest in longer-term, higher-return projects.

Recent empirical work has only specified linear relationships between financial development and economic growth, and has generally confirmed the positive correlation of most theory. For example, Levine and Zervos (1998) find that the level of financial development is positively correlated with economic growth over the period 1976–1993. In a sample of 40 countries covering the period 1980–1988, Atje and Jovanovic (1993) find "large" effects of stock markets on subsequent economic development in a sample of 94 countries covering 1970–1988.

However, in Bencivenga et al. (1995), there are interesting nonlinearities between decreasing transactions costs in financial markets and economic growth. Their model allows for a number of different production technologies used to convert final goods into rentable capital, with more productive technologies requiring longer gestation periods, and therefore secondary capital markets in which to sell capital-in-process. This model is presented in more detail in Section 2; the key result for the purpose of motivation is that their model implies that, depending on the level of financial market liquidity (transactions costs), a decrease in transactions costs may increase, decrease, or have no effect on the steady-state rate of economic growth. Previous empirical work that specifies a linear relationship between financial development and economic growth cannot uncover such nonlinearities.

Motivated by models like Bencivenga et al. (1995), this paper investigates whether there are nonlinearities in the relationship between financial indicators and economic development using regression tree analysis (a semi-parametric technique that allows for an unspecified number of endogenous sample splits). The hypothesis to be tested is whether the partial correlation between financial development and economic growth differs based on a country's level of financial development. The number of data splits is determined by the procedure, not by the researcher, and every split is tested against the possibility of no splits (i.e., linear regression on the full sample).

I find evidence to support models like Bencivenga et al. (1995), in that the relationship between financial market indicators and economic growth appears to vary depending on the level of financial development. Specifically, although the strong, positive relationship between stock market development and economic growth identified by previous studies is confirmed for countries with the most highly developed financial sectors, this relationship does not hold for countries at lower levels of financial development.

Section 2 presents an example from Bencivenga et al. (1995) to motivate the possibility of nonlinearities between growth rates and financial market development. Section 3 describes the regression tree procedure, and Section 4 presents the results. Section 5 concludes.

2. The BSS model

In this section, I present an example from Bencivenga et al. (1995) (hereafter BSS) to show how the level of financial development may generate nonlinearities in the data.[1] Their model is a two-period, overlapping generations model. Young agents supply one unit of labor inelastically; old agents are retired. At each date $t = 0, 1, \ldots,$ a new generation of $N > 1$ members appears.

In each period, a single final good is produced using N intermediate goods. Young agent $i = 1, \ldots, N$ produces $x_t(i)$ of intermediate good type i, using both capital $[K_t(i)]$ and labor $[L_t(i) = 1]$. The intermediate goods production technology is linear in $K_t(i)$, allowing for the existence of an equilibrium with a constant growth rate. Aggregate production Y_t is produced according to a standard constant returns to scale production function:

$$Y_t = \left[N^{\theta-1} \sum_{i=1}^{N} x_t(i)^{\theta} \right]^{1/\theta}, \quad \theta < 1. \tag{1}$$

Let C_{1t} (C_{2t}) denote young (old) consumption of the final good by a representative agent of time t. Agents maximize utility over C_{1t}, C_{2t}, and a vector of savings allocations, subject to budget constraints and non-negativity. Utility is assumed to be logarithmic in the example: $u(C_{1t}, C_{2t}) = (1 - \lambda) \ln C_{1t} + \lambda \ln C_{2t}$ and the savings rate equals $\lambda \in (0, 1]$.

Two production technologies indexed by $j = 1, 2$ convert final goods into capital. One unit of the final good invested in technology j at time t yields $R_j > 0$ units of capital at $t + j$ (gross of transactions costs). Transactions costs are not relevant for technology 1, since the capital matures during the agent's lifetime. A young agent who invests in technology $j = 2$, however, will sell the "immature" capital in a secondary capital market in the following period. BSS introduce proportional transactions costs: a fraction $\alpha \in [0, 1)$ of capital-in-process is consumed in the process of transferring ownership.

