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Financial Development and Economic Growth an Advanced Econometric Modeling Approach

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Abstract *Financial development is essential for economic growth for all economies. In the current study, we examine the importance of financial development on economic growth for different countries using advanced econometric techniques of model selection. We use Autometrics, Elastic Net, and Extreme Bound Analysis to retain the variables that affect the economic growth by using the data (1980-2019) on 32 countries from different regions. We used an advanced approach (retention frequency) to investigate the relationship between financial development and economic growth. The results show that financial development is a significant retention frequency in the case of Asian, European, and American countries directly and indirectly. For in-sample forecasting, we use root mean square error (RMSE) and mean square prediction error (MSPE). Extreme Bound Analysis presents a superior predictive performance in terms of the lowest RMSE and MPSE that are 1.03 and 0.05, respectively.*

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Introduction

Economic growth is an important pillar for the well-being of billions of people in all economies, whether it is developed or developing. Current advancements in technology and in industrialization create a gap between the per capita income of the people of poor countries and people of developed countries. There are many theoretical models of economic growth that offer possible explanations for this growth, and each model has a separate set of regressors. If we take all theories and consider all variables, there will be a lot of variables; then, it will create the problem of variable selection because every theory tells about a different set of variables. Modeling economic growth is a typical case; there are many theories and models which describe the mechanism of current economic activities that can influence

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future economic growth and how it can be sustained. Economists concluded from different research that economic growth is necessary for the wellbeing of people. Theories of economic growth have evolved from time to time in terms of the evolved period and the dynamics of the economy. The importance of financial development is emphasized by many theories of economic growth. In the process of economic growth, financial development has a very important role whether the economy is developed or developing. If financial development promotes economic growth or not, there are two main schools of thought. According to first thought: financial development has a positive impact on economic growth (Goldsmith, 1969), (Levine, 19970), (McKinnon, 1973), and the second one says that financial development is not very important to boost economic growth (Lucas, 1988). But many current studies support the first school of thought, which claims that financial development has a positive impact on economic growth (Beck et al., 2000). For verification of the relationship between financial development and economic growth, it is necessary to develop a correctly specified model. For a correctly specified model, the researcher can use the model selection procedure.

Model selection is a core element of empirical research in both the presence and absence of any seeded theory. The correct specification is a major concern of many sciences, and there have been many studies on model selection scattered in the communities of statistics, machine learning, economics, etc. The continuous and evolving research from the empiricists has resulted in a diverse set of model selection procedures. The search for the most parsimonious model has become the new maxim of many applied researchers. The reality of any (economic growth) phenomenon is essentially a complex event, so the true model is usually unknown, and model selection methods can only approximate the reality (model selection methods approximate true variables, approximate functional form, approximate structural breaks, etc.) with observed data. Thus, model selection may take many forms; finding the variables carrying the best possible information about the variable of interest i.e., the variable specification, identifying the functional form of the model, finding the order for the autoregressive process i.e., lag selection, to discover the change points in the models of time series i.e. identification of breaks, and finding the best estimates of parameters. In our current study, our focus is on variable selection in a model, which is the most important part of model selection.

A variety of techniques have been developed for each respective objective; a researcher may take in model selection. The variables selection Is one of the most crucial steps of econometric modeling, and it is still a wide-open problem for all experimental research fields. In statistical model building, it is a crucial question which variables to be included in the model given a large number of variables. In particular, the identification of the technique of having better accuracy in the selection of true underlying variables for the model remained an open research question.

There are a variety of model selection procedures in variable selection as well, so it becomes significant to find an appropriate criterion to evaluate the performance under different circumstances. Furthermore, the presence of a large number of potential candidate variables, often called the curse of dimensionality, makes the task more difficult to retain the most relevant variables. The presence of correlation amongst the variables and the existence of outliers are the major challenges to work on for any valid inference and predictions.

