



Does financial development increase rural-urban income inequality?

Rural-urban
income
inequality

Cointegration analysis in the case of Indian economy

151

Aviral Kumar Tiwari

*Faculty of Management Studies, ICFAI University Tripura,
Kamalghat, India*

Muhammad Shahbaz

*Department of Management Sciences,
COMSATS Institute of Information Technology, Lahore, Pakistan, and*

Faridul Islam

*Department of Economics, Morgan State University,
Baltimore, Maryland, USA*

Abstract

Purpose – The purpose of this paper is to investigate the impact of financial development on the rural-urban income inequality in India using annual data from 1965 to 2008.

Design/methodology/approach – The Ng-Perron unit root test is utilised to check for the order of integration of the variables. The long run relation is examined by implementing the ARDL bounds testing approach to cointegration.

Findings – The results confirm a relation among the variables. Evidence suggest that financial development, economic growth and consumer prices aggravate rural-urban income inequality in the long run.

Research limitations/implications – The present study offers fresh insights to policy makers on crafting appropriate policies that reduce rural-urban income inequality in India.

Originality/value – The contribution of this paper is lies in extending the literature in the context of India towards an extensively researched area of rural-urban divide but in time series framework and utilization of a better approach of time series approach, i.e. ARDL. Specifically, to the best of the authors' knowledge, this is the first empirical study to test poverty-finance nexus using the basic principles of the GJ hypothesis and provide evidence of short- and long-run dynamics on the postulated relation for India.

Keywords Financial development, Rural-urban inequality, India, ARDL, Rural regions, Urban regions

Paper type Research paper



JEL classification – G00, G28, O11, O15, O16

The authors are grateful to two anonymous referees and the Editor for their constructive comments and suggestions on an earlier draft of the manuscript without which the paper would have remained flawed and incomplete. The authors are solely responsible for any remaining errors.

1. Introduction

India, a latecomer to economic reforms and liberalization, joined the club in the 1990s in the wake of a severe external balance crisis. On the verge of bankruptcy, India had few options. Learning from the experience of her East Asian neighbors' achievement of high growth and poverty reduction, India made her choice. To avert the crisis India adopted a policy of greater export orientation; and an active private sector. While some steps were taken earlier in the 1980s, only from the 1990s was a systemic shift made towards more liberalization and a reliance on market as the strategy. A healthy and active private sector, inflow of foreign investment and restructured government were seen as the growth paradigm for post-reform India. During the years from 1992 to 2002 the economy grew at an average rate around 6.0 percent, slightly better than the rate of 5.7 percent in the 1980s. In the later period growth was fuelled by of external debt buildup which was unsustainable, as manifested in the crisis in 1991. The growth in the 1990s was hallmarked by external stability despite the Asian flu. Poverty decline in the 1990s was at a faster rate than in the 1980s (Datt and Ravallion, 1996). The growth performance during the decade masks one fact: despite an impressive rate of 6.7 percent in the first five years following reforms, the slowdown to 5.4 percent over the next five years was disappointing. Analysts differ on the reasons behind the growth deceleration. The global crisis can explain part of the story but India's exposure on the world economy had not been significant enough to account for that kind of dip. While critics of liberalization squarely put the blame it on the trade policy reforms (Nambiar *et al.*, 1999; Chaudhuri, 2002), those opposed suggest that the slowdown was rooted in the failure to implement effective reforms. The policy of gradualism in India frustrates many, and this was just one example.

The ascendancy of India to a major regional player in the economic and political landscape on the global stage is no accident, rather an outcome of well-designed strategy of divorce from the old socialist paraphernalia and a commitment to market reforms. The reforms were targeted in the areas of trade, financial sectors and fiscal matters; deregulation of market and divestment of public sector to eradicate poverty, reduce unemployment rate and economic inequality by gender, wages, and last but not least the rural-urban income. While improvement was noticeable in some areas, overall the mission did not make the passing grade; and in some cases they worsened (Tiwari, 2009, 2010a, b, 2011; Tiwari and Aruna, 2011).

The linkage between financial development, inequality and poverty is complex multi-dimensional phenomenon. The logical structure for the relation is derived from the Greenwood and Jovanovic (GJ, 1990) hypothesis which posits that at the initial stages of financial development income distribution may deteriorate; but as the process takes full effect over time, income inequality tends to improve. While GJ deals with income inequality in general, the basic framework can still apply to rural-urban income distribution. It is easy to see the GJ hypothesis within the Kuznets hypothesis which states that income inequality worsens at the initial stages of economic growth but improves as the growth process continues. The inverted U-relationship posited in the GJ hypothesis is intuitively appealing particularly, when one considers the broader impact of financial development on human capital formation; as well as the implications for the growth of small entrepreneurial class. Whether or not stimulation of economic activity ultimately will reduce income inequality depends on particular economic policies adopted, which must be determined empirically. The topic is important in light of the

potential for financial development as policy tool to reduce the widening rural-urban income inequality and poverty. The idea that social justice and economic growth should not be seen in isolation of each other is an important component of normative economics. There are some who consider economic growth without distributive justice as socially malign and destabilizing in the long run. The idea that financial development can enhance economic growth goes back to the days of Schumpeter, but has been rekindled in the context of poverty reduction.

