

# **Financial Development and Income Inequality in Pakistan: An Application of ARDL Approach**

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**Abstract:** Relevant literature illustrates different observations about the relationship between financial sector development and income inequality, while little empirical work compares their relative explanatory power in the case of a developing country, like Pakistan. Several studies reveal that, inequality might increase at initial levels of financial sector deployment and then decreases as financial sector matures (Greenwood and Jovanovic, 1990). Developed financial sector reduces income inequality by alleviating credit constraints and increasing the access to investment opportunities for poor households. With wider financial opportunities poor could be able to invest in their own education and that of their offsprings. This could lead to increase and improve their mobility and economic prospects, and hence break the cycle of persistent inequality. So the relation between financial development and income distribution is important for policy that, how macroeconomic policies affect inequality in developing country, like Pakistan. In this study, we used time series data for Pakistan from 1971 to 2005 and investigated the relationship between financial development and income inequality. The present study investigated both short-run as well as long-run relationship between financial development and income distribution by employing Autoregressive Distributed Lag Model (ARDL) and Error Correction Model (ECM) and obtained relatively more robust empirical evidence on the issue concerned. We found that financial development decreases inequality both in long run as well as in short run as economic growth improves in Pakistan. The coefficient of trade do support the Leontief Paradox in Pakistan both in long run as well as in short run. While Financial Instability increases inequality only in long run but not in short run. Therefore for persistent reduction in poverty/ income inequality consistent financial sector reforms are perquisite to have a developed financial sector in Pakistan.

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## **I. Introduction**

The last decade saw an explosion in research interest on economic growth. There have been a large number of thorough investigations on the differences in growth rates among countries over long periods of time. These studies tend to emphasize particular aspects or cause of the growth process. Among the important correlates of economic growth that have been studied are growth and the extent of financial sector development. There is ample evidence that financial development and well functioning financial systems promote long-run growth<sup>1</sup>. Higher levels of financial development are significantly and robustly correlated with current and future rates of economic growth, physical capital accumulation and economic efficiency improvements[see, Khan, (2000); and Goldsmith (1969) and Mckinnon (1973); Roubini and Sala-i-Martin,(1992); King and Levine,(1993); Esterly, (1993); Pagano and Volpin,(2001);Gertler and Rose,(1994); Levine, Loayza and Beck,(2000); Khan and Senhadji,(2000); Christodoulou and Tsionas,(2004); Iqbal, et al., (2006) and, Khan Arshad, et al.,(2005)]. However, capital markets improvements may be associated with increases in inequality because the better off may be able to exploit more effectively the new opportunities, including the adoption of capital intensive technologies that may be complementary with highly skilled labor but substitute for less skilled labor. However, the access of the poor households to bank credit may be impede by the high cost of small loans and so financial development may be regressive for the poor particularly at initial stages of development (Greenwood and Jovanovic, 1990). That is, benefiting from the screening and risk pooling that financial intermediation offers requires an initial set-up cost that poor households cannot afford. As they are not in a position to use their savings for this outlays, that position pushes them further below in the income distribution [Behrman, et. al., (2001); Dollar and

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<sup>1</sup> Conceptually, finance may be considered a special barrier, in the end, it is an empirical matter: how important is access to finance relative to other barriers to entry and growth? As much recent evidence has shown, access to finance is critical for growth and the importance of financial sector development for growth is well documented empirically (Levine 2004 reviews). Some of this evidence is, however, subject to the criticism of identification as, on a cross-country basis, many barriers are highly correlated with limited financial sector development. Some survey evidence indeed suggests that the importance of financial constraints has been exaggerated relative to such obstacles. Johnson, McMillan and Woodruff (1998) find that in surveys, Eastern European entrepreneurs rate property rights as more important than finance. Other surveys also suggest that other barriers contribute more to constraining firm growth than finance does.

Kraay, (2002); Beck, et. al., (2004)]<sup>2</sup>. Since financial market imperfections such as financial asymmetries, transaction costs, and contract enforcement costs, may be especially binding on the poor entrepreneurs who lack collaterals, credit histories, and connections. These credit constraints will impede the flow of capital to poor individuals with high-return projects [Banerjee and Newman, (1993); Galor and Zeira, (1993)] thereby reducing the efficiency of capital allocation and intensifying income distribution [Banerjee and Newman, (1993); Aghion and Bolton, (1998); Greenwood and Jovanovic, (1990)]. The relationship between financial development and reductions in income inequality is not only a correlation, but a causal relationship. The positive relationship between private credit and faster growth for the poor might be driven by higher demand for financial services as the poor gain a larger share in national income. Similarly, reduction in income inequality might lead to political pressure to create more efficient financial system that, found projects based on market criteria, not on political connections. No particular study has determined whether financial development benefits the whole population, or it primarily benefits the rich, or disproportionately helps the poor [Honohan, (2004); Beck, et. al., (2004); Perotti and Claessense, (2005), and Britten-court, (2006)].

Available empirical work relies on different controls (only a few variables are included in all studies), estimation techniques (studies use simple OLS), and model specifications. Dollar and Kraay (2003) results based on a regression of the growth rate of incomes of the lowest quintile of the population against average growth and set of regressors to capture the impact of trade, inflation, government consumption and financial development on income distribution revealed that, more trade would lead to higher equality, whereas higher inflation, higher government consumption, and financial

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<sup>2</sup> There are many economic, technical and institutional explanations why access to finance can be unequal. Although finance can support the enhanced participation of individuals in autonomous production, financial services and financial contracting may establish relatively high threshold for poor and new firms. The formal financial sector often refuses to deal with the individuals who do not have an official address, or some formal education, or some certification. Even in developed countries, of dual financial services markets exist in which formal, insured depository institutions largely serve middle-and-upper income clients, and check cashers and other basic services providers largely serve low-income individuals[Khan and Abuhik (2000);Claessense,(2005); Perotti,(1996)].

development would lead to higher inequality. The specification of Li and Zou (2002) is similar to the one in Barro (2000) with the level of the Gini as the dependant variable and controls that include inflation, financial development, government spending and openness. Their results suggest that, higher inflation would lead to lower inequality, whereas higher government spending, improved financial sector, and better education would lower it. Calderon and Serven (2003) found that, financial depth increases inequality while better education lowers it. Finally, the findings of Lopez (2004) are based on the estimation of a dynamic panel with fixed effects for the change in the Gini coefficient. The results suggest that, improvements in education and lower inflation rates would reduce the levels of inequality, while, financial development, trade openness, and reduction in government size would be associated with increase in inequality. Lopez also found that, economic policies are likely to be pro-poor in the long-run (i.e. the growth effects offsets the increase in inequality) but might also lead to temporary short-run increase in inequality in the absence of compensatory measures. The effect of financial development is, however, not very large and dominated by agricultural factors and other sectoral factors [Khakwani and Pernia, (2000); Khan and Senhadji, (2000); Christodoulou and Tsionas, (2004)].