The different mainstream classes for variables selection criteria as well as for model selection includes the variables selection procedures based on ordinary least square residuals; R square (R2), Adjusted R squared and finite prediction error (FPE), etc. Variables selection procedures are based on information criteria; like the first criterion is Akaike Information Criterion (AIC), the second criterion based on information theory is Bayesian Information Criterion (BIC), next is Extended Bayesian Information Criterion, Mallow's Cp, Likelihood Ratio test (LR), Hannan and Quinn Criterion (HQC), and Bridge Criterion (BC). Variables selection criteria based on Stepwise Regression, including forwarding Stepwise Regression, Backward Stepwise Regression, and Bi-directional Stepwise Regression. Variables selection procedures based on regularized methodology; the first procedure is Ridge Regression, the second one is Least Absolute Shrinkage, and Selection Operator (LASSO), Elastic net, etc. Automatic procedures for variable selection; PcGets and Autometrics. Variables selection procedures based on consistency of parameters; Leamer's Extreme Bound Analysis (EBA) and Sala-i-Martin Extreme Bound Analysis.

The choice of the variable selection procedure is the persistent unresolved issue; because the reality (economic growth models) is complex, simultaneously dynamic, non-synchronous, and involves high-dimensional data structure. Social structures may also influence as they also change from time to time, thus adding to the complexity of model making process. To coup, these challenges, over time, advanced and updated variable selection procedures are emerging (Autometrics Elastic net). In the current study, we the latest techniques of model selection to model economic growth. Our main objective in the current study is: whether financial development plays an important role in the economy or not. To achieve this goal, we take data from various countries to form different regions (Asia, Europe, America, and Africa) and apply the different advanced econometrics techniques of model selection. We use an advanced method to check the significance of variables, for this, we calculate the relative frequency of different variables in our model. If a variable is significant, it is retained otherwise dropped. It is expected that the retention frequency of financial development will be higher than other variables.

Literature and Theoretical Framework

There are many theories of economic growth from which some popular theories are following. The neoclassical model Harrod-Domar says that saving is an important factor of economic growth. Some growth theories are highlighted too much for the increment of domestic savings; therefore, they claim that investment drives further growth. This has been a key growth factor. $Y = f(K)$ (2.1)

Y is output, K is capital

These theories take the savings as capital, and capital further boosts economic growth.

A neoclassical theory of economics is the theory of Robert Solow, and he got Nobel Prize because of this theory. The main theme of Robert Solow's theory of economic theory is that more capital and advanced technology boost economic growth.

In the aggregate production function, the single good is created by the two elements labor (L) and capital (K). $Y(t) = k(t)^{\alpha}(A(t)L(t))^{1-\alpha}$ (2.2)

In equation (2.2) t is for time and $0<\alpha<1$ = capital elasticity for output, Y(t) =production, A= labor augmented technology and AL= effective labor.

Romer presented the endogenous economic growth theory highlighting the technology, which is the result of a researcher who responds to economic incentives. Many factors can affect the efforts of the researcher, like new tax policy from the state, research and development funds, education, etc. The fundamental contribution of Romer is that a better understanding of economic ideas and how the new ideas lead to economic growth. Romer was the main basic founder of endogenous growth theory.$Y_t = AK_t$ (2.3) And $K_t = Sy_t - \Delta k_t$ (2.4)

Here "A" is a productivity parameter, and it is the constant rate for investment and exogenous. K is the physical capital, and in Romer (1986), K was introduced as for knowledge, and in Lucas (1988), this was used for human capital.

In many studies, the relationship between economic growth and financial development has been analyzed. King and Levine (1993a) researched by taking the data from 80 countries and sample is 1960-1989 and found that financial development boosts the economic growth. Zingales (1996) determined that financial development has a significant part in the growth of an economy. Khan and Senhadji (2000) researched by taking the data of 159 countries and used the sample 1960-1999 and found a strong relationship between these variables. Another research is done by Beck et.al. (2000), taking the different variables like real economic GDP per capita total factor productivity growth. They used the panel data for 1960-1995 and applied the GMM method for estimation. Their findings were that better the financial sector boost the factor productivity, which further boosts the economic growth. Christopoulos and Tsionas (2004), Zhong et al. (2012) find a strong relationship between financial development and economic growth. Herwartz and Walle (2014) used the data of 73 countries and sample size 1975-2011 and found that financial development has a positive effect on economic growth. Arvin, Bahmani, Hall, and Norman (2017) used several proxies for financial development by using the of ASEAN countries, and the sample size is 1991-2011 and found cointegration among per capita income growth, bond market development, banking sector development, insurance market development.

