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"Stock Markets and Growth: A Re-Evaluation"

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Abstract

There is a large body of literature stressing the importance of developing financial markets, including stock markets, to enhance countries' growth. I argue that the relationship between stock markets and growth is exaggerated and that the simple act of opening a formal stock market is not a good predictor of whether a country will experience economic growth. While it is possible that in some instances opening a stock market can lead to increased growth, I do not find any evidence that opening a stock market has any impact.

This research uses two Bayesian econometric methods, Extreme Bounds Analysis (EBA) and Bayesian Model Averaging (BMA), to discover if there are meaningful links between stock markets and growth in developing economies. Superior to traditional cross-sectional regressions, these methodologies allow for determining the true impact of certain variables. Using a similar dataset to multiple other studies, I find a zero, or weakly negative, correlation between the opening of a stock market and growth in developing countries. 82 countries and 32 independent variables were used comparing all stock market openings between 1960 and 1999 to those without a stock market on growth between 2002 and 2007.

Keywords: Bayesian Econometrics, Growth, Stock Markets, Development
JEL Classification: O17, E44, C11,

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Section 1: Introduction

I hypothesize that the relationship between financial development and growth is overstressed and that opening a stock market is not a good predictor of whether an economy will grow. The large body of research between finance and growth points to positive relationship, where more developed financial markets are found in countries with higher levels of growth. Much of this "shows" a positive causal relationship running from financial development to growth. Therefore, policy prescriptions pushing opening stock markets have been applied to developing countries based on studies of The West. These recommendations precipitated the large number of openings during the 1990s as can be seen in Figure 1. I posit that opening a stock market has little influence on growth and provide evidence, in contrast to the existing literature, that the simple act of opening a stock market does not contribute to growth, and may have a negative impact.

In estimating the impact of opening a stock market on growth, I am estimating an empirical growth model paying special attention to stock market variables of my construction. Research performed by Levine and Renelt (1992) examines the empirical work on growth using a new (at the time) procedure known as Extreme Bounds Analysis to test for robustness on the empirics of the growth literature. Results from these estimations were that most variables were fragile, only finding two robust correlations: share of investment in GDP and ratio of international trade to GDP. Sala-i-Martin (1997) acknowledges the benefits of the approach, but does provide strong criticisms, saying "…the test is too strong for any variable to pass it….Thus, giving the label of nonrobust to all variables is all but guaranteed." Sala-i-Martin then averages over two million regressions a likelihood-weighted sum of normal cumulative distribution functions. This rudimentary approach was the predecessor of Sala-i-Martin et. al (2004), which uses a model averaging approach known as Bayesian Averaging of Classical Estimates (BACE). This process takes the Bayesian concept of averaging across models and combines it with classical OLS estimations. Adding to the literature on Bayesian estimations of growth theory is Fernandez et. al (2001) who use Bayesian Model Averaging to confirm the 'optimistic' conclusions of Sala-i-Martin (1997) that some variables do have some explanatory power.

The approach taken in this paper is the marriage of the techniques of Levine and Renelt (1992) and Sala-i-Martin et. al (2004). Where my approach differs from Sala-i-Martin et. al (2004) is. that instead of averaging over classical estimations with BACE, I use Bayesian Model Averaging (BMA) with a null prior. BACE is derived from this purely Bayesian technique of BMA and is typically used when presenting to those not familiar with Bayesian techniques. The reason for the divergence is that BMA is better equipped to handle model uncertainty and in recent years has been able to incorporate detailed image plots for a more intuitive presentation. While Sala-i-Martin (1997) provides criticisms of the Extreme Bounds approach, it is still a useful tool and should not be discarded. If a variable is robust with bounds that do not cover zero, it is then absolutely certain of the direction of correlation. This combination of techniques uses EBA to test for robustness and BMA for assessing "importance." There are numerous studies evaluating the determinants of growth, but I make no attempts at reconciling. While some results are presented on the relationships between certain indicators and growth, the impact of this paper is the determination of whether the simple act of opening a stock market can positively influence growth.

The empirical results of this paper are straightforward. I find little evidence that the act of opening a stock market in developing countries has any influence on growth; if there is any relationship it is most likely negative. Section two provides theory on the link between financial development and growth, and places this research in the relevant literature. Section three is a detailed explanation of the estimation procedures used while section four presents the data and results. Section five concludes.

Section 2: Theory

The benefits of stock markets include: increasing liquidity, reducing risks to investors, lowering transactions costs and increasing capital accumulation. It has been contested that even in the absence of a stock exchange there is still a market for the shares of a company and that opening an official exchange encourages regulation and oversight. This comes in the form of accurate reporting of pertinent financial information, reducing asymmetric information and information costs. Societal functions of stock markets are that capital will move from surplus to deficit units more efficiently, increasing investment and long run growth.

The majority of current literature finds a positive link between financial development and growth. In the past twenty years, that focus has shifted more towards stock market development and its effect on growth. Levine (1991) emphasizes the positive role of stock market liquidity on long-run growth with cross-country regressions. Atje and Jovanovic (1993), and Bencivenga, Smith, and Starr (1995) concur, finding that stock market liquidity is not only correlated, but also facilitates long run growth. Levine and Zervos (1998) expand the sample size of the earlier studies and introduce new measures of stock market and bank development concluding that "results suggest that stock markets provide different functions than banks, otherwise they would not enter in to the regressions significantly." Rousseau and Wachtel (2000) confirms these finding using a virtually identical study, but instead of using cross-sectional data, they perform estimates with panel econometric techniques. Building on this, Beck and Levine (2002) extend the time series and using slightly different panel procedures confirm previous results. They find that stock market capitalization is not correlated with growth and that it is not the listing of the companies itself that is important, but rather it is the ability to allocate capital to a country's high productivity sectors. Arestis et. al. (2001) uses time series analysis and in contrast to the earlier cross-sectional research they find a weaker correlation, but still a positive relationship.