The internal rates of return on the two technologies (net of transactions costs) are given by $\gamma_1 = \rho R_1$ and $\gamma_2 = [\rho(1 - \alpha) R_2]^{0.5}$ where ρ is the marginal product of capital. The equilibrium choice of technology is then $j = 2$ iff

$$(1 - \alpha) R_2 / R_1 > \rho R_1. \tag{2}$$

When transactions costs (α) are sufficiently high, Eq. (2) is not satisfied, $j = 1$, the value of secondary capital market transactions is zero, and the condition determining the steady-state rate of growth can be written as[2]

$$\sigma^* = \gamma_1 \lambda (1 - \theta)/\theta \equiv \sigma_1, \tag{3}$$

which is independent of transactions costs.

[1] The reader is referred to their paper for the more general model as well as a more complete discussion of this example.

[2] The steady-state growth rate is derived from the equilibrium conditions that: the return on savings equals the internal rate of return on investment, portfolio weights are constant over time, and only the technology that maximizes the internal rate of return is in use (here, it is unique).

When Eq. (2) holds, technology 2 maximizes the internal rate of return on investment ($j = 2$). In this case, the equilibrium growth rate can be written as

$$\sigma^* = \gamma_2\{[1 + 4\lambda(1 - \theta)/\theta]^{0.5} - 1\}/2 \equiv \sigma_2. \tag{4}$$

When $\sigma_2 > \sigma_1$, reductions in transactions costs that generate a change in the equilibrium capital technology choice are growth-enhancing. This holds iff

$$\gamma_2/\gamma_1 > [2\lambda(1 - \theta)/\theta]/\{[1 + 4\lambda(1 - \theta)/\theta]^{0.5} - 1\}. \tag{5}$$

For very high transactions costs, $\gamma_2/\gamma_1 < 1$ holds, $j = 1$, and the growth rate $\sigma^* = \sigma_1$. Reductions in transactions costs that result in $\gamma_2/\gamma_1 > 1$ will cause the economy to shift to two-period capital investments. However, if γ_2/γ_1 is very close to one, the reduction in transactions costs will *reduce* the equilibrium growth rate, although larger decreases in transactions costs will increase growth rates.

Fig. 1 illustrates the relationship between the equilibrium growth rate σ^* and transaction costs α. When transaction costs are very high ($(1 - \alpha)R_2$ is very low), $\sigma^* = \sigma_1$ and growth rates are constant with respect to marginal changes in α. However, when α is low enough that $\gamma_2/\gamma_1 > 1$, the equilibrium growth rate switches to $\sigma^* = \sigma_2$. In Fig. 1, $\tilde{R}^*$ is the threshold value at which $\gamma_2 = \gamma_1$. Beyond $\tilde{R}^*$, the relationship between the cost of financial market transactions and economic growth is negative. Notice that it is possible for growth rates to be lower under the more productive technology 2 than under technology 1, if returns lie in the region between $\tilde{R}^*$ and $\tilde{R}^{**}$. Intuitively, once longer gestation capital technology earns higher returns, some investment is transferred from new investment to purchasing capital in

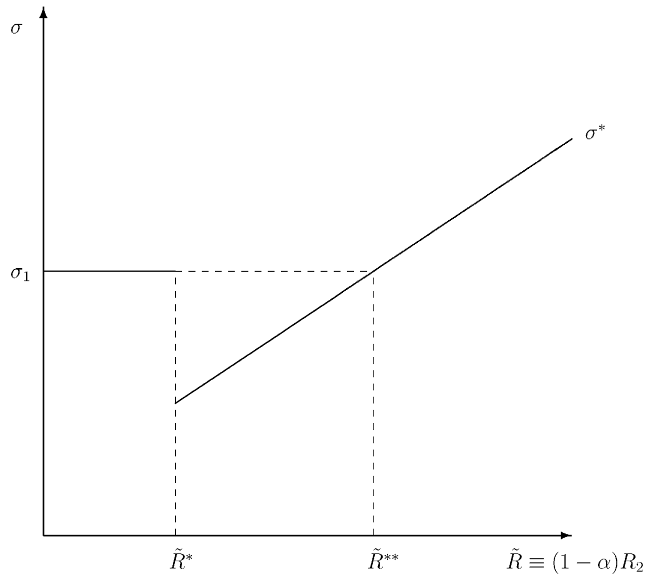

Fig. 1. Steady-state growth rate as a function of transactions costs. *Note*: As transactions costs decrease, $\tilde{R}$ increases. The upward sloping portion of the σ function is not necessarily linear.

process, decreasing overall investment. In this region, this effect dominates the increased productivity of technology 2.