Indeed, in so far as the financial system is becoming healthier, powerful and competitive, it is possible that, a greater capacity and desire exists to bear the high costs of small credits (Rajan and Zingales 2003). Moreover, the development of informal credit, which is often the only source of borrowing for poor people, is made easier by the growth of the formal financial system which offers opportunities of profitable investments to informal financial institutions or agents. Finally, in a framework of competitive markets of goods and production factors, credit may improve the well-being of the poor, even if they do not directly receive the loans (Beck, et. al., 2004). Apart from this, effects of financial instability upon poor people may be argued an indirect effect resulting from the fact that financial instability induces growth instability. Indeed, as the rate of investment depends on the availability of finance, financial instability induces the instability of this rate and therefore that of the rate of growth. Furthermore, financial instability leads to a volatility of relative prices since the prices of the different goods or services are not influenced in the same proportion by a credit variation: tradable goods prices are

determined by foreign prices and the nominal exchange rate while non-tradable goods prices depend on the domestic supply and demand and so are more directly linked to the credit level. Both these instabilities (that of the rate of investment and that of the real exchange rate) lead to growth volatility. So it is likely that financial instability inducing growth volatility impedes economic growth. As economic growth is a necessary condition for sustainable poverty reduction, financial instability hurts the poor through its detrimental impact on growth. Moreover, poor people may be more vulnerable to the cyclical nature of economic growth than the rich, due to the asymmetry between periods of falling and rising aggregate income; falling periods reduce the income of the poor more than the rising ones improve it (Beck, et. al.,2004).

Pakistan is a developing country that has been known for its high earnings income inequality and also for presenting poor macroeconomic performance, particularly in the 1980's and first half of the 90's. Pakistan is now on the way of gaining economic growth and the government has significantly improved macroeconomic stability and policy credibility. The very high growth rates in recent years would have been expected to increase income of the poorest segments of population. However, claims of huge gains in poverty reduction seem difficult to reconcile the face of some obvious partially offsetting poverty-increasing factors. These include the inflation (remains high) and rising income inequality. The high inequality is exemplified by a Gini coefficient of .42 in (2002) and the poor macroeconomic performance by very high and volatile inflation rates<sup>3</sup>. The importance of financial<sup>4</sup> development in such an economic environment is twofold:

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<sup>3</sup>Other developing countries that presented similar poor economic conditions, with high inequality and high inflation rates were, e.g., Bolivia, Colombia, Indonesia, Mexico, Peru and Tanzania.

<sup>4</sup>Conceptually, finance may be considered a special barrier, in the end, it is an empirical matter: how important is access to finance relative to other barriers to entry and growth? As much recent evidence has shown, access to finance is critical for growth and the importance of financial sector development for growth is well documented empirically (Levine 2004 reviews). Some of this evidence is, however, subject to the criticism of identification as, on a cross-country basis, many barriers are highly correlated with limited financial sector development. Some survey evidence indeed suggests that the importance of financial constraints has been exaggerated relative to such obstacles. Johnson, McMillan and Woodruff (2003) find that in surveys, Eastern European entrepreneurs rate property rights as more important than finance. Other surveys also suggest that other barriers contribute more to constraining firm growth than finance does. Mutual funds reform in Pakistan seems to have benefited few. Insider lending was related to political motives as political firms borrow 40 percent more and have 50 percent higher default rates, with economy wide costs of rent seeking estimated to be 0.3 to 1.9 percent of GDP per year (Khwaja and Mian , 2004).

firstly, more access to credit markets benefits the poor via the investment in productive activities channel. With more access to credit the poor could invest in their own education and that of their offsprings. They can then increase and improve their mobility and economic prospects, and hence break the cycle of persistent inequality. Secondly, in countries which presented high and volatile inflation rates for long periods, access to financial markets and other fully indexed assets offer to those at the top of the distribution even daily indexed protection of their earnings-income against high inflation. However, the poor, who are financial markets constrained, have to hold cash instead, and in a high inflation environment those holding cash lose much more with high inflation via inflation-tax channel. Hence, financial development in Pakistan and most certainly in developing countries too, is important because it provides the poor with the much needed credit to be invested in all sorts of productive activities and, because it offers to those with access to financial markets protection against chronic poor macroeconomic performance<sup>5</sup>.

The contribution of financial sector development in economic growth in Pakistan is not researched with respect to income inequality<sup>6</sup>. This study is a first attempt to start this particular direction in economic development. The objective of such endeavor is to investigate relationship between financial development and income inequality in an Autoregressive Distributive Lag (**ARDL**) framework for Pakistan utilizing data over the period 1971-2005. The residual-based co-integration tests are inefficient and can lead to contradictory results, especially when there more than  $I(1)$  variables under consideration. This **ARDL** modeling approach is superior than other methods for analyzing the long-run relationships when the variables are mixed order of integration, i.e.,  $I(0)$  and  $I(1)$  ; and

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<sup>5</sup> As bluntly put by the Inter-American Development Bank recently: “An interruption in credit supply can lead to a disruption in investment, economic growth and prosperity” Inter-American Development Bank (2005).

<sup>6</sup> Inequality is itself can be hinder to productive financial reforms and financial development when powerful interest block or manipulate reforms so as to capture benefits and avoid the costs. Or, if more financial just leads to the expansion of stronger economic entities at the cost of weaker ones, in part as cost become socialized, financial reforms can actually worsen distribution of income and wealth may, over time, create a strong backlash and make financial reforms politically sustainable means benefiting rich quintile (Perotti and Claessense, 2005 and Brittencourt, 2006). As recent and empirical work has shown, ex ante inequality can hinder welfare enhancing reforms. Concentrated economic and political powers will likely block financial (and other reforms) or manipulate their design or implementation, so that benefits reach few individuals (Perotti and Claessense, 2005).

when there is structural break in the time series data. The rest of paper is designed as: section II explains the model and data collection procedure, section III describes the methodology, and section IV investigates the empirical results. Finally, section V presents the conclusion and policy implications.

## II. Modeling, Data and Methodological Framework

To inquire the relationship between financial development and inequality, the following equation is being modeled;

$$Gini = \alpha_0 + \alpha_1 FD + \alpha_2 CV + \varepsilon_t \quad \dots\dots\dots (1)$$

Where claims on private credit by financial institutions as the percentage of GDP (private-credit ratio)<sup>7</sup> is the measure of financial development (FD). The main focus of analysis is Financial Development which, based upon the discussion of earlier theoretical models linking income distribution to financial Development, the following functional form is being assumed;

$$\alpha_{11} FD + \alpha_{12} FD^2$$

The inequality-narrowing hypothesis predicts  $\alpha_{11} < 0$  and  $\alpha_{12} = 0$ , the inequality-widening hypothesis predicts  $\alpha_{11} > 0$  and  $\alpha_{12} = 0$ , and inverted U-shaped hypothesis predicts if  $\alpha_{11} > 0$  and  $\alpha_{12} < 0$ , if  $\alpha_{11} < 0$  and  $\alpha_{12} > 0$  U-shaped hypothesis predicts.