A researcher has a large number of candidate variables that can potentially explain the dependent variable. The variable selection procedure selects the best subset from candidate variables which are assumed to provide the most appropriate explanation for the dependent variable. The studies in literature used a traditional method to check the significance (5% level or 10% level) of variables, and also had been used to check the significance of financial development on economic growth.

But no one study has calculated the frequency for the significance of financial development of different countries; frequency means how many times the financial development is significant in the total number of countries under consideration. We use a total of 32 countries by groups from all over the regions and from the specific regions like Asia we take 14 countries, from Europe we take 8 countries, from America and Africa we take 5 countries. The analysis of our current study covers all the world and we take important countries.

Methodology and Data

Based on different economic growth

models explained earlier we make a general model in which all variables are included. The general model for economic growth can be defined as,

Functional form Economic growth

$Y = f(FD, FDI, DS, CF, INF, LB, FA, REM, HC, TO)$ (3.1)

Where Y=Economic growth, FD=Financial development, FDI=Foreign direct investment, DS=Domestic investment, CF=Capital formation, INF=Inflation, LB=Labour force, FA=Foreign assets, REM=Remittances, HC=Human Capital, TO=Trade openness

Econometric form of the above model

$$Y = \beta_0 + \beta_1(FD) + \beta_2(FDI) + \beta_3(DS) + \beta_4(CF) + \beta_5(INF) + \beta_6(LB) + \beta_7(FA) + \beta_8(REM) + \beta_9(HC) + \beta_{10}(TO) + \varepsilon \quad (3.2)$$

These are potential determinants of economic growth. We put all determinants into one equation called the general unrestricted model (GUM), keeping in mind the properties of GUM. We use the latest three model selection procedures: one is Elastic Net, and it is from the family of regularized regressions models, second is Autometrics, its latest form of general to specific methodology and third is Extreme Bound Analysis this from the family of the model selection procedure which selects the model by using consistency of parameters methodology. A brief explanation of these three model selection procedures is as follows.

Elastic Net

An elastic net is an advanced form of regularized type regression, it combines the two penalties of Ridge regression penalty and LASSO regression penalty. Although LASSO has shown a lot of success in many ways, it has its limitations. Consider the following three scenarios. Here "p" is a number of variables, and "n" is a number of observations.

In the case of p>n, due to the nature of the convection correction problem, LASSO mostly chooses new variables. (b) If there is a group of variables that are closely related by a pair, then LASSO selects only one of the groups and does not care which one is chosen. (c) For the normal situation, when n>p and there is a high correlation between independent variables, then results of LASSO prediction are dominated by ridge regression (Tibshirani, 1996). Scenarios (a) and (b) in some cases, make LASSO the method of choosing the irrelevant variable. As for as predictive performance is concerned, scenario (c) is no less of a regression issue. Therefore, it is possible to further strengthen LASSO predictive power. Simulation results and real data results demonstrate that Elastic Net often outperforms LASSO concerning forecasting accuracy.

Automatic Model Selection Procedures (General to specific modeling)

The two methods (forward stepwise and backward stepwise) are recognized as specific-to-general and general-to-specific (GETS). The mixture of these two methods is known as Autometrics (Doornik & Hendry, 2007) (Doornik, 2009). Autometrics is a new and advanced algorithm for automatic model selection tilting more towards a general-to-specific framework (also known as the 'Hendry' or 'LSE' methodology). The algorithm is presented within a likelihood framework, allowing for applications beyond regression models.