Extending this research to developing countries brings with it the criticisms that developed countries were the primary research subject and have substantially different characteristics. Contrasting earlier research, Harris (1997) finds that the relationship between stock market activity and growth is weak at best for developing countries. He did find that there is a positive and statistically significant result for stock market activity on growth in the developed countries, but "… finds no hard evidence that the level of stock market activity helps to explain growth in per capita output" for anyone other than the most developed countries. Bhide (1993) finds hidden costs of one of the benefits of stock markets – increased liquidity. His findings indicate that liquidity discourages internal monitoring because of information asymmetry problems that can impair the societal benefits of a well-functioning stock market.

Lucas (1988) contends that financial development is "irrelevant" for growth. Ram (1999) found that many of the conclusions of King and Levine (1993) and Levine and Zervos (1998) are not supported by empirical evidence. Ram found a "predominant pattern" for 95 individual countries of a negligible or weakly negative correlation using time series data. Ram was also unable to find any evidence of a positive correlation using individual country multiple-regression models. Singh (1997) argues that the expansion of stock markets through the 1980s and 1990s hinders rather than assists growth and development. His argument hinges on the idea that volatility and the arbitrary way asset pricing occurs in developing countries does not lend to efficient investment allocation. Singh also provides numerous historical examples of economies that experienced high levels of growth in the absence of a functioning stock market.

In recent years, a small amount of research has arisen examining the effects the simple act of opening a stock exchange has on growth. Baier, Dwyer, and Tamura (2004) look at the openings of stock markets on productivity growth as measured by total factor productivity (TFP) and conclude that increases in TFP can and will lead to increases in long run growth. Minier (2009), on the other hand, looked directly at the effect a stock market had on growth, showing a statistically significant positive result of growth in the first five years after opening a stock market. This was conducted by comparing growth rates for the five years before and after the opening of the stock market. The problems associated with this method are that successive values of GDP are serially correlated; some of the effects of a pre-stock market economy could carry over to the period after the stock market is opened. Enders (2004) has shown that such tests are poorly designed for this reason.

Section 3: Empirical Methodology

Extreme Bounds Analysis

The variations in empirical results summarized in the literature above are not surprising. Econometric analyses often differ due to varying data, model selection, or statistical techniques. In this paper we begin an empirical exploration by utilizing global sensitivity analysis introduced by Leamer (1978). Extreme Bounds Analysis (EBA) is a Bayesian procedure computes the range with which variable coefficients can take. While we cannot know the exact "true" magnitude of a given variable's coefficient, EBA allows for the determination of the bounds within which a coefficient will take. It is not enough to say that the true value is “New York City” if it cannot even be verified that it is in New York State. The strength of EBA lies in its ability to verify the actual bounds a variable can take; it literally can rule out the possibility that the variable is in New Jersey.

EBA computes the possible bounds for the posterior mean for a normal linear regression model utilizing a natural conjugate prior. The model is represented as:

$$Y = X\beta + Z\Gamma + \varepsilon$$

where X represents a set of variables that are always included in a regression and Z is a set of variables which might be dropped from a regression specification. Interest is in the set of β coefficients on the focus variables of interest. The fact that sets of variables (Z) might be dropped from a regression induces a coherent prior on the coefficient vector, Γ. From a Bayesian perspective, the prior mean for Γ is the zero vector with perfect precision. Remarkably, the choice of a set of Z variables, called doubtful variables, allows for the calculation of the extreme posterior values for the coefficients associated with the X variables.

Setting a variable to doubtful is a twist on proper prior specification by setting the prior mean equal to zero and would be dropped from any given specification. Dropping these variables is the same as setting a proper prior at zero with perfect precision. Therefore, when calculating the extreme posterior means, the bounds would necessarily include zero. “Free” variables are those that are not properly specified and not associated with a prior specification. “Doubtful” variables are those that we do not think are important indicators. Whereas in traditional cross-sectional specifications we would just drop these variables, they are still included as doubtful variables in the event that they influence the free variables. With a large dataset and a large number of explanatory variables there are an exponentially large number of doubtful/free combinations.[1]

<u>BMA Overview</u>

Upon completion of EBA, the next logical step is the use of Bayesian Model Averaging (BMA). Since EBA provides the bounds a coefficient can take, BMA is able

[1] For details on EBA see Leamer (1982). EBA calculations and code are available on request.

to estimate the importance of variables. Since we do not know what the "true" model looks like, we average over every possible model, assessing probabilities to each variable that it is included. These Bayesian methodologies are complimentary in that one checks and verifies robustness, while the other ranks models according to their explanatory power. This differs greatly from the traditional quest for statistical significance in that rather than arbitrarily adding or subtracting variables the established algorithm chooses the most representative models. These models and the variables included in each are then assigned a probability of being the true model. The higher the assigned posterior probability, the more it is considered an "important" indicator.

In econometrics, one of the most difficult and contentious issues is in model selection. This uncertainty can lead to misspecification errors and erroneous conclusions. A major issue in the use of linear regression models with ordinary least squares is that in the search for a high R^2 many naïve econometricians will arbitrarily add variables. With the rise of high computer power and statistical software it becomes an easy to run thousands of models while adding or subtracting variables until the desired result is discovered (as shown by EBA). If, for example, a variable with large explanatory power were to show the opposite of the desired result, the economist could easily remove this variable from the regressions shown in the final paper without making any mention of it. It is for this reason that many economists are weary of econometrics and the result they show. In BMA, however, the economist shows his intentions before running the first regression, allowing an established algorithm to show the correlations.