We also include several other variables to control factors which might affect inequality alongwith financial development. That is, initial real per capita GDP to capture the effects of financial development on steady-state of inequality; inflation rate, assuming that, monetary instability hurts poor and middle class relatively more than rich because latter class has better access to financial instruments that allow them to hedge their exposure to inflation<sup>8</sup> and expecting positive effect of inflation on inequality; measure of government general consumption expenditures<sup>9</sup> conjecturing negative effect on inequality, but there can be opposite effect of government consumption on inequality if rich households use their political powers to exploit the poor. To capture the effect of financial crisis or banks crisis on inequality, we calculate a measure of financial

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<sup>7</sup> Credit to private sector refers to financial resources provided to the private sector, such as through loans, purchase of non-equity securities, and trade credits and other accounts receivable that establish a claim for repayment

<sup>8</sup> See for example, Easterly and Fisher (2001)

<sup>9</sup> Government consumption expenditures for the purchase of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation.

instability as a deviation from trend<sup>10</sup> and trade (export + import as share of GDP) variable to scrutinize effect on inequality which can be in either way positive or negative. Finally, manufacturing sector value added as share of GDP to check the sectoral structure of an economy.

Since, this study relies on a commonly used measure of financial development that existing work shows is robustly related to economic growth. **Private Credit** equals the value of credit by financial intermediaries to the private sector divided by GDP. This measure excludes credits issued by the central bank and development banks. Furthermore, it excludes credit to the public sector, credit to state-owned enterprises, and cross claims of one group of intermediaries on another. Thus, Private Credit captures the amount of credit channeled from savers, through financial intermediaries, to private firms. Private Credit is a comparatively comprehensive measure of credit issuing intermediaries since it also includes the credits of financial intermediaries that are not considered deposit money banks. Previous studies have established a robust positive relationship between Private Credit and the growth rate of GDP per capita. The data has been collected from IFS (International Financial Statistics), WDI (World Development Indicators) and Economic Survey of Pakistan (Various Issues) except income inequality<sup>11</sup> covering data period over 1971-2005. Table no.1 represents descriptive statistics and bivariate correlations. The estimations of Table no.1 show that income inequality is positively correlated with Financial Development and negatively associated with Financial Instability. Initial GDP per Capita, Government Spending, manufacturing Sector and Trade are positively correlated with inequality but Inflation causes the inequality and government spending negatively. Financial development is associated negatively with financial instability and inflation while it is positively and significantly correlated with government spending and initial GDP per capita. Initial GDP per capita is positively correlated with government spending but negatively with inflation. And manufacturing is associated positively with trade and negatively with financial instability while financial instability and inflation move in same direction.

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<sup>10</sup> see Loayza and Ranciere (2002)

<sup>11</sup> see Jamal Haroon (2005)

**Table.1**  
***Descriptive Statistics and Correlation Matrix***

Variables	Gini-coefficient	Private Credit	Financial Instability	Initial GDP per Capita	Government Spending	Inflation	Manufacturing Value-added	Trade (Openness)
Observations	35	35	35	35	35	35	35	35
Mean	36.62	26.75	1.147	1.18	2.4E+11	8.87	16.09	33.34
Median	36.87	27.14	0.77	1.14	2.6E+11	7.84	16.11	34
Maximum	42.88	33.5	5.25	2.28	5.1E+11	26.66	17.41	38.9
Minimum	30.37	18.91	0.0023	0.67	8.4E+10	2.91	14.99	19.9
Gini-coefficient	1.000000							
Private Credit	0.670049	1.000000						
Financial Instability	-0.409476	-0.21923	1.000000					
Initial GDP per Capita	0.927757	0.609868	-0.38847	1.000000				
Government Spending	0.958298	0.673733	-0.398473	0.937031	1.000000			
Inflation	-0.474147	-0.60205	0.438877	-0.45733	-0.383523	1.000000		
Manufacturing Value-added	0.255529	0.218546	-0.00119	0.217823	0.400345	0.125554	1.000000	
Trade(Openness)	0.318414	0.217012	-0.12295	0.133691	0.374084	0.19200	0.566104	1.00000

There are many methods available for conducting the Co-integration test; the most widely used methods include the residual based Engle-Granger (1987) test<sup>12</sup>, and Maximum Likelihood based Johansen (1991; 1992) and Johansen-Juselius (1990) tests. All these require that the variables in the system be of equal order integration. These methods do not include the information on structural break in time series data and suffer from low predicting power.<sup>13</sup>

Recently, an emerging body of work led by Pesaran (1997), Pesaran and Smith (2000), Pesaran and Shin (1999), and Pesaran et al (2001) has introduced an alternative Co-

<sup>12</sup> The residual-based co-integration tests are inefficient and can lead to contradictory results, especially when there are more than two  $I(1)$  variables under consideration

<sup>13</sup> It goes without saying that structural change is of considerable importance in the analysis of macroeconomic time series. Structural change occurs in many time series for any number of reasons, including economic crises, changes in institutional arrangements, policy changes regime shift war. An associated problem is the testing of the null hypothesis of structural stability against the alternative of a one-time structural break. If such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, results may be biased towards the erroneous non-rejection stationary hypothesis (Leybourne and Newbold, 2003; perron, 1989, 1997).

integration technique known as the “Autoregressive Distributive Lag” or **ARDL** bounds testing. It is argued that ARDL has a numerous advantages over conventional Johansen Co-integration technique. The first advantage is that it can be applied irrespective of whether underlying regressors are purely  $I(0)$ , purely  $I(1)$  or mutually co-integrated (Pesaran and Pesaran, 1999). The second advantage of using the bounds testing approach to Co-integration is that Monte Carlo studies that it performs better than Engle and Granger(1987), Johansen (1990) and Philips and Hansen (1990) Co-integration test in small samples (see e.g. Haug, 2002). The third advantage of this approach is that, the model takes sufficient number of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chai, 2003). However, Pesaran and Shin (1999) contented that, “appropriate modification of the orders of the **ARDL** model is sufficient to simultaneously correct for residual serial correlation and the problem of endogenous variables”.