Autometrics is an extension of GETS, which incorporates further steps in finding the final model. Autometrics apply the tree search method, which takes up space to overall the model. However,

finding all possible models is mathematically ineffective. So many strategies, such as pruning, bunching, and chopping, are implemented to remove the irrelevant paths and make the process fast.

In general, to specific modeling, the general unrestricted model (GUM) has great importance. Using the general to specific modeling, we start with the General Unrestricted Model (GUM) and then check whether the GUM captures the essential features of the data or not, then eliminate insignificant regressors one by one.

Main modern improvements in the automatic model selection are multi-path searches, encompassing choices, impulse saturation, and non-linearity. Autometrics is a powerful model-selection procedure and has null rejection frequency close to the nominal level of significance, and power is close to starting with Local Data Generating Process (LDGP) and has unbiased estimates for standard errors.

Extreme Bound Analysis (EBA)

In extreme bound analysis, different groups of doubtful variables are selected, and the coefficient of the core variable is estimated. If the coefficient of the core variable is beyond these extreme bounds, then this variable is not included in the final model. If the coefficient remains within these limits, then it will be retained in the final model. This occurs when the core and doubtful variables are independent. EBA was presented by Edward E. (Leamer 1983) and then enhanced by Clive Granger and Harald Uhlig in 1990.

For any variable v, the two bounds are clear as the minimum and maximum estimates of $\widehat{B}_j \pm \tau\widehat{\sigma}_j$ for M number of regressions, and for the confidence level τ is the critical value and 1.96 on the confidence level of 95 percent. If two bounds have the same sign, the variable will be robust otherwise fragile. The range of bounds shows that there is no difference in the coefficient estimate $\widehat{B}_j$. Intuitively, Leamer's version of EBA searches several models for the lowest to highest values at some significance level.

Leamer's EBA is a high-demand criterion for robustness, a variable that will be considered critical even if the extreme limits are in all approximate models except for one symbol. In comeback to the professed inflexibility of EBA that is presented by Leamer, a substitute method by Sala-i-Martin (1997) includes the whole distribution of coefficients, not just extreme bounds. In Sala-i-Martin EBA the binary label robust or fragile is not given to a variable, but it assigns such a confidence level for robustness to the variable under consideration.

We have taken various countries from Asian, European, American, and African countries. We apply all model selection procedures on data of all countries and calculate the frequencies of retained variables, the root means square error (RMSE) and mean square prediction error (MSPE) is used for in-sample forecasting.

Table 1. Selected Countries

S. No	Abr	Country Name	S. No	Abr	Country Name
Asian Countries					
1	PAK	Pakistan	8	HOK	Hong Kong
2	IND	India	9	JAP	Japan
3	BAN	Bangladesh	10	TUR	Turkey
4	SRI	Sri Lanka	11	KUW	Kuwait

S. No	Abr	Country Name	S. No	Abr	Country Name
Asian Countries					
5	CHI	China	12	OMO	Oman
6	RUS	Russia	13	SUA	Saudi Arabia
7	KOR	Korea	14	UAE	United Arab Emirate
European Countries					
15	GER	Germany	19	SPI	Spin
16	UK	United Kingdom	20	SWI	Switzerland,
17	FRA	France	21	AUS	Austria
18	IT	Italy	22	SWE	Sweden
American Countries					
23	US	United States	26	CAN	Canada
24	BRA	Brazil	27	PER	Peru
25	MEX	Mexico			
African Countries					
28	EGY	Egypt	31	SA	South Africa
29	NIG	Nigeria	32	MOR	Morocco
30	ETH	Ethiopia			

Abr=Abbreviation

The frequency of retained variables for the model of Economic Growth

The frequency for total countries is calculated as

Let us calculate the relative frequency of a variable X.

The frequency of retention of the variable is calculated in the following way. Let X denote a variable from the general model for which we are calculating the relative frequency.

$$Retention\ Frequency\ (X) = \left(\frac{n(X)}{N}\right) \times 100 \quad (3.4)$$

Here n(x) is the number of times a variable is retained by a variables selection procedure, and N is the total number of countries. 50% means a variable is retained from half of the countries.