Developed financial sector helps economic growth through two channels. First, cheaper credit makes investment attractive, where small entrepreneurs are likely to benefit more. The entrepreneurial talent is unleashed through access to financial resources which generates employment opportunities, boosts output, and enhances welfare of the poor. Second, borrowing at low cost allows the financially disadvantaged families to invest in education and health of their children and promote human capital formation – a ladder to come out of the poverty trap. Education expands opportunity set for all[1]. Human capital helps innovation and thus technological progress which is an engine of economic growth. However, economic growth alone may not be sufficient to reduce income inequality[2]. Empirical evidence to date on the topic however, is mixed. The two strands behind this idea are:

- (1) “trickle-down” mechanism; and
- (2) the Kuznets’ inverted “U” hypothesis[3].

Kuznets (1955) was the first to recognize the relationship between distribution of income and economic development, but Frankema (2006) decomposed income inequality along spatial dimensions by splitting the Kuznets’ hypothesis into within- and between-sector inequality. The former refers to rural-urban; and the latter to intra-urban and intra-rural inequalities. Research focus has been on the relationship between regional inequalities and development but little empirical evidence is available on the rural-urban income inequality in India.

Researchers have examined the role of financial development and economic growth extensively. While experience shows that liberalization in the areas of trade and finance generally helps economic growth, the impact on poverty reduction is less clearly understood. India has initiated substantial financial sector reforms and is among the fastest growing economies. With some 300 million poor, the Indian experience will be of much interest to other nations in assessing the efficacy of policy reforms in the respective socio-economic context. The case study may help disentangle the complex interaction among financial and real variables. An in-depth analysis of the finance-inequality nexus has remained somewhat neglected (Ang, 2010). As Bell and Rousseau (2001) observes, results from case studies can be related to the prevailing institutional structure and thus be of value to academicians and policy makers alike.

The objective of the paper is to examine the impact of financial development on poverty reduction in India using annual data from 1965 to 2008 by implementing the autoregressive distributed lag (ARDL) approach to cointegration. This paper contributes to the literature in several ways as it examines an important and yet understudied area using multivariate time series approach. First, this is the first empirical study to test poverty-finance nexus using the basic principles of the GJ hypothesis and provide evidence on the short- and long-runs dynamics with regard to the postulated relation for India. Second, the paper implements the ARDL approach

which is better suited in small samples. Third, the study explicitly includes control variables that are theoretically justified in the Indian context. Fourth, the paper complements other similar studies. In particular, the study closely follows the methodology by Ang (2010) but differs in research focus. Ang uses financial development-inequality nexus for India while we examine the financial development rural-urban inequality nexus for India. The later topic merits close scrutiny as many nations are plagued with rising inequalities in income; as the march for globalization and liberalization takes the center stage in growth saga.

Jha (2004) examined rural-urban inequality in India between 1993-1994 and 1999-2000. He found that the Gini coefficients for both rural and urban areas have increased in 1993-1994 but declined between 1997-1998 and 1999-2000. To our knowledge this is first formal test of the spirit of the GJ hypothesis to examine India's rural-urban income distribution. The results should help craft policies to achieve equity in rural-urban income distribution and address the issues of distributive justice (Figure 1[4]).

Rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes data sources, defines variables, and outlines empirical methodology. Section 4 interprets the results while and Section 5 offers conclusions based on the results.

2. Literature review

Several studies have used household consumption expenditure data from the National Sample Survey (NSS) of India to show trends in rural-urban inequality at the aggregate and regional levels; but the results so far, have been inconclusive. During 1993-1994 and 1999-2000 both urban and rural Gini coefficients have declined. The rural inequality decreased in 15 out of 16 major states; and urban inequality declined in eight of the 17 states of India (Bhalla, 2003). Based on the findings, he concludes that inequality did not worsen in India during the reform period. According to Singh *et al.* (2003, p. 3), "there are some indications of increases in regional inequality, but they are neither uniform nor overly dramatic". The *National Human Development Report*, Government of India (2001) reports that among the 32 states and union territories seven saw rise in rural inequality and another 15 experienced an increase in

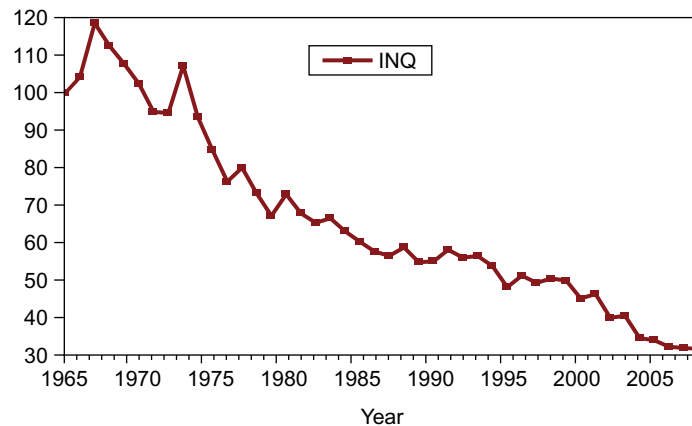


Figure 1.
Trends in gap of
rural-urban earnings
in India

urban inequality. In five North-Eastern Indian[5] states, the urban and rural inequalities increased. Between 1965 and 2008, earnings of the urban population increased more compared to the rural population (Figure 1) which added further to rural-urban income inequality.

The relationship between financial development and economic growth has drawn much research interest (King and Levine, 1993; Demetriades and Hussein, 1996; Arestis and Demetriades, 1997; Levine *et al.*, 2000; Bell and Rousseau, 2001; Luintel *et al.*, 2008); but the finance-inequality nexus has not, a near exception is Claessens and Perotti (2007). The authors argue that financial development reduces income inequality, while financial liberalization can do just do the opposite (Ang, 2010).