We use log-linear modeling specification. Bowers and Pierce (1975 suggest that Ehrlich’s (1975) findings with a log linear specification are sensitive to functional form. However, Ehrlich (1977 and Layson (1983) argue on theoretical and empirical grounds that the log linear form is superior to the linear form. Both Cameron (1994) and Ehrlich (1996) suggest that a log-linear form is more likely to find evidence of a deterrent effect than a linear form. This makes our results more favorable to the deterrence hypothesis. Moreover, a dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation (Banerjee *et al.* 1993). The ECM integrates the short-run dynamics with the long-run equilibrium without losing long-run information. It is also argued that using the **ARDL**<sup>14</sup> approach avoids problems resulting from non-stationary time series data (Laurenceson and Chai 2003).

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<sup>14</sup> The early discussion on ARDL Modelling approach can be found in Charemza and Deadman (1992).

The error correction version of the **ARDL** model is given below for the above given

**Equation no.1:**

$$\begin{aligned} \Delta LGINI_t = & \alpha_0 + \alpha T + \sum_{i=1}^p \beta_i \Delta LGINI_{t-i} + \sum_{i=1}^p \delta_i \Delta LFD_{t-i} + \sum_{i=1}^p \varepsilon_i \Delta LFNFD_{t-i} + \sum_{i=1}^p \sigma_i \Delta LGDP_{t-i} \\ & + \sum_{i=1}^p \omega_i \Delta LIFL_{t-i} + \sum_{i=1}^p \partial_i \Delta LGS + \sum_{i=1}^p \phi_i \Delta LM_{t-i} + \sum_{i=1}^p \varphi_i \Delta LTGDP_{t-i} + \lambda_1 LGINI_{t-1} + \lambda_2 LFD_{t-1} \\ & + \lambda_3 LFD FN_{t-1} + \lambda_4 LGDP_{t-1} + \lambda_5 LIFL_{t-1} + \lambda_6 LGS + \lambda_7 LM_{t-1} + \lambda_8 LTGDP_{t-1} + \mu_t \dots \dots \dots (2) \end{aligned}$$

Where *GINI*= Gini-Coefficient, *FD* = Financial Development proxies by credit to private sector as share of GDP, *FNFD* = Financial Instability, *GDP* = Initial Real GDP Per Capita, *IFL* = Inflation, *GS* = Government Spending, *M*= Manufacturing value added as share of GDP, *TGDP*= Trade openness (Export + import/ GDP).

The first part of equation (2) with  $\beta, \delta$  and  $\varepsilon$  represents the short-run dynamics of the model whereas the second part with  $\lambda$ s represent the long-run relationship. The null hypothesis in the equation is  $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = \lambda_8 = 0$ , which means the non-existence of the long run relationship. While alternative hypothesis in the equation  $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq \lambda_7 \neq \lambda_8 \neq 0$  shows the existence of long-run relationship among variables.

The ARDL model testing procedure starts with conducting the bounds test for the null hypothesis of no Co-integration. The calculated *F-statistic* is compared with the critical value tabulated by Pesaran and Pesaran (1997) or Pesaran *et al.* (2001). If the *F-test* statistic exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected regardless of whether the underlying orders of integration of the variables are *I(0)* or *I(1)*. Similarly, if the *F-test* statistic falls below the lower critical value, the null hypothesis is not rejected. However, if the sample *F-test* statistic falls between these two bounds, the result is inconclusive. When the order of integration of the variables is known and all the variables are *I(1)*, the decision is made based on the upper bounds. Similarly, if all the variables are *I(0)*, then the decision is made based on the lower bounds.

The ARDL method estimates  $(p+1)^k$  number of regressions in order to obtain optimal lag length for each variable, where  $p$  is the maximum number of lags to be used and  $k$  is the number of variables in the equation. The model can be selected using the model selection criteria like Schwartz-Bayesian Criteria (SBC)<sup>15</sup> and Akaike's Information Criteria (AIC). SBC is known as the parsimonious model: selecting the smallest possible lag length, whereas AIC is known for selecting the maximum relevant lag length. In the second step, the long run relationship is estimated using the selected ARDL model. When there is a long run relationship between variables, there exists an error correction representation. Therefore, in the third step, the error correction model is estimated. The error correction model result indicates the speed of adjustment back to the long run equilibrium after a short run shock.

To ascertain the goodness of fit of the **ARDL** model, the diagnostic test and the stability test are conducted. The diagnostic test examines the serial correlation, functional form, normality and heteroscedasticity associated with the model. The stability test is conducted by employing the cumulative sum of recursive residuals (**CUSUM**) and the cumulative sum of squares of recursive residuals (**CUSUMsq**). Examining the prediction error of the model is another way of ascertaining the reliability of the **ARDL** model. If the error or the difference between the real observation and the forecast is infinitesimal, then the model can be regarded as best fitting.

### **III. Empirical Results**

Prior to determining whether all the series are integrated, this study examines the integrating order of all the variables by applying unit-root test (ADF), i.e. Dickey and Fuller (1981). Unit-root test are classified into series with and without unit roots, according to their null hypothesis, in order to conclude whether each variable is stationarity. All the variables are first tested for stationarity using the Augmented Dickey-Fuller (ADF). The results in Table 2 show that the majority of variables are  $I(1)$ , although

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<sup>15</sup> The mean prediction error of AIC based model is 0.0005 while that of SBC based model is 0.0063 (Min B. Shrestha, 2003).

IFL, GDP and FNFD are integrated at  $I(0)$ . The ambiguities in the order of integration of the variables lend support to the use of the ARDL bounds approach rather than one of the alternative Co-integration tests.

**Table .2**  
**Unit-Root Estimation**

	Level		First Difference	
	Intercept and trend	No. of lags	Intercept and trend	No. of lags
GINI	-0.969	1	-5.59*	1
FD	-2.583	1	-5.44*	1
IFL	-3.646**	1	-4.44*	1
FNFD	-4.451*	1	-5.730*	1
GS	-1.354	1	-3.23*	1
M	-2.380	1	-5.03*	1
GDP	-6.815*	1	-7.41*	1
TGDP	-2.797	1	-4.08*	1

Note: \*\*, represents significant at level with intercept and trend at 5% having critical values as -3.6752, -2.9665, -2.6220 and -4.3226, -3.5796, -3.2239 while at first difference \* is presenting the picture of significance at 1% with intercept and trend having critical values.