Data

The data is taken from the world development indicator (WDI) 1980-2019.

Results and Discussion

In the first column of Table 3.2, the countries' acronyms are written and in the second different criteria of variables selection is written in the third column root mean square error (RMSE), and in the fourth column, mean square prediction error (MSPE) is written. All other columns show the potential determents of Economic Growth.

✓is for the determinants that are retained by different variable selection criteria. By analyzing the whole table 3.2 the E-Net retains more variables for all regions than other variables selection procedures.

Table 2. Variables retained for the model of Economic Growth

		RMSE	MSP	Financial Development	FDI	Savings	Capital Formation	Inflation	Labor force	Foreign Assets	Remittances	Human Capital	Trade Openness
PAK	E-Net	1.84	14.4	✓	✓	✓	✓	✓		✓	✓	✓	

		RMSE	MSP	Financial Development	FDI	Savings	Capital Formation	Inflation	Labor force	Foreign Assets	Remittances	Human Capital	Trade Openness
IND	Auto	1.80	0.83				✓	✓			✓		
	EBA	1.81	0.78	✓			✓	✓			✓		
	E-Net	1.76	3.55	✓			✓	✓		✓			✓
BAN	Auto	2.09	6.44	✓		✓							✓
	EBA	3.78	8.99	✓				✓				✓	
	E-Net	1.08	1.67	✓	✓	✓	✓			✓		✓	✓
SRI	Auto	1.90	1.30						✓				✓
	EBA	1.03	0.05	✓		✓	✓			✓			
	E-Net	1.87	5.20				✓			✓			
CHI	Auto	1.89	27.09				✓			✓			
	EBA	1.80	3.17		✓		✓			✓			
	E-Net	2.41	13.48	✓	✓	✓	✓	✓		✓		✓	✓
RUS	Auto	2.39	2.22		✓				✓	✓			
	EBA	3.20	10.90	✓	✓			✓		✓			
	E-Net	4.55	7.36	✓	✓			✓				✓	
KOR	Auto	3.77	8.99	✓		✓						✓	✓
	EBA	4.97	10.76	✓			✓			✓			
	E-Net	3.62	15.0	✓	✓			✓		✓			✓
HOK	Auto	3.94	5.96				✓	✓		✓			
	EBA	4.05	13.33	✓				✓		✓			✓
	E-Net	3.22	5.60	✓		✓			✓				✓
JAP	Auto	5.37	5.26	✓						✓		✓	
	EBA	7.88	7.46		✓		✓			✓			✓
	E-Net	1.65	1.23	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TUR	Auto	1.69	0.34	✓			✓						
	EBA	1.70	0.76	✓	✓	✓				✓			
	E-Net	3.46	0.28	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KUW	Auto	3.75	1.67		✓		✓	✓		✓			
	EBA	4.11	1.93						✓	✓		✓	
	E-Net	5.64	20.22	✓									✓
OMN	Auto	5.83	2.91	✓								✓	
	EBA	7.09	14.63	✓						✓			
	E-Net	4.38	14.41	✓		✓	✓	✓	✓		✓	✓	✓
SAU	Auto	4.16	5.22	✓					✓				✓
	EBA	4.62	3.80	✓							✓	✓	
	E-Net	6.91	18.39	✓	✓		✓	✓		✓			
UAE	Auto	6.69	14.27				✓			✓		✓	
	EBA	6.86	1.04		✓		✓	✓					
	E-Net	4.33	6.77	✓	✓			✓					✓
GER	Auto	5.34	8.55				✓	✓		✓			✓
	EBA	8.44	10.44	✓		✓				✓			
	E-Net	3.22	6.44			✓	✓	✓					✓
UK	Auto	4.33	3.55		✓		✓			✓		✓	
	EBA	5.67	6.23	✓				✓					✓
	E-Net	1.30	0.32	✓	✓	✓	✓	✓				✓	