Bayesian statistics looks to establish posterior probabilities based up a given prior. The BMA model used in this study sets a prior for all variables at zero. This is setting diffuse priors and is one way of expressing ignorance in the initial conditions; it is performed in this manner in order to determine the true magnitudes of the variables selected for the models. Posterior probabilities are calculated as:

$$p(\Delta|D) = \sum_{k=1}^{k} p(\Delta|D, m_k)p(m_k|D)$$

Where Δ is the unknown quantity of our dependent variable and D is a given matrix of available data. $p(\Delta|D, m_k)$ is the posterior distribution of Δ given the model m_k and $p(m_k|D)$ is the posterior probability that m_k is the best model. BMA determines this posterior distribution of Δ as a weighted average of the posterior distributions of the models weighted by their posterior probabilities.

Once the models have been narrowed down, selection of the best models comes by way of using the Bayesian Information Criteria (BIC). This process is similar to Akaike Information Criteria (AIC) but differs in that the penalty for adding variables under BMA is much less than under AIC. The following equation gives the calculation for BIC where R_k^2 is the value of the computed R^2 and $p_k$is the number of independent variables regressed on model k. The lower the value of BIC, the better story the model tells, with the best model having the lowest BIC.

$$BIC_k = n\log(1 - R_k^2) + \ p_k \log n$$

This process of adding variables is discounted in BMA as the process penalizes models for more explanatory variables and rewards models with better explanatory power. BMA will sort through all possible models throwing out the worst models in a search to find the models with the most explanatory power. The methods used to specify the best models is the benefit of using Bayesian Model Averaging; it deals with the uncertainty of the models themselves as well as providing better inferences than OLS. BMA does an exhaustive search of possible models using the leaps and bounds algorithm developed by Raftery (1995) that leads to the optimal model. For a more thorough overview of BMA please see Raftery, Painter and Volinsky (2005) or Hoeting et. al. (1999).

Section 4: Results

Data

The existing growth literature has discovered a large number of variables with significant correlations. With such a large selection of variables, choices had to be made regarding which to keep and which to remove. Variables were narrowed down into smaller subsets and the most reliable of these were kept. Variables used in this model closely follow those used in the growth literature, but may have slightly different specifications.

Control variables are shown in table 3 and take into account such issues as property rights, human capital, infrastructure, and monetary assets and flows. Data has been collected from the Demirguc-Kunt and Levine (2009) data series, World Bank, World Governance Indicators, and UNESCO. In order to test for the impact of opening a stock market on growth it is necessary to include countries that do not currently have a stock market. The dataset uses 59 countries that opened a stock market between 1960 and 2000 along with 36 countries that do not currently have a stock market for a total sample size of 95 countries as shown in Table 1. Because of limitations on data collection some countries have been excluded from this research.

The dependent variable in this study is average per capita growth from 2002 to 2007 as measure in 2000 US Dollars. This time period was chosen to smooth any fluctuations and to give time between the last openings of the sample. The time spacing was necessary as there is a necessary lag between the time a market opens and impacts on growth are felt. Concerns may be raised as to the efficacy of using averaged growth in a cross sectional nature, but in order to refrain from dropping a number of explanatory variables, this was deemed the most appropriate method. Once there is enough data collected from the primary sources this analysis would be able to easily incorporate any such increases in availability. These concerns can be allayed with the realization that

Using two variables of my own construction – *Stock.Dummy* and *Years.Open* – I am able to estimate the impact of opening a stock market on growth. *Stock.Dummy* is a dummy variable equal to one if a stock market is present and zero if not. This simplistic measure is able to test the simple question of whether the existence of a stock market accelerates growth. The other variable, *Years.Open*, is a measure counting backwards from 2010 in the number of years the stock market has been open. Countries without a stock market carry a value of zero. Of the countries with a stock market, the lowest number of years open is eleven since the cutoff for inclusion of opening a stock market was the year 2000. The implicit assumption is that the longer a stock market has been open the more developed and efficient the market has become in allocating capital. The longer the market has been open, the more growth we should see. If the existence of a stock market influences growth, one of these two variables should play a significant role in the regressions.

As with any econometric exercise there is always room for debate about whether the "correct" variables were used; there may be other variables besides these thirty-two that tell a significant part of growth, but the end result in regard to stock markets should remain unchanged. In addition, it has been suggested that other aspects of stock or bond markets should be included, but no adequate measure was to be found since they had to extend over to countries without stock markets. These variables would also be inappropriate to use in growth regressions as there is a limit to the number of variables that could be included and controlling for these factors could only lessen the impact of the stock market variables.

EBA Results

The combinations of free and doubtful variables have been broken into a social/political set where these social and political effects can be captured as free variables; a financial set that sets the financial variables as free with the others as doubtful, all explanatory variables set as doubtful; and one with both the stock market dummy and years open set as free with the others set as doubtful. The reason for running multiple EBA estimates is to check for robustness. In our search for the "true" value of a particular parameter, we first wish to know the direction of correlation. If it is possible to generate both positive and negative coefficients it sheds doubt on any particular value. The free variables whose bounds do not cover zero are robust in that the coefficient will always have the same sign regardless of how the model is specified.

The EBA model uses all thirty two of the independent variables as discussed in the above section and summarized in Table 3. Where there is not an entry in the table the variable was set as doubtful, while each value reported is set as a free variable. Those variables that are robust and do not cover zero have bolded results in the table. These variables include: GDP in 1992, life expectancy, rural population, government effectiveness, export index, expected levels of school, and the Human Development Index. To Development scholars, the fact that these variables are robust should not be a surprise. What may be surprising to some is the direction of these coefficients. *Life.Expect* and *Exp.School* are both negatively robust; indicating that as schooling and life span increase, growth is expected to decrease. Additionally, percentage of population living in rural areas (*Rural.Pop*) carries a positive value indicating that highly urbanized countries have lower growth rates. Diagnostics and interpretations of the results needs to wait until the data has been estimated with Bayesian Model Averaging.