The frenzy with globalization and liberalization has driven many nations to get aboard the ship without giving due consideration local features. They have paid hefty price. This has led many economists to rethink the outcome of such move. Stiglitz (2004, p. 465) is particularly critical of this[6]. The theoretical literature pertaining to the effects of finance on income inequality is far from settled. Rajan and Zingales (2003) point out that the beneficiaries of an improved formal financial sector are primarily the rich. A good financial market helps the poor to borrow and invest in human and physical capital development, thereby lower income inequality (Banerjee and Newman, 1993; Galor and Zeira, 1993; Aghion and Bolton, 1997; Mookherjee and Ray, 2003, 2010; Shahbaz and Islam, 2011). However, Bourguignon and Verdier (2000) argue that poor may not benefit because their high dependence on informal credit market. Here financial development benefits the rich alone. Canavire-Bacarreza and Rioja (2009, p. 3) argue that, “given their lack of collateral and scant credit histories, poor entrepreneurs may be most affected by financial market imperfections such as information asymmetries, contract enforcement costs, and transactions costs”.

Theories of poverty and income inequality does not clearly address how financial development, or for that matter financial sector policies, affect income inequality (Demirgüç-Kunt and Levine, 2008). Clarke *et al.* (2006) used data from 83 countries from 1960 to 1995 to examine the effect of financial development on the Gini coefficient. They found that financial deepening lowers inequality in income, although the non-linear effect is not robust. Beck *et al.* (2007a) examined the impact of financial development on income distribution of the poor. They found that the former lowers the Gini coefficient, and raises income of the poor. However, some indirect evidence, provided in a survey (Arestis and Caner, 2004), suggest that the effect of financial liberalization on income distribution is ambiguous.

Recent evidence suggests that openness does not necessarily help income distribution in the developing economies. Bensidoun *et al.* (2005) argue that trade openness hurts the poor as most exporting firms employ educated workers. The poor are thus left out[7]. Bhagwati and Srinivasan (2002, p. 7) point out that:

While freer trade, or “openness” in trade, is now widely regarded as economically benign, in the sense that it increases the size of the pie, the recent anti-globalization critics have suggested that it is socially malign on several dimensions, among them the question of poverty. Their contention is that trade accentuates not ameliorates, deepens not diminishes, poverty in both the rich and the poor countries. The theoretical and empirical analysis of the impact of freer trade on poverty in the rich and in the poor countries is not symmetric, of course.

Several economists echo the concern of Bhagwati (Agènor, 2003; David and Scott, 2005; Osmani, 2005; Sindzingre, 2006; Shahbaz *et al.*, 2007b; Shahbaz and

Aamir, 2008; Shahbaz, 2010). Shahbaz *et al.* (2007a) found that a 1 percent rise in trade openness increases income inequality by 0.091 percent in Pakistan. Arestis and Caner (2004) suggest three channels that influence income inequality/poverty. First, the economic growth channel, proposed by McKinnon (1973) and Shaw (1973) which works via economic growth, but the links is far from unambiguous. Second, the financial crisis channel which works through macroeconomic volatility caused by crises following financial liberalization where the poor bear the brunt. Finally, better access to credit and financial services can have profound impact on the poor.

As India enters the 11th five-year plan, proposal is underway to achieve sustainable development by focusing on the financial sector reforms. Research by Kai and Hamori (2009) and Ang (2010) shows that financial deepening lowers income inequality[8]; and Li *et al.* (1998) found that financial development helps to reduce income inequality and raise the average income of the bottom 20th percentile of the population. Honohan (2004) also found that financial depth is negatively associated with a headcount measure of poverty. Using data from a world-wide sample Beck *et al.* (2007a) reported that financial development raises the income of the bottom quintile more compared to top quintile and thus reduce income inequality.

Bali moune-Lut and Lutz (2005)[9] examined the effects of financial deepening, trade openness and foreign capital on rural-urban income inequality in African countries. They found insignificant impact of financial deepening and foreign capital on reduction of rural-urban income inequality; but openness appears to be helpful. Shahbaz *et al.* (2007b) investigated the relationship between financial development, trade-openness and rural-urban income inequality. They found that the financial development reduces rural-urban income inequality in Pakistan; and economic growth, foreign capital, and openness widen the rural-urban income gap. Low inflation adds to rural-urban income inequality.

3. Methodology and data source

In empirical implementation of the model, we follow Ang (2010), but also add a square term to test the inverted U-shaped curve. The study uses annual data on the relevant variables, transformed into natural log, covering 1965 to 2008. The data has been taken WDI (CD-ROM, 2011). India's economic growth has been remarkable since liberalization policies were adopted. Openness has had profound impact on the economic growth. The nation had bouts with sever inflation at times. For these reasons the inclusion of economic growth, trade-openness and consumer prices are justified from theoretical considerations. We considered other relevant variables but did not explore them in the empirical part due to length of the series which can produce unreliable and poor estimates[10]. The estimable equation is as follows:

$$\ln INQ_t = \beta_0 + \beta_{FD} \ln FD_t + \beta_{GDPC} \ln GDPC_t + \beta_{CPI} \ln CPI_t + \beta_{TR} \ln TR_t + \varepsilon_t \quad (1)$$

To capture the postulated inverted U-relation, that is the impact of financial development on rural-urban earnings gap follows Kuznets form, we include the squared term of $\ln FD_t$ in equation (1). The estimable equation is as follows:

$$\begin{aligned} \ln INQ_t = & \delta_0 + \delta_{FD} \ln FD_t + \delta_{FD^2} \ln^2 FD_t + \delta_{GDPC} \ln GDPC_t + \delta_{CPI} \ln CPI_t \\ & + \delta_{TR} \ln TR_t + \varepsilon_t \end{aligned} \quad (2)$$

where FD_t is domestic credit to the private sector as share of GDP, a proxy for financial development. INQ_t is ratio between agricultural to industrial value-added as share of GDP, a measure of rural-urban income inequality. While there is a potential for endogeneity with the financial development series[11] this is less likely to be a serious problem in this paper. This paper follows Baillamoune-Luts and Lutz (2005) and Shahbaz *et al.* (2007b)[12]. $GDPC_t$ is real GDP per capita and its growth rate represents economic growth. Consumer price index (CPI)[13] proxies consumer prices; and TR_t [(export + imports)/GDP] captures openness to foreign trade[14]. The ε_t is assumed to be white noise process.