**Table .3**  
**Lag length Selection**

Order of lags	Schwartz Bayesian Criteria	F-test Statistics
1	-17.62182	2.627
2	-16.17425	5.89*

**Short-run Diagnostic Test-Statistics**  
*Serial Correlation LM, F = 1.64(0.212)*  
*Normality J-B Value = 1.60(.4487)*  
*Heteroscedasticity Test, F = 2.65(0.0296)*  
*Ramsey RESET Test, F = 0.601935(0.445746)*

After finding integrating order of all variables, the two-step ARDL Co-integration (See Pesaran *et al.*, 2001) procedure is implemented in the estimation of equation (1) for Pakistan utilizing annual data over the period 1971-2005. In the first stage, the order of lag length on the first differenced estimating the conditional error correction version of the ARDL model for equation 2 is usually obtained from unrestricted vector autoregression (VAR) by means of Schwartz Bayesian Criteria which is 2 based on the minimum value as shown in Table 3. In such small sample of observations we cannot take lag length more than 2 lag order. The total number of regressions estimated following the ARDL method in the equation No.3 is  $(2+1)^8 = 6561$ . The results of the

bounds testing approach for Co-integration show that the calculated *F-statistics* is 5.89<sup>16</sup> which are higher than the upper level of bounds critical value of 4.75 at the 1 percent level of significance, implying that the null hypothesis of no Co-integration cannot be accepted and that there is indeed a Co-integration relationship among the variables in this model. Having found a long-run relationship, we applied the **ARDL** method to estimate the long run and the short run elasticities (see Pesaran *et al.*, 2001 and Pesaran and Shin, 1999 for details).

Long-run coefficients of the variables under investigation are shown in the Table 4. To test the inequality-widening or inequality-narrowing hypotheses, we regressed the natural-log of the Gini-coefficient on linear terms for the measure of financial sector development (private credit as share of GDP) and additional control variables. The coefficient on private credit is negatively but statistically significant indicating that financial sector development will reduce inequality in long-run. This suggests that financial sector development (easy access of credit to private sector) improves income distribution, supporting the inequality-narrowing hypotheses and rejecting the inequality-widening hypotheses of financial sector development. Inequality is significantly associated with financial instability positively, suggesting that higher inequality is caused by high financial crisis or bank crisis. 1% increase in real per capita GDP raises inequality by 7.3%. Government consumption and inequality are having same direction indicating positive and significant relationship, meaning that government consumption causes to raise inequality by 17.3%, if there is 1% increase in government spending. The major reason of this opposite result is that rich households use their political powers or their connection to exploit the poor in the country. Trade Openness also increases inequality in the country significantly, i.e., 1% increase in trade worsens income distribution by 9.1%. Negative and significant coefficient of manufacturing suggests that inequality is lower if manufacturing accounts for a greater share of GDP. Finally, negative coefficient on inflation shows that higher inflation will cause to reduce inequality, i.e., poor gain from high inflation.

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<sup>16</sup> As can be seen from Table 3, although the results of the *F-test* changes significantly at lag order 1, support for Co-integration is less. *F-test* statistics is highly sensitive with the lag order; there is strong evidence for Co-integration because our calculated *F-value* is greater than its critical value when second lag is imposed.

**Table .4**  
**The long-run results**

Panel A: The Long-run Results				
Dependant Variable LGINI				
Regressor	Coefficient (1)	<i>prob-values</i>	Coefficient (2)	<i>prob-values</i>
C	.472 (1.033)	0.3110	0.601 (0.407)	0.689
LFD	-0.122 (-3.017)	0.0056	-0.206 (-0.225)	0.8233
LFD^2			0.0128 (0.091)	0.9277
LFNFD	0.0051 (2.084)	0.0471	0.0050 (1.90)	0.0681
LGDP	0.073 (2.346)	0.0268	0.0733 (2.23)	0.0343
LGS	0.173 (7.452)	0.0000	0.1741 (7.10)	0.0000
LIFL	-0.013 (-1.773)	0.0879	-0.0134 (-1.73)	0.0949
LM	-0.462 (-5.268)	0.0000	-0.4654 (-4.95)	0.0000
LTGDP	0.091 (1.981)	0.0583	0.0914 (1.93)	0.0646
$R^2 = 0.982908$ $\bar{R}^2 = 0.978306$ <i>F</i> -Statistics = 213.5959 Durbin-Watson stat = 1.8132			$R^2 = 0.9829014$ $\bar{R}^2 = 0.977446$ <i>F</i> -Statistics = 179.7695 Durbin-Watson stat = 1.8244	

Note: *t*-values are given in parentheses

To test the inverted-U-shaped hypothesis of financial sector development suggested by Greenwood (1990) that “inequality increases at initial stages of development of financial sector development, remains high at peak and goes down at latter stages of financial sector development”, we include squared term for the measure of financial sector development (see column 4 of Table 4). The coefficient on squared term is statistically insignificant with positive sign in the model specification; the results do not support this hypothesis. Although the coefficient on linear term becomes insignificant in model specification when the squared term is included, it is important to note that the linear and squared terms are having negative and positive signs supporting the hypothesis of U-shaped curve (Kuznets, 1955) but not statistically significant. After the investigation of long-run relationships among the variables, to obtain short-run dynamics of these

variables, we establish the error correction representation of ADRL model based on equation 1 can be shown as follows:

$$\Delta GINI = \alpha_0 + \sum_{j=0}^n \beta_1 \Delta IFD + \sum_{j=0}^n \beta_2 \Delta LFNFD + \sum_{j=0}^n \beta_3 \Delta LIFL + \sum_{j=0}^n \beta_4 \Delta LM + \sum_{j=0}^n \beta_5 \Delta LGS + \sum_{j=0}^n \beta_6 \Delta LTGDP + \sum_{j=0}^n \beta_7 \Delta LGDP + \eta CE_{t-1} + \varepsilon_t \dots \dots \dots (3)$$

After establishing the long run relationship between financial development and income inequality in the case of Pakistan as discussed in Table 4 in column 2. Table 5 reports the short-run coefficient estimates obtained from the ECM version of ARDL model. The ECM coefficient shows how quickly/ slowly variables return to equilibrium and it should have a statistically significant coefficient with negative sign. The error correction term  $CE_{t-1}$ , which measures the speed of adjustment to restore equilibrium in the dynamics model, appear with negative sign and is statistically significant at 5 percent level, ensuring that long run equilibrium can be attained. Bannerjee et al., (1998) holds that a highly significant error correction term is further proof of the existence of stable long run relationship. Indeed, he has argued that testing the significance of  $CE_{t-1}$ , which is supposed to carry a negative coefficient, is relatively more efficient way of establishing Co-integration. The coefficient of  $CE(-1)$  is equal to (-0.1375) for short run model respectively and imply that deviation from the long-term inequality is corrected by 13.75 percent over the each year. The lag length of short run model is selected on basis of Schwartz Bayesian Criteria.