What is important for this piece of research is that both stock market variables (*Years.Open* and *Stock.Dummy*) are fragile. Each of the three models shows that while the bounds may vary, they will always cover zero. If we were to assign a coefficient to these variables, the maximum likelihood estimate for both is negative, indicating a weakly negative result. This is especially evident in Model 2 as the positive values are moving pretty far into the tail. Knowing that these variables can generate a coefficient in any direction warrants a fuller investigation into their effect on growth; Bayesian Model Averaging quantifies this.

<u>BMA Model</u>

The thirty two explanatory variables included in this model can yield 2^{32} (4,294,967,296) total models. The vast number of models possible can lead to "cherry picking" models that best sell the hypothesis with the reader having no idea how many models failed. It is for this reason that many economists do not trust other economists' data and why procedures such as BMA have arisen. The model presented in this paper makes a valiant effort at objectively quantifying the elements important in accelerating growth. While the explanatory variables - besides the stock market dummy and years open - are not discussed here, Fernandez et. al (2001) address model uncertainty in cross-country growth regressions using BMA.

The results of BMA return 75 models with Table 4 reporting the top five models. The p!=0 column is the posterior probability of that variable being included in the model, EV is the BMA posterior mean, and SD is the posterior standard deviation of each variable. The values forR^2, BIC and the posterior probability of that particular model being the "true" model are shown on the bottom of table 4. The higher the posterior probability, the more relevant it is as an explanatory variable with the values under each model number being the coefficients of the individual model. The coefficients on each model can vary widely, and therein lies the averaging portion of BMA; the expected value of the mean (EV) is computed by a weighted average of each coefficient and the posterior probability when the variable enters into a model. When a variable carries a posterior probability of zero, no coefficients enter into the output, and therefore, also have an EV of zero. An EV of zero means that according BMA's averaging procedure the variable has no impact on the dependent variable.

Where this method is complimentary to Extreme Bounds Analysis is that the distribution of expected coefficients and standard deviation is given. This provides a weaker bounds test than EBA and incorporates another element to evaluate the issue. If a variable's expected value and standard deviation cover zero, it cannot be definitively concluded what direction of correlation exists. This situation does not arise very often because averaged bounds are not computed when the variable does not enter into any of the models (posterior probability of zero).

Figure 2 shows selected variables' posterior distributions. The vertical black line at zero is the posterior probability of the variable not being in a model with the curve being the coefficient's model averaged posterior density of a variable being in a model. The height of this curve is the probability of being included in a model; the heights of both the model averaged posterior density and posterior probability will equal unity. The plots without a vertical black line are those considered to be included in the "true" model 100 percent of the time according to posterior probabilities. Charting this output of the BMA posterior distribution provides slightly more information than the summary and offers another way of viewing the results.

While displaying both the summary output and posterior probabilities would be sufficient, another feature of BMA is the ability to produce an image plot as shown in figure 3. This output is easier to understand for those not familiar with the procedure. Variables are listed on the vertical axis with the rankings of the models along the horizontal axis. The variables selected are shown in their rows by being either red or blue. Red indicates a positive influence while blue indicates a negative correlation. Variables included in a particular model (1-72) are highlighted in either red or blue while those not included are not highlighted. The width of the column is proportionate to its posterior probability for each model; higher ranking models have higher posterior probabilities and wider columns. The total width of all columns is equal to the cumulative posterior probability as reported in Table 4. The image plot (figure 3) is quite influential in showing which variables are important indicators due to the abundance of color associated with these variables. The variables with high posterior probabilities –

GDP.1992, Avg.Infl, Life.Exp, RQ, nrbloan, Exp.Index, Exp.School and *HDI* – appear prolifically in the image plot.

Comparing the EBA results to BMA is a two stage process in verifying the importance of certain variables. If a variable has non-zero bounds and high posterior probabilities, it can be concluded that it is an important indicator and one without question of the correlation's sign. This dataset has four variables that are robust with high posterior probabilities; these are *Exp.Index, HDI, Exp.School* and *Life.Exp*.

Exp.Index is an index of exports with the base year set at 100. Countries that have imported more than they exported have a value less than 100, while countries with a trade surplus have values greater than 100. *Exp.Index* has a posterior probability of 100, is included in every model and has a positive correlation with an expected value of .045. As confirmed by EBA, this variable is robust in that it does not cover zero and is an extremely important indicator of growth in my sample of countries. This provides the expected result that countries with higher levels of exports will tend to grow faster.

The Human Development Index (*HDI*) is a composite statistic of life expectancy, education and income computed by the United Nations Development Programme. This variable has a posterior probability of 100.0 and carried the largest coefficient with an expected value (EV) of 26.78 and Maximum Likelihood (from EBA) of 32.443. The size of the coefficient is indicative of the weight this variable holds; the other part being due to the small size of the *HDI* variables (between 0 and 1).

One question that arises is how BMA handles multicollinearity issues; two other variables deemed important are *Exp.School* and *Life.Expect*, which are used in the computation of *HDI*. This is handled in my model because they are not perfectly collinear and the fact that multicollinearity does not reduce the predictive power of the model as a whole. Multicollinearity only affects calculations of individual variables as it may not give valid results. However, when the collinear variables are bundled together the aggregate effects estimate is reliable and adequate for this paper. Since I am not attempting to quantify the individual effects, the best way to deal with this multicollinearity issue is to leave the model as is.

Exp.School is measure of the expected years of schooling. This variable proxies for human capital as the assumption is that higher levels of education lead to a more productive workforce and higher rates of growth. Highly important, the posterior probability is 79.5 with an expected value of -0.448 and was found to be robust by EBA. This negative coefficient lies in contrast to our expected result. The most logical explanation is in regards to the collinear aspects as described above. The same negative relationship is observed between *Life.Expect* and growth. *Life.Expect* is the life expectancy at birth in number of years. It would be expected that this variable would have a positive effect on growth due to this variable being a component of human capital. A healthier society should be more productive over the long run as there is less time spent away from work because of illness and it does not take another member of the family away from productive activities to care for them. The posterior probability of being included in the true model is 79.6 with an EV of -0.15 and a robust Maximum Likelihood -0.1995. This negative coefficient is also indicative of the multicollinearity present between *Life.Expect* and *HDI*.