To check the stationarity properties of the series; we use Ng and Perron (2001) test which does not suffer from severe size distributions properties when error term has negative moving-average root, as can be the case with others tests[15]. Ng-Perron (2001) test utilizes GLS de-trended data which are based on modified SIC/AIC, while DF/ADF, P-P and DF-GLS unit root tests are based on non-modified information criteria. The calculated values of these tests, based on Philips and Perron (1988), are Za and Zt statistics, the Bhargava (1986) R_1 statistics, and the Elliot *et al.* (1996) statistics.

The paper implements the ARDL bounds testing approach to cointegration *a la* Pesaran *et al.* (2001) to explore a long-run relation among the series: rural-urban income inequality, financial development, economic growth, consumer prices and trade openness. The procedure has several advantages over others. First, the short- and long-runs parameters are estimated simultaneously. Second, it can be applied irrespective of the order integration of the regressors, i.e. $I(0)$, $I(1)$, or mutually cointegrated. Third, it has better small sample properties. Fourth, the error correction method integrates the short-run dynamics with long-run equilibrium, without losing long-run information. The ARDL bound testing approach involves estimating the unconditional error correction version (UECM) of the ARDL model which is modeled as follows:

$$\begin{aligned} \Delta \ln INQ = & \alpha_o + \alpha_T T + \alpha_{INQ} \ln INQ_{t-1} + \alpha_{FD} \ln FD_{t-1} + \alpha_{GDPC} \ln GDPC_{t-1} \\ & + \alpha_{CPI} \ln CPI_{t-1} + \alpha_{TR} \ln TR_{t-1} + \sum_{i=1}^b \alpha_i \Delta \ln INQ_{t-i} \\ & + \sum_{j=0}^q \alpha_j \Delta \ln FD_{t-j} + \sum_{l=0}^n \alpha_l \Delta \ln GDPC_{t-l} + \sum_{n=0}^n \alpha_n \Delta \ln CPI_{t-n} \\ & + \sum_{O=0}^O \alpha_m \Delta \ln TR_{t-O} + \mu_i \end{aligned} \quad (3)$$

The decision about cointegration in ARDL model depends on the critical bounds generated by Pesaran *et al.* (2001). The null hypothesis of no cointegration is: $H_o : \alpha_{INQ} = \alpha_{FD} = \alpha_{GDPC} = \alpha_{CPI} = \alpha_{TR} = 0$ is tested against the alternate of cointegration: $H_a : \alpha_{INQ} \neq \alpha_{FD} \neq \alpha_{GDPC} \neq \alpha_{CPI} \neq \alpha_{TR} \neq 0$. The calculated F -statistic is compared with lower critical bound (LCB) and upper critical bound (UCB) from Pesaran *et al.* (2001). The null hypothesis is rejected if computed F -statistic exceeds UCB. The decision is for no cointegration if LCB exceeds the computed F -statistic. Finally, if the F -statistic lies between UCB and LCB, the decision about cointegration is inconclusive. To check reliability of the estimates we conduct diagnostic and stability tests to examine the presence of serial correlation, incorrect functional form, non-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 (CUSUM_{SQ}).

4. Results and interpretation

All series in the model are normally distributed, significant at the 5 percent level (Appendix, Table AI). Results of stationary arechecked by applying the Ng-Perron (2001) unit root test and reported in Table I.

Although ARDL bounds testing to cointegration holds regardless of the order of integration of each series, we still formally test it to insure that none of the series is $I(2)$ or higher in which case the calculated F -statistic becomes invalid (Ouattara, 2004).

Results reported in Table I suggest that these series: rural-urban income inequality, financial development, economic growth, consumer prices and trade openness are non-stationary in levels but are first difference stationary. This sets the stage for cointegration. The results are presented in Table II. The lag for each series is chosen by AIC. We set the optimal lags at three for $\ln INQ_t$ lag; and two for $\ln GDPC_t$, $\ln CPI_t$ and $\ln TR_t$.

It is evident that the series: rural-urban income inequality, financial development, economic growth, consumer prices and trade openness are cointegrated at the 1 percent level (the calculated F -statistic, $10.397 > F$ -statistic, 8.643) (Table II) using unrestricted intercept and trend. The estimated long-run coefficients are reported in Table III and for both linear and non-linear models (with FD-squared).

The results in Table III show that the impact of financial development, economic growth, and inflation on rural-urban inequality is negative and significant at the 1 percent level. In other words, the three series are delivering exactly the opposite of what was expected. They widen the rural-urban earnings gap even in the long run. The evidence suggests that government policies to boost economic growth and thus help poor by deepening of financial institutions are not delivering the intended consequence. The poor suffer from growing rural and urban income inequality. These results contrast with those found by Shahbaz *et al.* (2007b) for Pakistan.