It should be noted that the BSS model is not dynamic, in the sense that Fig. 1 does not represent a "transition path" from one type of capital technology to another. Therefore, the analysis presented in Section 4 is based on a cross-section of countries. Additionally, the general BSS model does not limit itself to two technologies, but allows for any number. Likewise, the regression tree procedure is not limited to identifying only one split in the data (the possibilities of no splits and of multiple splits are both considered).

I use the regression tree procedure described in the following section to test for this type of nonlinearity between growth rates and transactions costs, using several measures of financial market development to proxy for transactions costs. Specifically, I look for threshold levels of financial development at which the relationship between growth and financial development changes.[3]

3. Regression tree framework

Regression tree analysis allows for the endogenous determination of subsamples, given a specified regression and potential "split" variables. It is a semi-parametric data-sorting procedure that identifies an unknown number of sample splits over multiple control variables.[4]

Say that the regression of interest is

$$y_i = \beta \cdot \mathbf{X}_i + \varepsilon_i, \tag{6}$$

where $\mathbf{X}_i$ is the vector of explanatory variables. There may be reason to believe that the relationship between the $\mathbf{X}$ variables and the variable y depends in some way on the level of some "control variables" $\mathbf{S}$.[5] Regression tree analysis provides a method of endogenously determining whether sample splits based on the proposed $\mathbf{S}$ variables yield better prediction than full sample (OLS) estimation.

The procedure is as follows. For each proposed control variable s, the observations are indexed by that variable, and all possible binary data splits based on that control variable are examined. For each split, regression (6) is estimated on each subsample, and the sum of squared residuals over both subsamples is computed. This procedure is repeated for each control variable; the data split that minimizes the total sum of squared residuals is considered the first split of the data. This process is repeated on each of the subsamples until the data cannot be split further.

[3] Of course, there are other means of testing for nonlinearities, but they generally require knowledge of either the functional form of the nonlinearity or the appropriate division of the sample into subsamples. The regression tree procedure requires neither.

[4] See Breiman et al. (1984) and Härdle (1990) for more complete discussions of regression tree analysis. Other economic applications of this procedure include Cooper (1998), Durlauf and Johnson (1995), and Minier (1998).

[5] The control variables may or may not be a subset of the $\mathbf{X}$ variables.

Since splits to this point have been costless, the tree that results from the above procedure is likely to be overparameterized. The tree is "pruned" by introducing a cost to splits in order to eliminate splits that yield only small decreases in error variance. This cost function is defined as

$$\phi = SSR + \alpha(\#(N) - 1), \tag{7}$$

where SSR is the total sum of squared residuals over all terminal node observations and $\#(N)$ is the number of terminal nodes in the tree.[6] Beginning with the full tree identified by the original procedure, terminal splits are eliminated sequentially as α is increased from zero. Increasing α produces a series of trees, from the full tree identified by the original procedure ($\alpha = 0$) to the OLS regression on the full sample, with no splits ($\alpha = \infty$).

The final specification is selected based on cross validation, using the "leave-one-out" method. For each of the trees identified by the pruning procedure—the OLS regression on the full sample, the "full" tree containing all identified splits, and each intermediate tree identified by the pruning procedure—the cross-validated sum of squared residuals is calculated. The tree with the smallest cross-validated sum of squared residuals produces the piecewise linear approximation that converges in mean squared error to the best nonlinear predictor.[7] Notice that the full sample OLS specification is tested against the identified splits; if the relationship is linear, the regression tree procedure does not force a nonlinear specification on the data.

4. Empirical results

Previous studies, such as Levine and Zervos (1998) and Atje and Jovanovic (1993), have been based on various specifications of growth regressions, where indicators of financial development are included with other explanatory variables typically included in growth regressions.[8] In this section, I use regression tree techniques on this type of growth regression to investigate the possibility of a nonlinear relationship between financial development and economic growth, as implied by the BSS model presented in Section 2. For purposes of comparison, I retain the regression and data of Levine and Zervos (1998).