Because *Life.Expect, Exp.School* and *HDI* are highly collinear it becomes an issue to take conclusions on these variables individually. The estimations provided here show that education, health and income are important determinants of whether a country will grow, but it would be erroneous to prescribe reduced education for a country. Bundling these three variables together gives a strongly positive correlation and attempts should be made to increase each of the individual factors. Quantifying the impact is outside the scope of this paper and is an area that deserves more attention than I am able to provide.

GDP.1992 captures the absolute level of GDP in 1992 and exhibits a posterior probability of being included in the "true" model of 80.7. This variable captures the size of the economy, and since it does not measure the number of people, does not incorporate relative richness. With an expected value of 1.166e-11 it has an extremely small coefficient; this is due to the fact that GDP is measured in billions. With a standard deviation of 1.018e-11, the majority of this variables distribution is robust; it is only in one tail that it becomes negative. Because of the small size of the coefficient, EBA was unable to give bounds on this variable, but when combining the methodologies, absolute size of GDP is one of the more important determinants of per capita GDP growth.

GE and *Rural.Pop* are special cases of robust values as shown by EBA, but not important as shown by BMA. This is similar to saying that a variable is statistically significant but not important. Just knowing that a particular variable is robust does not necessarily mean that it is important, as shown for these two variables. Using both EBA and BMA provides valuable insight into the true impact – variables need to be able to pass both methodologies in order to be certain of their impacts; anything less opens the door for interpretation.

Avg.Infl and *nrbloan* were fragile, but deemed important by the BMA methodology. Inflation's (*Avg.Infl*) impact on growth has been well documented in the literature. My results show that it is important (posterior probability equal to 65.7) and most likely has a positive correlation (EV of .018 and a SD of .015), meaning that higher levels of inflation indicate higher levels of growth[2]. Non-resident bank loans (*nrbloan*) was also fragile, carrying a negative coefficient (-0.482), yet was included 65.7 percent of the narrowed models. This result implies that higher levels of offshore bank loans to GDP correlate with lower levels of per capita growth. These two variables appear important, but offer lower levels of certainty because the bounds cover zero.

RQ, regulatory quality index computed by the World Bank Governance Indicators, has fragile extreme bounds, but entered into the BMA output as reasonably important with a posterior probability of 30.6. The expected value coefficient for *RQ* is -0.548, yet has a standard deviation of 0.9. This places a significant portion of the coefficient distribution on the other side of zero, effectively questioning how robust this variable is. The less stringent checks for robustness as provided by BMA are able to question, and probably throw out, this variable as an important determinant of growth. Rule of Law, *RL*, was another variable that did not past the weaker robustness check in BMA, but is of less concern because it does barely registers due to its posterior probability of 5.7.

The most interesting thing to note, and objective of this paper, is that the variables *Years.Open* and *Stock.Dummy* show a posterior probability of being included at exactly zero – meaning that neither of these variables could possibly be included in the "true" model. This means that both measures of stock markets do not display any explanatory

[2] This is an interesting result as this relationship is surely not linear, nor always positive. One explanation behind this result could be that it is an artifact of the time period examined where there was a high level of relative stability with only three outliers – Angola, Democratic Republic of the Congo and Liberia experiencing extremely high inflation (above 200 percent annually). Angola was actually one of the faster growing in the sample with an average growth rate of 14.1% and average inflation of 222.3%.

power, and therefore, cannot be concluded to be an important indicator of growth. The reliability of this methodology in predicting growth is rather high, reporting R^2 in excess of 0.5 on the individual models. This fit is in keeping with the much of the results in the existing growth literature.

Conclusion

In every area of economics there has been substantial debate among economists who have been able to "prove" their theories using various econometric estimation procedures. The main thrust of this paper is to provide an analysis as objective as possible in order to shed light on what the true relationship is between opening a stock market and growth. Using Extreme Bounds Analysis I have been able to sufficiently show that a stock market dummy and number of years open variable are fragile and not robust. Bayesian Model Averaging has the ability to objectively look at data and determine which variables have the most explanatory power in the true model. Both the stock market variables exhibited posterior probabilities of being included in the true model of 0.0, showing that the simple act of opening a stock market is not indicative of growth in this sample of countries.

The results from this study provide significant evidence that opening a formal stock market has little influence on growth. While there are certainly cases where stock markets are a boon to an economy, there are also instances where opening a stock market is detrimental or has no effect on growth. Individual characteristics of the instances where stock markets deliver societal benefits are likely the most important determinant of whether a stock market will influence growth. Further research is needed to evaluate the conditions where opening a stock market is beneficial rather than "one size fits all" policy prescriptions of increasing financial development.