Looking at the coefficients, the adverse impact of economic growth on rural-urban inequality is the largest followed by CPI. Trade openness has positive impact but is statistically insignificant. There is some indication that rural-urban migration is

Variables	MZa	MZt	MSB	MPT
$\ln INQ_t$	-13.5193(1)	-2.5902	0.1916	6.7956
$\ln FD_t$	-3.5031(1)	-1.3117	0.3744	25.803
$\ln GDPC_t$	-0.0016(1)	-0.0007	0.4298	47.864
$\ln CPI_t$	-10.3464(2)	-2.2108	0.2136	9.1050
$\ln TR_t$	-9.4741(1)	-2.0894	0.2205	9.9778
$\Delta \ln INQ_t$	-29.4357(1)*	-3.8361	0.1303	3.0974
$\Delta \ln FD_t$	-17.7627(1)**	-2.9707	0.1672	5.1874
$\Delta \ln GDPC_t$	-27.9191(1)*	-3.7360	0.1338	3.2648
$\Delta \ln CPI_t$	-24.6406(2)**	-3.5100	0.1424	3.6983
$\Delta \ln TR_t$	-23.7325(1)**	-3.4103	0.1437	4.0455

Table I.
Ng-Perron (NP)
unit root test

Note: Significance at: *5 and **1 percent levels

Panel I: bounds testing to cointegration

Estimated equation $\ln INQ_t = f(\ln FD_t, \ln GDPC_t, \ln CPI_t, \ln TR_t)$

Optimal lag structure (3, 2, 2, 2)

F-statistics 10.397

Significant level Critical values ($T = 49$)^a

Lower bounds, $I(0)$ Upper bounds, $I(1)$

1 percent 7.337 8.643

5 percent 5.247 6.303

10 percent 4.380 5.350

Panel II: diagnostic tests Statistics

R^2 0.8875

Adjusted R^2 0.7891

F-statistics 9.019 (0.0001)

J-B normality test 0.7663 (0.6816)

White heteroskedasticity test 1.6094 (0.1306)

ARCH LM test 0.4260 (0.6559)

Ramsey RESET 0.0294 (0.8653)

Note: ^aCritical values generated by Narayan (2005, p. 1990) using unrestricted intercept and unrestricted trend

Table II.
ARDL bounds testing to cointegration

Variable	Dependent variable = $\ln INQ_t$			
	Coefficient	t-statistic	Coefficient	t-statistic
Constant	4.5584	4.9168 *	5.2192	3.3386 *
$\ln GDPC_t$	-0.3832	-3.9739 *	-0.4470	-2.8804 *
$\ln FD_t$	-0.1059	-2.7555 *	-0.3376	-0.7656
$\ln FD_t^2$	-	-	0.0385	0.5273
$\ln CPI_t$	-0.2435	-3.9870 *	-0.2100	-2.3736 **
$\ln TR_t$	0.0467	0.8339	0.0388	0.6652
R^2	0.9811		0.9813	
Adjusted R^2	0.9794		0.9791	
F-statistics	573.808		451.571	
D.W	1.6414		1.6682	
Test	F-statistic	Prob-value	F-statistic	Prob-value
χ^2 Normal	1.3307	0.5140	1.4303	0.4891
χ^2 Serial	0.3538	0.7041	0.2966	0.7449
χ^2 ARCH	0.0450	0.8329	0.0184	0.8926
χ^2 Hetero	2.1302	0.0930	1.8178	0.1296
χ^2 Reset	1.0485	0.3116	1.3590	0.2682

Notes: Significance at: *1 and **5 percent levels; χ^2 Normal indicates to the Jarque-Bera statistic of the test for normal residuals, χ^2 Serial is the Breusch-Godfrey LM test statistic for no serial relationship, χ^2 ARCH is the Engle's test statistic for no autoregressive conditional heteroskedasticity, χ^2 Hetero is the heteroscedasticity and χ^2 Reset is Ramsey's test statistic for no functional misspecification

Table III.
Long run results

bringing fruits as a result of trade openness in India. It is likely that large-scale migration to the urban areas, the hubs of manufacturing sector with higher wage, helped the poor.

The coefficients of financial deepening/development and its square have negative and positive sign, respectively, but both are insignificant. Based on sign of the estimated coefficients, the function generates U-shaped relation between financial

development and earnings of rural population. This produces exactly the kind of relation policy makers never want to see happening in the long run!

The diagnostic tests show that residual in both models is normally distributed with no evidence of serial correlation. The autoregressive conditional heteroscedasticity and white heteroscedasticity seem to be absent. Both the models are well specified as shown by Ramsey Reset *F*-statistic (Table III).

Results of short-run dynamics using the ECM version of ARDL are reported in Table IV. The short-run results are strikingly different from the long-run ones. Economic growth and inflation lowers rural-urban income inequality while trade openness increases it. Financial development aggravates rural-urban inequality, but is not significant. Based on the ECM term, the deviation from the long-run equilibrium path is corrected 37.16 percent per year which is much lower compared to other developing countries. For example, Shahbaz *et al.* (2007b) found 62.9 percent adjustment rate for Pakistan.

Hansen (1992) admonishes that in time series analysis estimated parameters can vary over time. As such he suggests testing for parameters stability. Unstable parameters indicate model misspecification. To address this, cumulative sum of recursive residuals (CUSUM) and the CUSUM square (CUSUM_{SQ}) tests proposed by Brown *et al.* (1975) have been applied [16]. The null hypothesis is constancy of the regressions coefficients overtime, against the alternate that they are not. Brown *et al.* (1975) pointed out that these residuals are not very sensitive to small or gradual parameter changes, although can be detected by analysing recursive residuals. If the null hypothesis is correct, the recursive residuals have an expected value of zero. Our results suggest parameter consistency under both tests. The plots are within the critical bounds of 5 percent level of significance (Appendix). The model passes short-run diagnostic tests successfully.