**Table 5****Error Correction Corresponding to the ARDL (1, 1, 1, 1, 1, 1, 1 and 1)**

Dependant Variable			
Regressor	Coefficient	t-values	p-values
C	0.008658	12.28408	0.0000
$\Delta LFD$	-0.016710	-1.814880	0.0821
$\Delta LFNFD$	0.000167	0.520348	0.6076
$\Delta LGDP$	0.029236	3.176856	0.0041
$\Delta LGS$	0.017481	2.012486	0.0555
$\Delta LIFL$	-0.002815	-1.784427	0.0870
$\Delta LM$	-0.064481	-2.215575	0.0365
$\Delta LTGDP$	0.016312	1.925878	0.0660
$CE(-1)$	-0.137587	-1.903184	0.0691
$R^2$	0.500842	Adjusted $R^2$	0.334456
S.E. Regression	0.003013	SIC	-8.136587
R.S.S	0.000218	F-statistic	3.010123
L-L Equation	149.9880	DW-stat	1.473282

Note: ARDL (1, 1, 1, 1, 1, 1,1and 1) selected on the basis of SBC. R.S.S, LL, SBC and DW are respectively residual sum of squares, log Likelihood, Schwartz Bayesian criteria and Durbin Watson stat.

$$CE = LGINI + 0.122LFD - 0.005115LFNFD - .17LGS + .0135LIFL + 0.46LM - .074LGDP - .092LTGDP - .472C$$

Short run dynamics results also provide evidence that inequality decreases as the country develops more its financial sector not in log run but also in short run. In the short run credit to private as share of GDP (financial development) reduces inequality by 1.67% each year which is lower than coefficient of FD that is 12.2% as 1 percent increase in the value of financial development in long run, and significant at 5% level. A one percent increase in initial real GDP per capita in short run is increasing the inequality by 2.9% having lower value, and significant at 1 percent level. Inflation is also negatively associated with inequality but significant at 5 percent level. Manufacturing sector development decreases income inequality in short run by 6.4% and significant at 1 percent. Finally trade and government consumption are major inequality increasing factors in short run, and significant at 5 percent level respectively while coefficient of  $LFDFN$  (financial instability) is having increasing effect on inequality in short run but not significant . Finally, coefficient of trade openness measurement is positively associated with inequality supporting the Leontief Paradox that benefit from openness is more likely to favor the relatively ‘privileged’ groups within an economy. Concentration

of both human and physical capital in the hands of well off groups ensures that they would be the first to realize the benefits of openness both in short-run as well as in long-run.

### **Diagnostic and Stability Tests**

Diagnostic tests for serial correlation, normality, heteroscedasticity and functional form are considered, and results are shown in Table 3. These tests show that short-run model passes through all diagnostic tests in the first stage. The results indicate that there is no evidence of Autocorrelation and that the model passes the test for normality, and proving that the error term is normally distributed. Functional form of model is well specified but there is existence of white heteroscedasticity in model. The presence of heteroscedasticity does not affect the estimates and time series in the equation are of mixed order of integration, i.e.,  $I(0)$  and  $I(1)$ , it is natural to detect heteroscedasticity (Shrestha, 2005). Finally, when analyzing the stability of the long-run coefficients together with the short run dynamics, the cumulative sum (**CUSUM**) and the cumulative sum of squares (**CUSUMsq**) are applied.

According to Pesaran and Shin (1999) the stability of the estimated coefficient of the error correction model should also be empirically investigated. A graphical representation of **CUSUM** and **CUSUMsq** are shown in fig. 1 and 2. Following Bahmani-Oskooee (2004) the null hypothesis (i.e. that the regression equation is correctly specified) cannot be rejected if the plot of these statistics remains within the critical bounds of the 5% significance level. As it is clear from Fig. 1 and 2, the plots of both the **CUSUM** and the **CUSUMsq** are within the boundaries and hence these statistics confirm the stability of the long run coefficients of regressors which affect the inequality in the country. The stability of selected ARDL model specification is evaluated using the cumulative sum (**CUSUM**) and the cumulative sum of squares (**CUSUMsq**) of the recursive residual test for the structural stability (see Brown et al., 1975). The model appears stable and correctly specified given that neither the **CUSUM** nor the **CUSUMsq** test statistics exceed the bounds of the 5 percent level of significance (see figure given in appendix).

## VI. Conclusions and Policy Implications

There is paucity of empirical literature on the specific relationship between financial development and income inequality but none exists in the case of Pakistan. This study investigates the importance of financial development, i.e., more broad access to financial and credit markets in reducing inequality in the country. Further, it examined the inequality-narrowing hypothesis [(Galor and Ziera, 1993) and Newman (1993)], and predicts a negative relationship between financial development and inequality. In contrast to an inverted U-shaped relationship between finance and income inequality in non-linear fashion as suggested by Greenwood and Javanovic (1990), however, present endeavour did not support the said hypothesis for Pakistan.

Scrutinizing the link between financial development and inequality in a large time series sample over the period 1971-2005, we experimented with simple specification and as well as specification that controls for simultaneity. The results reject the inequality-widening hypothesis. We explored the linear<sup>17</sup> model to investigate finance-inequality relationship both in long run as well as in short run, and found that, our results provide the support for the inequality-narrowing hypothesis both in long run and short run. This indicates that, more access of the poor individuals to financial markets and credit will be having a significant policy measure to decrease income inequality in the country not only in the long run but also in short run.

Coefficients to measures growth momentum, government spending and trade openness are appeared to be positively association with inequality. Though, financial instability shows positively and significantly effect on inequality increase in the long run only but in short run appeared to be insignificant. This indicates that, financial crisis has no direct impact on income inequality in the country. Estimated coefficients of value added in manufacturing and inflation having a negative relation with inequality, which means that, higher growth in manufacturing and inflation decrease inequality both in long run and in short run. We apply ARDL method to investigate the long run relationships among

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<sup>17</sup> We investigated the linear model in long run as well in short run examination but non-linear model only for long run.

inequality and financial development, in ECM version of this model showed that the error correction coefficient which determined speed of adjustment, had expected and significant negative sign. The results indicated that deviation from the long-term in inequality was corrected by approximately 13.7 percent over the following year or each year. The results of the diagnostic and stability tests indicated that model passed all the diagnostic tests. The error term was normally distributed. The CUSUM and CUSUMsq stability test showed that the estimated coefficients of the error correction model were stable. Finally, the estimated long-term coefficient showed highly significant effect on inequality reduction in the country.

It is therefore important to consider not only general macroeconomic policies in this context but particularly those that financial development and financial markets. Appropriate application of policies in the area of finance which is focused to more access of the poor and on the needs of relatively more dis-empowered groups within the country, that , will not only contributes towards a more equal distribution of income but also directly reduces poverty index at the same time GDP growth will be enhanced. Financial development without an appropriate focus on governance-including regulation and supervision of the financial sector , as well as broader measures transparent, honest-governance can contribute to financial crisis that harm the poor the most. The main implication from the arising evidence that the policy of making financial sector more developed and credit markets more widely available will be having the advantage of being a non-distortionary fiscal policy that clearly reduces the persistent inequality in Pakistan, and that will improve the welfare of the poor with out affecting economic efficiency. This highlights the importance of credit allocation and, how efficiently it helps to reduce inequality or to increase the earning share of the poor. More access to credit markets, particularly by the poor, will be having a positive impact on reduction in inequality through investment in productive channels like investment in education of their children and small manufacturing sectors etc. Moreover, financial development proved to be important also via the access to indexed good channel, i.e., access to financial markets actually provide insulation against poor macroeconomic performance recurrently existent in Pakistan.