Tables and Figures

Figure 1: Stock Market Openings over Time

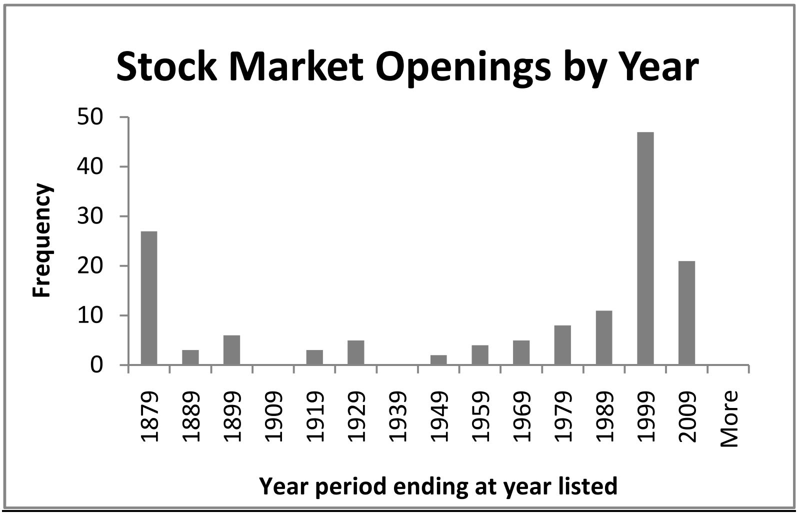


Table 1: Countries in Sample

Country	Year Open	Country	Year Open	Country	Year Open
Albania	1996	Fiji	N/A	Namibia	1992
Algeria	1999	Gabon	N/A	Nepal	1993
Angola	N/A	Gambia, The	N/A	Nicaragua	1990
Armenia	N/A	Georgia	1999	Niger	1998
Bahrain	1989	Ghana	1990	Nigeria	1961
Belarus	1998	Guinea	N/A	Oman*	1989
Belize	N/A	Guinea-Bissau	1998	Papua New Guinea	1999
Benin	1998	Haiti	N/A	Romania	1995
Bhutan*	1993	Honduras	1990	Russian Federation	1992
Bolivia	1990	Iceland	1986	Samoa*	N/A
Botswana	1989	Iran, Islamic Rep.	1968	Saudi Arabia*	1985
Brunei Darussalam	N/A	Jamaica	1969	Senegal	1998
Burkina Faso	1998	Jordan	1999	Seychelles*	N/A
Burundi	N/A	Kazakhstan	1993	Slovak Republic	1991
Central African	N/A	Kiribati*	N/A	Solomon Islands	N/A
Republic	N/A	Kyrgyz Republic	1995	Sudan	1995
Chad	1990	Lao PDR	N/A	Suriname	1994
China	N/A	Lesotho	N/A	Swaziland	1990
Comoros	N/A	Liberia	N/A	Tajikistan	N/A
Congo, Dem. Rep.	N/A	Lithuania	1993	Tanzania	1996
Congo, Rep.	1976	Macedonia, FYR	1995	Thailand	1975
Costa Rica	1998	Madagascar	N/A	Togo	1998
Cote d'Ivoire	1991	Malawi	1996	Tonga	N/A
Croatia	1996	Mali	1998	Trinidad and	1981
Cyprus	N/A	Malta	1992	Tobago	1969
Djibouti	N/A	Marshall Islands*	N/A	Tunisia	N/A
Dominican Republic	1970	Mauritania	N/A	Turkmenistan*	1997
Ecuador	1997	Mauritius	1989	Uganda	1991
Egypt, Arab Rep.	1965	Micronesia, Fed.	N/A	Uzbekistan*	N/A
El Salvador	N/A	Sts.*	1994	Vanuatu*	N/A
Equatorial Guinea	N/A	Moldova	1991	Yemen, Rep.	1993
Eritrea*	N/A	Mongolia*	1999	Zambia	
Ethiopia		Mozambique			

*Countries not included in model due to insufficient data: total countries observed is 82.

Table 2: List of Variables			
Variable Name	**Description**	**Mean**	**Std Dev**
Avg Growth	Dependent variable – average growth of per capita GDP from 2002-2007, expressed as percentage. 2000 constant dollars (World Bank)	4.305	4.104
Years.Open	Number of years stock market has been open. Equal to 0 if no stock market	12.93	12.3
Stock.Dummy	Dummy equal to 1 if country has stock market, 0 otherwise	n/a	n/a
Low.Mid	Dummy variable equal to 1 if lower middle quartile country, 0 otherwise (as defined by the World Bank)	n/a	n/a
Upper.Mid	Dummy variable equal to 1 if upper middle quartile country, 0 otherwise (as defined by the World Bank)	n/a	n/a
Low.Income	Dummy variable equal to 1 if lowest income quartile country, 0 otherwise (as defined by the World Bank)	n/a	n/a
Per.Cap.GDP	Per capita GDP in 1992, 2000 constant dollars (World Bank)	1946.3	3785.79
GDP.1992	Absolute level of GDP in 1992, 2000 constant dollars (World Bank)	19.2 bil	70.54 bil
Avg.Infl	Average Inflation for period 1997-2002, expressed as percentage (World Bank)	24.54	79.25
Tax.Rate	Total amount of taxes payable by businesses after accounting for deductions and exemptions as a percentage of profits, 2007 – chosen for completeness of data. (World Bank)	57.36	54.76
FDI.Flow	Absolute value of foreign direct investment flows (UNCTAD)	1082.62	5415.99
Paved.Road	Percent of roads in country that are paved, average from 1995 - 2005 (World Bank)	37.99	29.93
Adj.Savings	Adjusted gross savings – difference between Gross National Income and public and private consumption, 2002 (World Bank)	16.55	14.34
Ag.Land	Percent of land area dedicated to agricultural produce, 2002 (World Bank)	41.53	22.45
Ag.Value.Added	Total amount of agricultural value added per worker, constant 2000 dollar (World Bank)	3082.25	9314.6
Life.Expect	Life Expectancy at birth in years, 2002 (UNESCO)	62	10.46
Pop.Growth	Average population growth 1997-2002 expressed as a percentage (UNESCO)	1.64	1.21
Cell.Phone	Number of cell phones per 100 people, 2002 (World Bank)	12.44	18.02
Curr.Acct	Current account balance, BOP, 2002 (World Bank)	0.62	5.23
Rural.Pop	Rural Population as percent of total population, 2002 (World Bank)	54.87	20.6
CC	Control and Corruption Index, 2002 (World Governance Indicators, World Bank)	-0.48	0.67
RL	Rule of Law Index, 2002 (World Governance Indicators, World Bank)	-0.5	0.73
RQ	Regulatory Quality, 2002 (World Governance Indicators, World Bank)	-0.39	0.74
GE	Government Effectiveness, 2002 (World Governance Indicators, World Bank)	-0.45	0.72
VA	Voice and Accountability, 2002 (World Governance Indicators, World Bank)	-0.41	0.79
Nrbloan	Offshore bank loans relative to GDP, 2002 (BIS Statistical Index via Demirguc-Kunt and Levine, 2009)	0.49	2.99
Exp.Index	Export index with 2000 as base year set at 100, 2000 (UNCTAD)	107.95	27.92
Exp.School	Expected years of schooling at birth (UNDP Human Development Index Report)	10.66	3.05
Fertility	Total fertility rate (births per woman), 2002 (UNESCO)	3.8	1.78
HDI	Human Development Index, 2000 (UNDP Human Development Index Report)	0.55	0.17
Dbacba	Deposit money bank assets / (deposit money + central bank) assets, 2002 (IMF International financial statistics via Demirguc-Kunt and Levine, 2009)	0.75	0.24
Bcbd	Private credit by deposit money banks as a share of demand, time and saving deposits in deposit money banks, 2002 (IMF International financial statistics via Demirguc-Kunt and Levine, 2009)	0.81	0.49
offdep	Offshore bank deposits relative to domestic deposits, 2002 (BIS Statistical Index via Demirguc-Kunt and Levine, 2009)	3.64	28.75