Dependent variable = $\Delta \ln INQ_t$			
Variable	Coefficient	SE	<i>t</i> -statistic
Constant	-0.0414	0.0152	-2.7234*
$\Delta \ln GDPC_t$	0.8235	0.2054	4.0088*
$\Delta \ln GDPC_{t-1}$	-0.5790	0.2007	-2.8849*
$\Delta \ln FD_t$	-0.0095	0.1105	-0.0861
$\Delta \ln CPI_t$	0.2024	0.1182	1.7123***
$\Delta \ln TR_t$	-0.0983	0.0585	-1.6806***
ECM_{t-1}	-0.3716	0.1385	-2.6829**
<i>Diagnostic tests</i>			
<i>R</i> ²	Statistics		
Adjusted <i>R</i> ²	0.6636		
<i>F</i> -statistics	0.6144		
Durbin-Watson test	13.483 (0.0000)*		
J-B normality test	1.9454		
Breusch-Godfrey LM test	1.0659 (0.5868)		
ARCH LM test	0.0801 (0.9232)		
Heteroscedisticity test	0.1521 (0.6983)		
Ramsey RESET	0.7055 (0.6469)		
	2.2262 (0.1435)		

Table IV.
Short run results

Note: Significance at: *1, **5 and ***10 percent levels

5. Conclusions and policy implications

In this study, we apply the ARDL bounds testing approach to cointegration to examine a long-run relationship between financial developments, rural-urban income inequality in India. As control variables we use economic growth, consumer prices and trade openness. The data covers 1965-2008. The Ng-Perron test is used to check for the stationarity properties of the series. All variables are non-stationary in their level, but first difference stationary. The series are cointegrated.

The study finds correlation rather than of causation which makes it hard for clearly making policy recommendation. Future research can look into this issue more carefully. Based on the results, we conclude that financial development policy has not delivered the desired outcome. The policy has not helped to reduce rural-urban inequality in the long run, although appear to have worked in the short run. This may be due to misalignment between the short-term objective; and the more important long-run strategy of sustainability. The old India used to be seen in the images of 300 million poor living under \$1 a day is now home to some 50-plus billionaires. The process of income and wealth concentration is likely to continue – something many see as the lopsided impact of globalization. In the unfolding saga of widening income disparity across the globe, if stark, however, India is not alone in this race!

Policy of micro-credit through micro-finance institutions intended to help the poor has been ineffective in reducing the rural-urban inequality in India in the long run. While India has maintained remarkable rates of economic growth, she also had had several bouts with severe inflation. The short- and long-run results are interesting. In the short-run inflation improves inequality, not in the long run. Although insignificant, trade openness lowers income inequality as workers gain job skill which takes longer time. There appear to be need for more deregulation so the market can play out its own course; keeping in mind that hasty and reckless decision can backfire. Evidence suggests that economies can benefit from liberalization if they are properly prosecuted and appropriately managed. Some sectors can be ready sooner than others. India should take more liberal, if careful and gradual, approach as she moves for structural reform in the area of trade. As Tiwari and Aruna (2011, pp. 87-8) documents, “trade with developing countries found to be having larger negative impact on share of wages of unskilled workers than the trade with developed countries”. This happens as a large proportion of unskilled workers in India live in the rural areas who suffer in the short run as the trading nations might have similar factor endowment and thus compete with each other. One limitation is that the study does not assess the impact of trade openness with developed and developing country separately; which can be an independent research.

In summary, we find significant differences in the long vs short-term outcome. The impact of financial development, economic growth, and inflation on rural-urban inequality is negative and highly significant in the long term. In the short term, economic growth and inflation lowers rural-urban income inequality while trade openness increases it. Financial development aggravates inequality, but not significant. The macroeconomic policies and structural reforms adopted by India are increasing rural-urban divide instead of reducing it. From policy perspective, focus should be on lowering the inequality in the long run. India should realign financial development policy with economic growth that also meets distributive justice. Second, implement and carefully monitor pro poor micro-credit policies; and make micro-credit financial institutions more effective. Third, identify areas of weakness in the current

policies, periodically review their efficacy, and change them as needed. Fourth, the largest negative coefficient on economic growth on inequality is troubling. Such outcome indicates that finance led economic growth is not sustainable. However, the recent sustainable growth objective by the Indian Government needs to be reviewed often in light of success or failure. The second highest negative coefficient of CPI is discomfoting. This indicates that India's long-term domestic policy particularly with respect to inflation is unfavourable to the rural poor. This cast doubt about efficacy of monetary policy and the long-term vision of the central bank (the RBI). Fifth, the U-shaped, instead of the inverted U-relation between financial development rural-urban income inequalities defies the outcome of the GJ hypothesis. This could be due to serious policy lapse that needs to be addressed, sooner rather than later.