The growth regression estimated is

$$\ln(y_{i,t}) - \ln(y_{i,t-1}) = \beta_0 + \beta_1 \cdot BK_{i,t-1} + \beta_2 \cdot TN_{i,t-1} + \beta_3 \cdot \mathbf{Z}_{i,t-1} + \varepsilon_i, \tag{8}$$

where $y_{i,t}$ represents per capita GDP at time t, BK_i is the ratio of bank credit extended to the private sector to GDP, TN_i measures stock market turnover, and $\mathbf{Z}_i$ is a vector of exogenous variables also believed to affect economic growth. Here, $\mathbf{Z}_i$ includes the log of initial GDP per capita, log of secondary school enrollment rates, the number of revolutions and coups, government expenditures as a share of GDP,

[6] Terminal nodes are nodes which are not split further.

[7] See Breiman et al. (1984).

[8] In Atje and Jovanovic (1993), the investment ratio; in Levine and Zervos (1998), variables such as initial GDP per capita, education, and political stability, discussed in the following paragraph.

Table 1
Output growth regression by sample splits

	(1) Full sample	(2) Low capitalization	(3) High capitalization
Bank credit	0.013 (0.005)	−0.015 (0.008)	0.017 (0.009)
Turnover	0.027 (0.009)	−0.075 (0.014)	0.027 (0.011)
Log initial GDP	−0.014 (0.005)	−0.014 (0.002)	−0.020 (0.006)
Log enrollment	0.023 (0.012)	0.052 (0.004)	0.031 (0.014)
Revolutions and coups	−0.035 (0.011)	0.070 (0.011)	−0.049 (0.013)
Government	−0.062 (0.038)	−0.349 (0.044)	−0.041 (0.046)
Inflation	−0.007 (0.006)	−0.064 (0.008)	−0.010 (0.024)
Black market premium	−0.00002 (0.0001)	−0.001 (0.0001)	0.00001 (0.0001)
Constant	0.046 (0.025)	0.018 (0.012)	0.061 (0.033)
Observations	42	11	31

The dependent variable is log growth of GDP per capita, 1976–1993. All explanatory variables are initial (1976) values, except the variable measuring revolutions and coups, which is averaged over the 1980s. Conventionally estimated standard errors appear in parentheses after each estimate; they are heteroskedasticity-consistent in Regression 1. This split into subsamples is the split identified by the regression tree procedure described in Section 3; capitalization is split into high and low at a level of 0.03784. Data source: Levine and Zervos (1998).

inflation rate, and the black market premium, which are expected to have the usual signs.[9] The regression on the full 42-country sample, as reported in Levine and Zervos (1998), covers the period 1976–1993 and appears as Regression 1 in Table 1. The coefficient estimates on both banking credit and stock market turnover are positive, fairly large in magnitude, and statistically significant.

However, it is possible that this positive correlation overall obscures nonlinearities. To test this, I use the regression tree technique introduced in Section 3 on the growth regression (8). Initial GDP per capita and several indicators of financial development are considered as "control variables" identifying potential data splits. The BSS model predicts that splits in the data should be based on transactions costs in secondary capital markets. I use several measures of initial financial market development to proxy for these transactions costs, under the assumption that more developed financial markets have lower transactions costs: market capitalization (the ratio of the average annual value of listed shares to GDP, as a measure of market size), turnover (the ratio of the value of trades to the average value of listed shares, a proxy for market liquidity), value traded (the value of trades divided by GDP, which also measures liquidity), and the ratio of bank credit to GDP. Since it is unclear which of these variables best captures the level of financial development, all are included as potential split variables. Additionally, initial GDP is included as a measure of overall economic development.

[9] The data are taken directly from Levine and Zervos (1998); readers are referred to their paper for complete definitions and original sources.

Including a range of financial variables allows the data to endogenously determine the most appropriate measure of financial development.[10] Furthermore, including initial GDP as a potential split variable provides a test of the importance of financial development relative to economic development.

Table 1 presents the results of this procedure. Regression 1 is the regression on the full sample of 42 countries (identical to the regression of Levine and Zervos, 1998). Regressions 2 and 3 present the results of the regression on the subsamples resulting from the regression tree procedure. The only split remaining after the pruning procedure occurs at a fairly low level of initial market capitalization, dividing the sample into two groups: 11 countries in which the capitalization-GDP ratio is less than or equal to 0.038, and 31 countries with capitalization greater than that level. This level of capitalization was identified as a "better" split (in the sense of minimizing squared error) than any other feasible split based on capitalization, initial income, or the other financial development indicators considered (value traded, turnover, and banking credit). This split was also preferred to the full sample (OLS) specification by the cross-validation pruning procedure, as well as to specifications involving additional data splits.