		RMSE	MSP	Financial Development	FDI	Savings	Capital Formation	Inflation	Labor force	Foreign Assets	Remittances	Human Capital	Trade Openness
FRA	Auto	1.25	0.15	✓			✓	✓					
	EBA	1.44	0.26	✓		✓		✓					
	E-Net	1.05	0.73	✓		✓	✓	✓		✓		✓	✓
IT	Auto	1.21	0.21			✓	✓			✓		✓	
	EBA	1.18	0.08			✓						✓	
	E-Net	1.48	7.22			✓							
SPI	Auto	1.82	5.67			✓		✓			✓	✓	
	EBA	1.42	0.32			✓						✓	
	E-Net	1.63	0.79	✓	✓	✓			✓		✓	✓	
SWI	Auto	1.74	1.36	✓		✓			✓				
	EBA	1.58	0.62	✓		✓			✓	✓			
	E-Net	3.44	1.33	✓		✓		✓				✓	✓
AST	Auto	2.47	2.12	✓	✓	✓				✓			
	EBA	6.77	6.38	✓			✓						✓
	E-Net	1.36	2.44	✓					✓				✓
SWE	Auto	1.45	0.72	✓					✓		✓	✓	✓
	EBA	1.90	3.45			✓			✓				
	E-Net	1.44	3.03	✓	✓	✓		✓		✓		✓	✓
US	Auto	1.54	4.32	✓		✓						✓	
	EBA	2.33	5.26			✓	✓						✓
	E-Net	1.52	0.38		✓	✓	✓	✓		✓		✓	
BRA	Auto	1.79	0.11			✓		✓				✓	
	EBA	1.63	0.21			✓	✓	✓					
	E-Net	3.19	10.24			✓		✓		✓		✓	
MEX	Auto	3.20	15.23			✓							✓
	EBA	3.11	13.78			✓				✓		✓	
	E-Net	3.11	0.62		✓		✓	✓	✓			✓	
CAN	Auto	2.91	0.58		✓		✓	✓					
	EBA	2.88	0.23				✓	✓				✓	
	E-Net	2.0	0.54			✓		✓					
PER	Auto	1.75	0.16			✓	✓	✓		✓	✓		
	EBA	1.95	0.44		✓	✓							
	E-Net	4.43	3.43		✓			✓					
EGY	Auto	5.24	3.97		✓			✓					✓
	EBA	4.43	0.70		✓			✓					✓
	E-Net	1.87	1.88		✓	✓	✓		✓	✓		✓	✓
NIG	Auto	1.72	0.28				✓						✓
	EBA	1.70	0.21		✓	✓	✓						✓
	E-Net	4.22	7.01			✓	✓	✓	✓	✓		✓	✓
ETH	Auto	5.53	14.75				✓					✓	
	EBA	3.97	8.76				✓					✓	✓
	E-Net	5.91	8.72	✓					✓	✓	✓		
SA	Auto	6.41	7.86						✓		✓		
	EBA	5.49	7.58						✓	✓	✓		
	E-Net	1.48	1.09	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Auto	1.75	1.15					✓		✓	✓	✓	✓

		RMSE	MSP	Financial Development	FDI	Savings	Capital Formation	Inflation	Labor force	Foreign Assets	Remittances	Human Capital	Trade Openness
MOR	EBA	1.72	0.04					✓		✓			✓
	E-Net	2.31	4.15	✓	✓						✓		✓
	Auto	3.21	5.10			✓	✓			✓			
	EBA	1.32	3.40	✓			✓			✓			✓

The frequencies of retained variables by different model selection procedures is given in below table.