Notes

1. Developing countries face higher inflation over an extended period of time. Access to financial markets and/or fully indexed assets, available to the rich use the daily indexed protection against high inflation.
2. Cysne *et al.* (2004), Erosa and Ventura (2002), Lucas and Stokey (1987) and Sturzenegger (1992) develop models to answer this question. With cash-in-advance constraints, high inflation (or hyper inflation) is like a tax on goods. This forces to reallocate cash to consumption of goods using credit. This process of financial adaptation is imperfect, as the Brazilian experience shows, because the poor are financially strapped. They hold cash, and suffer due to high inflation tax which widens inequality.
3. The trickle-down effect posits that as economies expand poverty reduces but the rate may be adversely affected due to the increased inequality in the short run. Kuznets' (1955) inverted U relationship states that at the initial stage of economic development inequalities rise to a point (during middle-income stage), after which inequalities decrease as income per capita rises.
4. If value of INQ exceeds 100 then earnings of the rural population are increasing faster than that of the urban. If INQ is less than 100, then earnings of urban population are rising than that of the rural.
5. States and union territories where rural inequality has increased: Assam, Manipur, Mizoram, Nagaland, Sikkim, Chandigarh, Dadra and Nagar Haveli and Arunachal Pradesh. States and union territories where urban inequality has increased: Assam, Bihar, Gujarat, Haryana, Karnataka, Manipur, Mizoram, Nagaland, Punjab, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Daman and Diu. Both urban and rural inequality has increased in Assam, Manipur, Mizoram, Nagaland and Sikkim.
6. His comments deserve special scrutiny. "Even in its hey-day, the New Economy raised a question: if the New Economy meant an increased pace of growth in the developed world, if the developing countries could not take advantage of the new economy, then there would be increasing disparities in income. Rather than the convergence that was predicted".
7. They also found that international trade leads to increased inequality both in rich and poor countries while improve income distribution in middle-income countries.
8. Shahbaz and Aamir (2008) have also analyzed the role of foreign direct investment in Pakistan in reducing the inequality during 1971-2005. They found that FDI inflow have positive impact on inequality, i.e. it worsens income distribution because it is focused towards capital intensive industrial and services sectors of urban localities. Further, they found that relation between income distribution and trade-openness is as par the Leontief paradox, i.e. more trade promotes rich class more. Therefore, they concluded by saying that there is imperative need to revise the macroeconomic policy of attracting the FDI in Pakistan.

9. The variable used here to measure rural-urban inequality is taken from Baillamoune-Lutz and Lutz (2005). We do not claim being pioneer in this area to provide a measure as the ratio between agriculture and industrial value added to GDP. The same measure was also used by Shahbaz *et al.* (2007b) as proxy for rural-urban income inequality.
10. There are several other variables that could be considered, as indicated by the referee, such as such as human capital, macroeconomic stability, or institutional. However, we are constrained by data. Given that the objective is to examine impact of financial development on rural-urban inequality, we had to be very selective. We identified important and relevant variable in line with our mission which might be of help to the policymakers.
11. Theoretically endogeneity is plausible and cannot be ruled out a priori. Financial development in India is still in infancy. Given the short length of the sample, the reverse causality from income distribution to financial development is less likely. Also, India still has a sizeable non-monetized sector which will impede the reverse causality. However, a formal test was not done.
12. In the absence of a clear definition for rural-urban income inequality, the Gini coefficient is often used. Some used data from household level or sample survey by NSSO. In India, NSSO does not conduct annual survey regularly for which time series data is unavailable. The proxy used is consistent with other studies (Baillamoune-Lutz and Lutz, 2005; Shahbaz *et al.*, 2007a, b). Interestingly, the data depicts the same pattern as the NSSO survey data. In India most of the value added in the rural area comes from agriculture and related activities, but the direct contribution of agriculture is decreasing.
13. There are different CPI's for industrial workers (CPI-IW), and for agricultural laborers (CPI-AL), for rural laborers (CPI-RL). For purpose of our analysis, we used composite index of CPI constructed by RBI. Recall that we are interested in testing whether inflation affects rural-urban inequality. This can be done by two other ways without using the composite index of CPI. (a) we could take rural-urban CPI ratio; or (b) we could take difference of rural-urban CPI. However, in either case we would have created more problems due to complications with the rural CPI. Reserve Bank of India (RBI) provides composite index of CPI for industrial sector; but for rural sector RBI calculates two indices namely CPI's for agricultural laborers (CPI-AL) and for rural laborers (CPI-RL). Since, weighting procedure and calculation for rural CPI's is not very clear in the general reports of RBI, we preferred composite index of CPI.
14. We convert all series into natural logarithm.
15. If the root is close to -1 (e.g. -0.79) the rejection rate can be as high as 100 percent (Schwert, 1989).
16. The first of these involves a plot of the cumulative sum (CUSUM) of recursive residuals against the order variable and checking for deviations from the expected value of zero. Symmetric confidence lines above and below the zero value allow definition of a confidence band beyond which the CUSUM plot should not pass for a selected significance level. A related test involves plotting the cumulative sum of squared (CUSUMSQ) recursive residuals against the ordering variable. The CUSUMSQs have expected values ranging in a linear fashion from zero at the first-ordered observation to one at the end of the sampling interval if the null hypothesis is correct. Again, symmetric confidence lines above and below the expected value line define a confidence band beyond which the CUSUMSQ plot should not pass for a selected significance level, if the null hypothesis of parameter constancy is true. In both the CUSUM and CUSUMSQ tests, the points at which the plots cross the confidence lines give some indication of value(s) of the ordering variable associated with parameter change.