Table 3: EBA Results

Variable Name	**Maximum Likelihood Point Estimate**	**Model 1 Low**		**Model 2 Low**		**Model 3 Low**	
Constant (Int)	2.1857	-29.308	28.4340	-7.6931	9.3720	-38.4143	44.3200
Years.Open	-0.0125	-0.099	0.0780	-0.0692	0.0728	-0.1827	0.1961
Stock.Dummy	-0.6104	-2.467	1.8001	-1.8219	0.5597	-3.8707	3.6396
Low.Mid	-3.0917						
Upper.Mid	-2.6088						
Low.Income	-2.5896						
Per.Cap.GDP	0.0000						
GDP.1992[3]	0.0000						
Avg.Infl	0.0283						
Tax.Rate	-0.0038						
FDI.Flow	0.0000	-0.00051	0.00038				
Paved.Road	0.0086			-0.0074	0.0408		
Adj.Savings	-0.0450	-0.08878	0.08054				
Ag.Land	0.0135						
Ag.Value.Added	-0.0001						
Life.Expect	**-0.1995**			**-0.0729**	**-0.3587**		
Pop.Growth	0.6186			-0.6322	1.1535		
Cell.Phone	-0.0296			-0.1075	0.0695		
Curr.Acct	-0.1970	-0.94909	0.13024	-0.7776	0.5806		
Rural.Pop	**0.0341**			**0.0011**	**0.0654**		
CC	-0.4090			-2.1138	1.7308		
RL	-0.8849	-5.9948	4.412	-2.4408	0.2125		
RQ	-0.8106			-2.9101	0.0887		
GE*	**1.9580**			**0.1727**	**3.9121**		
VA	-0.5770			-1.4836	0.6655		
Nrbloan	-0.6539	-3.8377	3.8902	-3.4009	2.7470		
Exp.Index	**0.0520**	**0.01331**	**0.0844**	**0.0267**	**0.0680**		
Exp.School	**-0.5328**			**-0.9953**	**-0.1850**		
Fertility	-0.7244			-1.1120	0.4108		
HDI	**32.4433**			**11.7857**	**54.1040**		
Dbacba	-2.1391	-5.2162	3.3638				
Bcbd	1.1509	-0.7079	2.6319				
offdep	-0.0106	-0.4708	0.0364				

Bolded values are robust, not covering zero.

[3] Rounding to only four decimal places generates a 0.0000 Maximum Likelihood estimate. The current EBA code is unable to give the exact bounds, but appears as though they cover zero.

Table 4: BMA Summary Output

76 models were selected
Best 5 models (cumulative posterior probability = 0.1708):