The positive relationship between the level of financial development (measured both by banking credit and stock market turnover) and economic growth found in previous studies holds for the high capitalization countries (Regression 3 of Table 1). However, these coefficient estimates are negative in the low capitalization subsample (Regression 2), and the magnitudes of these estimates are quite large. This is consistent with nonlinearities of the type implied by the BSS model and illustrated in Fig. 1. Specifically, these results suggest the existence of a threshold level of stock market development above which positive growth effects of further development are seen. Based on these results, that threshold level appears to be at a level of market capitalization of approximately four percent of GDP.[11] This suggests that coefficient estimates from full-sample regressions may not be appropriate for all subsamples of countries.

The 42 countries included in this analysis are those with widely available stock market data, and so are generally the most highly developed financially overall. However, countries with less developed financial sectors (i.e., countries not included in this analysis, and with lower levels of financial development than most of the low capitalization subsample) are the countries that are most likely to interpret previous results as a compelling argument for rapid stock market development. They are also precisely those countries to which those results may not apply in the short run (i.e., Regression 2 may be more relevant for less financially developed countries than the full sample regression). These results should not be interpreted as an argument against stock market development, but rather as a warning to countries with less

[10] "Most appropriate" in the sense of the variable that generates a split into two subsamples with the lowest total sum of squared residuals across the two regressions.

[11] The highest value of capitalization in the low capitalization subsample is 3.78%, while the lowest value in the high capitalization subsample is 4.4%. The negative estimates on the financial market indicators suggest that the regression tree procedure may have split the data at a level between $\tilde{R}^*$ and $\tilde{R}^{**}$ in Fig. 1, rather than at the theoretical split of $\tilde{R}^*$.

Table 2
Countries in each sample split

Low capitalization	High capitalization		
Argentina	Australia	Greece	Netherlands
Austria	Belgium	Hong Kong	Norway
Côte d'Ivoire	Brazil	Israel	Philippines
Egypt	Canada	Italy	Singapore
India	Chile	Japan	Spain
Indonesia	Colombia	Jordan	Taiwan
Jamaica	Denmark	Korea	U.S.
Nigeria	Finland	Luxembourg	Venezuela
Portugal	France	Malaysia	Zimbabwe
Sweden	Germany	Mexico	
Thailand	Great Britain	Morocco	

Low capitalization refers to levels of market capitalization/GDP less than or equal to 0.03784; high capitalization to levels greater than 0.03784.

developed financial markets that the apparently positive growth effects may not be realized immediately.

Table 2 lists the countries in each of the two terminal nodes. The correlation between capitalization and economic development is not perfect; although the regression tree procedure allowed for a split based on initial GDP, the split on initial capitalization was preferred by the procedure. As a result, some relatively developed countries (in the economic sense) are assigned to the lower capitalization subsample.

5. Concluding remarks

While the previously established positive correlation between financial development and economic growth seems to hold for the majority of countries in this sample, the effect of stock market liquidity (turnover) and banking development on growth is less unambiguous among countries with less developed financial sectors. Endogenously determined splits suggest that the fairly strong, positive correlation seen in the full sample does not exist among less financially developed countries. Furthermore, these results suggest that the relationship between stock market development and economic growth may, in fact, be different in countries with smaller stock markets. In particular, opening a national exchange may not be enough to generate positive growth effects immediately: market capitalization may need to reach a certain level before these growth effects are realized.

Several caveats deserve mention. First, asymptotic theory that would allow for more formal testing based on the regression tree procedure has not been developed. Second, the sample is very small, limiting the precision of the regression estimates; this is of particular concern for the less financially developed subsample (with only eleven observations and nine regressors).[12] However, the regression tree procedure does identify a split that is preferred to the full sample regression, and the results of this split are consistent with nonlinearities of the type in Bencivenga et al. (1995).

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[12] To check for robustness, I repeated the analysis retaining only the variables most commonly included in growth regressions (education and initial income), in addition to the two financial development measures. This specification yielded two "significant" splits: the first split was based on the level of banking development, and the second split the higher banking development countries based on market capitalization. Again, the coefficient estimates on the least financially developed subsample (here, the low banking development group) were negative while the estimates for the other two groups were positive. Results using a similar data set covering a later time period were also comparable.