## Reference:

1. Aghion, P. and P. Bolton (1997), "A Theory of Trickle-Down Growth and Development", *Review of Economic Studies* 64: 151-172.
2. Aghion, Philippe and P. Howitt, (1998), "Endogenous Growth Theory", Cambridge: MIT Press.
3. Banerjee, A. and A. Newman (1993). "Occupational Choice and the Process of Development." *Journal of Political Economy* 101(21).
4. Banerjee, A. and A. Newman, (1993), "Occupational Choice and the Process of Development," *Journal of Political Economy* 101(21).
5. Bannerjee, A., J. Dolado and R. Mestre, (1998), "Error-correction mechanism tests for Cointegration in single equation framework", *Journal of Time Series Analysis*, 19, 267-83.
6. Barro, R., 2000, "Inequality and Growth in a Panel of Countries", *Journal of Economic Growth*, 5, 5-32.
7. Beck, T., A. Demirguc-Kunt, and R Levine, (2004), "Finance, Inequality, and Poverty: Cross-Country Evidence". NBER Working Paper Series.
8. Bittencourt Mayer. Maanoel F, (2006), "Financial Development and Inequality: Brazil 1985-99" Discussion Paper no.06/582. Department of Economics, University of Bristol, 8 Woodland Road, Bristol BS8 1TN.
9. Bowers, W. and Pierce, G., (1975), "The Illusion of Deterrence in Isaac Ehrlich's Work on the Deterrent Effect of Capital Punishment" *Yale Law Journal*, 85, 187-208.
10. Calderón C. and L. Servén, (2003), "Macroeconomic Dimensions of Infrastructure in Latin America". The World Bank,
11. Cameron, S., (1994), "A Review of the Econometric Evidence on the Effects of Capital Punishment", *Journal of Socio-economics*, 23, 197-214.
12. Charemza, Wojciech W. and Derek F. Deadman, (1992), "New Directions in Econometric Practice: General to Specific Modeling, Cointegration and Vector Autoregression", Aldershot, Edward Elgar.

13. Christopoulos D.K. and E.G. Tsionas, (2004), “Financial Development and Economic Growth: Evidence from Panel Unit Root and Cointegration Tests”, *Journal of Development Economics*, vol.73, no.1, February, p. 55-74.
14. Clarke, G., L. Xu, et al., (2003), “Finance and Income Inequality: Test of Alternative Theories”. World Bank Policy Research Working Paper.
15. Dollar D, and A. Kraay, (2003), “Growth is Good for the Poor”, *Journal of Economic Growth*, 7, 195-225.
16. Easterly W. and S. Fischer, (2001), “Inflation and the poor”, *Journal of Money, Credit and Banking*, vol.33, no.2, p.160-178.
17. Ehrlich, I., (1975), “The Deterrent Effect of Capital Punishment – A Question of Life and Death”, *American Economic Review*, 65, 397-417.
18. Ehrlich, I., (1977), “The Deterrent Effect of Capital Punishment Reply”, *American Economic Review*, 67, 452-58.
19. Ehrlich, I., (1996), “Crime, Punishment and the Market for Offences”, *Journal of Economic Perspectives*, 10, 43-67.
20. Engle RF, Granger CWJ., (1987), “Cointegration and error correction representation: estimation and testing. *Econometrica*, 55: 251–276.
21. Galor, O. and J. Zeira ,(1993), “Income Distribution and Macroeconomics”, *Review of Economic Studies*, 60(1), 35-52.
22. Goldsmith, R, (1969), “Financial Structure and Development”, *A Handbook*, Yale University Press, 1969.
23. Greenwood, J. and B. Jovanovic,(1990), “Financial Development, Growth, and the Distribution of Income”, *Journal of Political Economy* 98(5).
24. Haug, A., (2002), “Temporal Aggregation and the Power of Cointegration Tests: A Monte Carlo Study”, *Oxford Bulletin of Economics and Statistics*, 64, 399-412.
25. Honohan, P., (2004), “Financial Development, Growth and Poverty: How Close are the Links?” World Bank Policy Research Working Paper.
26. Iqbal A, Q. M. Ahmad, S. Alam, M. S. Akmal and M. S. Butt, (2006), “Financial Development and Economic Growth in Asian Countries: a Heterogeneous Dynamic Panel Data Approach”, unpublished.