Table 3. Frequencies of retained variables in growth model (%)

	Financial Development	FDI	Savings	Capital Formation	Inflation	Labor Force	Foreign Assets	Remittances	Human Capital	Trade Openness
All Countries										
E-Net	66	44	63	50	56	31	50	25	38	59
Autometrics	38	22	41	47	41	19	38	13	41	41
EBA	47	34	34	44	41	19	53	19	38	22
Asian Countries										
E-Net	93	64	50	64	71	29	64	29	50	71
Autometrics	43	14	14	50	29	21	50	7	29	36
EBA	71	36	21	43	36	7	71	14	21	14
European Countries										
E-Net	75	38	88	38	63	25	25	13	63	63
Autometrics	63	25	63	38	25	25	38	25	63	13
EBA	50	0	75	25	25	25	13	0	25	38
American Countries										
E-Net	0	60	60	40	100	20	40	0	60	0
Autometrics	0	40	60	40	80	0	20	20	20	40
EBA	0	60	60	40	100	20	40	0	60	0
African Countries										
E-Net	60	60	60	60	40	80	80	60	40	80
Autometrics	0	0	20	60	20	20	40	40	40	40
EBA	20	20	20	60	20	20	60	20	20	80

For all countries, the results show that financial development is retained with a higher frequency than other variables. The second number most retained variables in all selected countries are capital formation and foreign assets. As discussed earlier that capital is the factor for economic growth supported by many economic growth theories, so our findings are consistent with economic growth models. The third most retained variable is inflation. In the current era, inflation become a problem of many economies. In earlier eras, inflation remained an important factor for economic growth, so again this variable is consistent with earlier studies and consistent with economic growth models. Elastic Net retains the variables with higher frequencies than other model selection

procedures means the Elastic Net retains an over-specified model.

For Asia, the most retained variable is financial development and the retained frequency is (E-Net=93%, Autometrics=43% EBA=71%). For Asian countries, the second most retained variable is foreign assets and the retained frequency is (E-Net=64%, Autometrics=43% EBA=71%). In Asia, most economies are developing, so for these countries foreign assets have an important role. The third most retained variables are capital formation and retained frequency is (E-Net=64%, Autometrics=50% EBA=43%).

For European economies, the most retained variable is savings and retained frequency is (E-Net=88%, Autometrics=63% EBA=75%). Savings are related to financial development and capital formation and mostly growth theories put importance on capital formation for economic growth. The second most retained variable for European countries is financial development and retained frequency is (E-Net=75%, Autometrics=63% EBA=50%). This is consistent with earlier findings and consistent with growth models. Here Elastics Net retains more variables than other variables selection procedures.

For American countries, the most retained variable is inflation and retained frequency is (E-Net=100%, Autometrics=80% EBA=100%). The second most retained variable in the case of American countries is savings and retained frequency is (E-Net=60%, Autometrics=60% EBA=60%). For African countries, the most retained variable is trade openness and retained frequency is (E-Net=80%, Autometrics=40% EBA=80%). The second most retained variable is foreign assets and retained frequency is (E-Net=80%, Autometrics=40% EBA=60%).

For in sample comparison, mean square prediction error (MSPE) and root mean square error (RMSE) have been used. EBA presents a superior predictive performance in terms of lower RMSE and MPSE that are 1.03 and 0.05 respectively. If we see the highest value of RMSE that is 8.44 in the case of EBA. Moreover, the highest value of MPSE is 27.09 by Autometrics.

Conclusion and Recommendations

For the investigation of the relationship between economic growth and financial development, the data of 32 countries from different regions are used, and the sample size is 1980-2019. We make a general model after analyzing the different growth models (as different growth models explain a different set of variables) we put all variables in this general model. Then we have used the latest econometric model selection procedures to calculate the retention probability of different variables in the general model as well as calculate the retention probability of financial development. After analyzing the results and theories of economic growth; it is determined that financial development has a positive relationship with economic growth. These results are consistent in the case of Asian, European, and American countries as well as for all countries. The retention frequency of financial development is higher than other variables in the general model. And for modeling the economic growth Extreme Bound Analysis is a better procedure to estimate the model because its performance in the case of in-sample forecasting is better than other model selection procedures.

So for modeling the economic growth Extreme Bound Analysis is recommended for further research in this area.

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