	p!=0	EV	SD	model 1	model 2	model 3	model 4	model 5
Intercept	100.0	-2.011e+00	4.276e+00	3.753e-01	2.065e+00	-4.257e-01	-6.722e+00	-8.562e-01
Years.Open	0.0	0.000e+00	0.000e+00	.	.	.	.	.
Stock.Dummy	0.0	0.000e+00	0.000e+00	.	.	.	.	.
Low.Mid	0.3	-2.346e-03	6.049e-02	.	.	.	.	.
Upper.Mid	0.0	0.000e+00	0.000e+00	.	.	.	.	.
Low.Income	0.4	6.391e-03	1.270e-01	.	.	.	.	.
per.cap.GDP	14.8	-3.390e-05	9.237e-05	.	.	-2.340e-04	.	.
GDP.1992	80.7	1.166e-11	1.018e-11	1.197e-11	1.160e-11	1.210e-11	1.234e-11	1.250e-11
Avg.Infl	65.7	1.827e-02	1.518e-02	.	.	2.782e-02	3.246e-02	2.972e-02
Tax.Rate	0.0	0.000e+00	0.000e+00	.	.	.	.	.
Paved.road	15.1	3.971e-03	1.109e-02	.	2.703e-02	.	.	.
Adj.Savings	19.2	-1.069e-02	2.551e-02	.	.	.	.	.
Ag.Land	0.0	0.000e+00	0.000e+00	.	.	.	.	.
Ag.Value.Added	28.7	-2.502e-05	4.525e-05	.	.	.	-9.341e-05	-8.525e-05
Life.Expect	79.6	-1.502e-01	1.038e-01	-2.172e-01	-2.351e-01	-1.567e-01	.	-1.420e-01
Pop.Growth	0.0	0.000e+00	0.000e+00	.	.	.	.	.
Cell.Phone	4.9	-2.591e-03	1.292e-02	.	.	.	.	.
Curr.Acct	10.4	-2.244e-02	1.051e-01	.	.	.	.	.
Rural.Pop	6.7	2.507e-03	1.106e-02	.	.	.	.	.
CC	1.0	-1.756e-02	1.870e-01	.	.	.	.	.
RL	5.7	-9.363e-02	4.145e-01	.	.	.	.	.
RQ	30.6	-5.479e-01	9.006e-01	-1.860e+00	-1.775e+00	.	.	.
GE	0.0	0.000e+00	0.000e+00	.	.	.	.	.
VA	24.9	-2.889e-01	5.734e-01	.	.	.	.	.
nrbloan	65.7	-4.822e-01	4.030e-01	.	.	-6.881e-01	-9.174e-01	-7.436e-01
Exp.Index	100.0	4.530e-02	1.306e-02	4.348e-02	4.098e-02	4.190e-02	4.650e-02	4.416e-02
Exp.School	79.5	-4.475e-01	3.118e-01	-6.098e-01	-6.549e-01	-5.081e-01	.	-5.020e-01
Fertility	0.0	0.000e+00	0.000e+00	.	.	.	.	.
HDI	100.0	2.678e+01	9.653e+00	3.313e+01	3.165e+01	2.763e+01	1.037e+01	2.580e+01
dbacba	0.0	0.000e+00	0.000e+00	.	.	.	.	.
bcbd	2.0	1.840e-02	1.631e-01	.	.	.	.	.
nVar				6	7	8	6	8
r2				0.459	0.482	0.506	0.449	0.506
BIC				-2.392e+01	-2.303e+01	-2.251e+01	-2.250e+01	-2.250e+01
post prob				0.055	0.035	0.027	0.027	0.027

>

Figure 2: Selected Posterior Distributions

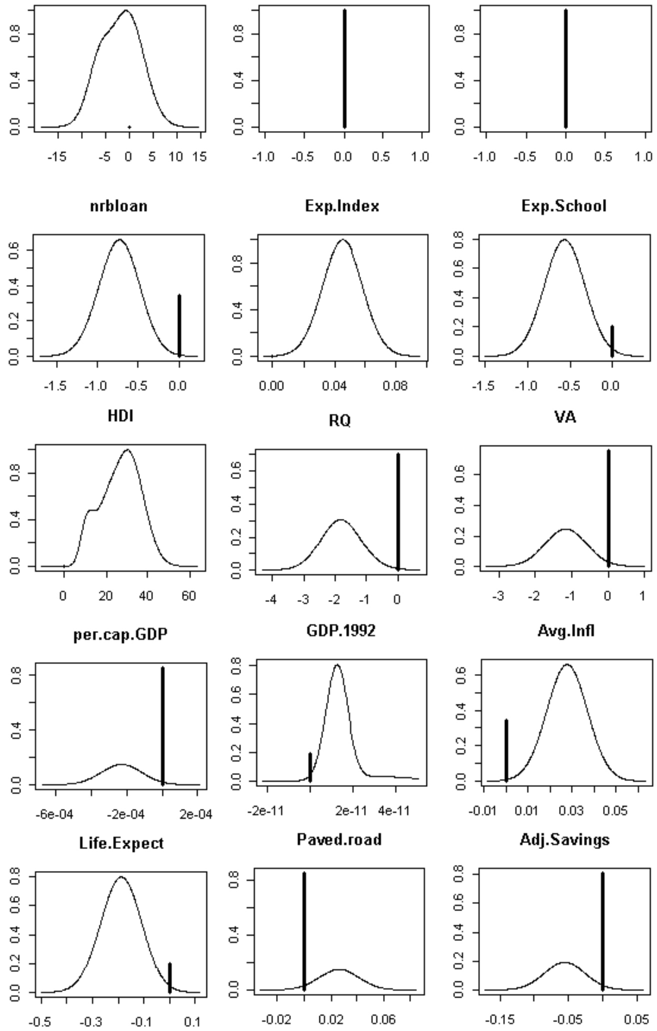
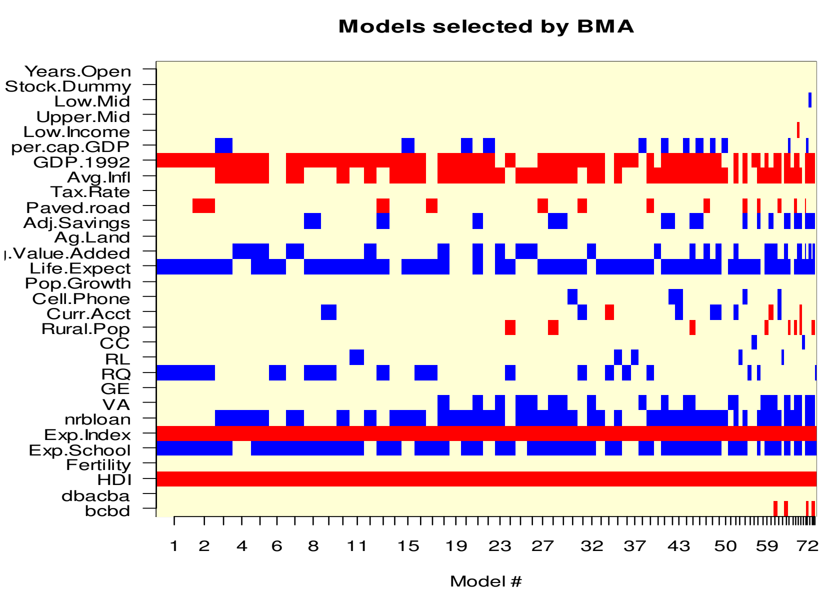


Figure 3: BMA Image Plot



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