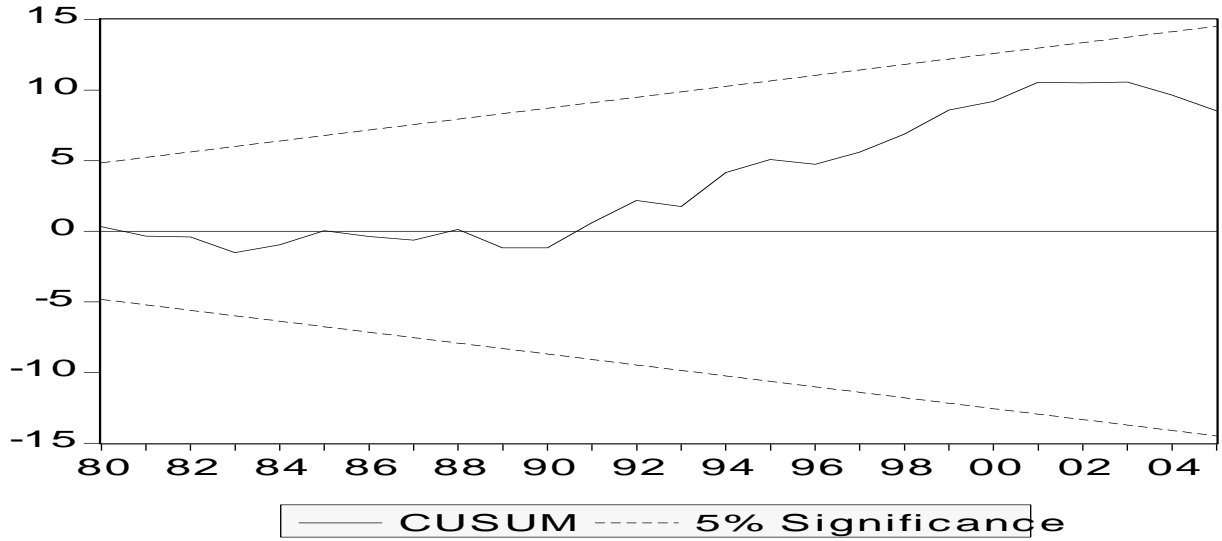
27. Johansen S. (1992), "Cointegration in partial systems and the efficiency of single-equation analysis". *Journal of Econometrics*, 52: 389–402.
28. Johansen S., (1991), "Estimation and hypothesis testing of co-integrating vectors in Gaussian vector autoregressive models", *Econometrica*, 59: 1551–1580.
29. Kakwani, N. and E. Pernia. (2000). "What is Pro-poor growth?", *Asian Development Review*, 18, 1-16.
30. Khan M.A, Qayyum .A and Skiekh S. A, 2005, "Financial Development and Economic Growth: The Case of Pakistan" Paper Presented at 21<sup>ST</sup> Annual Meeting & Conference, PIDE. Quid-I-Azam University Campus, Islam Abad.
31. Khan, M.S., and A.S. Senhadji, 2000, "Financial Development and Economic Growth: An Overview." IMF Working Paper, WP/00/209. December.
32. Khan, (2000) , "The Finance and Growth Nexus," *Business Review*, Federal Reserve Bank of Philadelphia.
33. Khwaja, Asim Ijaz and Atif Mian, (2004), "Do Lender Favor Politically Connected Firms? Renting-seeking in an Emerging Financial Market", University of Chicago.
34. King, R G. and R Levine,(1993) "Finance and Growth: Schumpeter Might Be Right," *Quarterly Journal of Economics*, 108.
35. Kremers, J.J.M., Ericsson, N.E., Dolado, J.J. (1992), "The Power of Cointegration Tests, in", *Oxford Bulletin of Economics and Statistics*, Vol. 54, pp. 325-348.
36. *Laurenceson, James and Joseph C.H. Chai, (2003), "Financial Reform and Economic Development in China", Cheltenham, UK, Edward Elgar.*
37. Layson, S., (1983), "Homicide and Deterrence: Another View of the Canadian Time Series Evidence", *Canadian Journal of Economics*, 16, 52-73.
38. Levine, R, (1997) "Financial Development and Economic Growth: Views and Agenda," *Journal of Economic Literature*, 35(2).
39. Li H. and H. Zou, 2002, "Inflation, Growth, and Income Distribution: A Cross-Country Study", *Journal of Economics and Finance*, 3, 85-101.
40. Loayza N. and R. Ranciere, (2005), "Financial Development, Financial Instability, and Growth". *IMF Working Paper* no.170

41. Lopez, H., (2004), "Pro-poor-Pro-growth: Is there a Trade Off?" The World Bank, Policy Research Working Paper No. 3378.
42. McKinnon, R I., (1973), "Money and Capital in Economic Development", Washington, D.C., The Brookings Institution.
43. Min B. Shrestha, (2003), "ARDL Modeling Approach to Cointegration Test" .
44. Pagano, M, and P Volpin, (2001), "The Political Economy of Finance", Oxford Economic Papers.
45. Perotti, R., (1996), "Growth, Income Distribution and Democracy", Journal of Economic Growth, 1, 149-87.
46. Pesaran MH, Shin Y, Smith RJ.,(2000), "Structural analysis of vector error correction models with exogenous I(1) variables", Journal of Econometrics, 97, 293–343.
47. Pesaran MH, Shin Y., (1999), "An autoregressive distributed lag modelling approach to cointegration analysis", Chapter 11 in Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Strom S (ed.). Cambridge University Press: Cambridge.
48. Pesaran, M. H., Y. Shin, and R. J. Smith (1996), "Testing for the existence of a long-run relationship," DAE Working Paper, No.9622, Department of Applied Economics, University of Cambridge.
49. PESARAN, SHIN and SMITH, (2001), "Bounds Testing Approaches to the Analysis of Level Relationships" Journal of Applied Econometrics. **16**: 289–326 (2001)
50. Rajan, R and L Zingales, (2003), "The Great Reversals: the Politics of Financial Development in the Twentieth Century," Journal of Financial Economics 69(1), pp. 5-50.
51. Roubini N. and X. Sala-i-Martin, (1992), "Financial Repression and Economic Growth". *Journal of Development Economics*, vol.39, no.1, January, p.5-30.
52. Stijn C and E Perotti, (2005), "The links between finance and inequality: channels and evidence", Research Report, University of Amsterdam

## Appendix

Figure 1

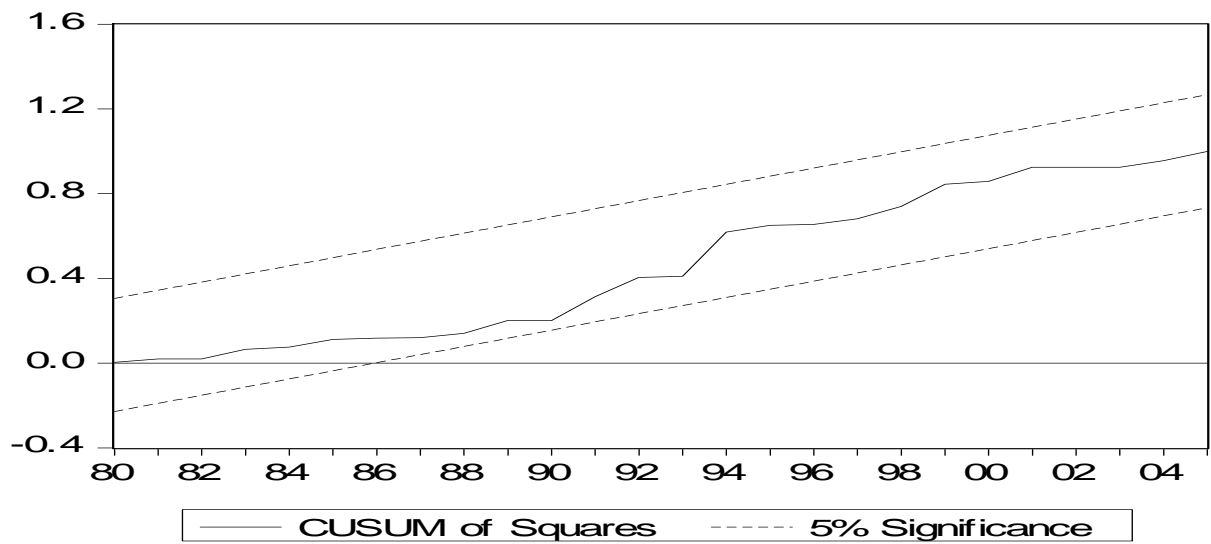
**Plot of Cumulative Sum of Recursive Residuals**



The straight lines represent critical bounds at 5% significance level.

Figure 2

**Plot of Cumulative Sum of Squares of Recursive Residuals**



The straight lines represent critical bounds at 5% significance level.