References

- Agènor, P.R. (2003), *Does Globalization Hurt the Poor?*, Mimeo, The World Bank, Washington, DC.
- Aghion, P. and Bolton, P. (1997), "A theory of trickle-down growth and development", *Review of Economic Studies*, Vol. 64 No. 2, pp. 151-72.
- Ang, J.B. (2010), "Finance and inequality: the case of India", *Southern Economic Journal*, Vol. 76 No. 3, pp. 738-61.
- Arestis, P. and Caner, A. (2004), "Financial liberalization and poverty: channels of influence", Economics Working Paper Archive wp_411, The Levy Economics Institute, New York, NY.
- Arestis, P. and Demetriades, P.O. (1997), "Financial development and economic growth: assessing the evidence", *Economic Journal*, Vol. 107 No. 442, pp. 783-99.
- Baili moune-Luts, M. and Lutz, S.H. (2005), "Rural-urban inequality in Africa: a panel study of the effects of trade liberalization and financial deepening", *Journal of African Development*, Vol. 57 No. 1, pp. 1-19.
- Banerjee, A.V. and Newman, A.F. (1993), "Occupational choice and the process of development", *Journal of Political Economy*, Vol. 101, pp. 274-98.
- Beck, T., Demirgüç-Kunt, A. and Levine, R. (2007a), "Finance, inequality and the poor", *Journal of Economic Growth*, Vol. 12 No. 1, pp. 27-49.
- Bell, C. and Rousseau, P.L. (2001), "Post-independence India: a case of finance-led industrialization?", *Journal of Development Economics*, Vol. 65 No. 1, pp. 153-75.
- Bensidoun, I., Jean, S. and Sztulmann, A. (2005), "International trade and income distribution: reconsidering the evidence", CEPII Working Paper No. 2005-17.
- Bhagwati, J. and Srinivasan, T.N. (2002), "Trade and poverty in the poor countries", *The American Economic Review*, Vol. 92 No. 2, pp. 180-3.
- Bhalla, S.S. (2003), "Recounting the poor: poverty in India, 1983-99", *Economic and Political Weekly*, Vol. 25 No. 31, pp. 338-49.
- Bhargava, A. (1986), "On the theory of testing for unit roots in observed time series", *Review of Economic Studies*, Vol. 53 No. 3, pp. 369-84.
- Bourguignon, F. and Verdier, T. (2000), "Oligarchy, democracy, inequality and growth", *Journal of Development Economics*, Vol. 62, pp. 285-313.
- Brown, R.L., Durbin, J. and Evans, J.M. (1975), "Techniques for testing the constancy of regression relationships over time", *Journal of the Royal Statistical Society: Series B*, No. 37, pp. 149-92.
- Canavire-Bacarreza, G. and Rioja, F. (2009), "Financial development and the distribution of income in Latin America and the Caribbean", *Well-Being and Social Policy*, Vol. 5 No. 1, pp. 1-18.
- Chaudhuri, K. (2002), "Convergence of inflation rates during flexible exchange rate period", *Indian Economic Review*, Vol. 37 No. 1, pp. 59-68.
- Claessens, S. and Perotti, E. (2007), "Finance and inequality: channels and evidence", *Journal of Comparative Economics*, Vol. 35 No. 4, pp. 748-73.
- Clarke, G.R.G., Xu, L.C. and Zou, H.-F. (2006), "Finance and income inequality: what do the data tell us?", *Southern Economic Journal*, Vol. 72 No. 3, pp. 578-96.
- Cysne, R., Maldonado, W.L. and Monteiro, P.K. (2004), "Inflation and income inequality: a shopping-time approach", *Journal of Development Economics*, Vol. 78 No. 2, pp. 516-28.
- Datt, G. and Ravallion, M. (1996), "Macroeconomic crises and poverty monitoring", FCND discussion papers 20, International Food Policy Research Institute (IFPRI), Washington, DC.
- David, M. and Scott, A. (2005), *Macroeconomics: Understanding the Wealth of Nations*, Wiley, New York, NY.

-
- Demetriades, P.O. and Hussein, K.A. (1996), "Does financial development cause economic growth? Time-series evidence from 16 countries", *Journal of Development Economics*, Vol. 51 No. 2, pp. 387-411.
- Demirgüç-Kunt, A. and Levine, R. (2008), "Finance and economic opportunists", *Revue d'économie du développement*, Vol. 22, pp. 5-29.
- Elliot, G., Rothenberg, T.J. and Stock, J.H. (1996), "Efficient tests for an autoregressive unit root", *Econometrica*, Vol. 64, pp. 813-36.
- Erosa, A. and Ventura, G. (2002), "On inflation as a regressive consumption tax", *Journal of Monetary Economics*, Vol. 49 No. 4, pp. 761-95.
- Frankema, E. (2006), "A Theil decomposition of Latin American income distribution in fresh look", *Economic and Political Weekly*, Vol. 15, pp. 1069-73.
- Galar, O. and Zeira, J. (1993), "Income distribution and macroeconomics", *Review of Economic Studies*, Vol. 60 No. 1, pp. 35-52.
- Government of India (2001), *National Human Development Report of India, 2001, Planning Commission*, Government of India, New Delhi.
- Greenwood, J. and Jovanovic, B. (1990), "Financial development, growth, and the distribution of income", *Journal of Political Economy*, Vol. 98 No. 5, pp. 1076-107.
- Honohan, P. (2004), "Financial development, growth and poverty: how close are the links?", World Bank Policy Research Working Paper 3203.
- Jha, R. (2004), "Reducing poverty and inequality in India: has the liberalization helped?", in Cornia, G.A. (Ed.), *Inequality, Growth and Poverty in an Era of Liberalization and Globalization*, UNU-WIDER Studies in Development Economics, Helsinki, pp. 297-327.
- Kai, H. and Hamori, S. (2009), "Globalization, financial depth, and inequality in Sub-Saharan Africa", *Economics Bulletin*, Vol. 29 No. 3, pp. 2025-37.
- King, R.G. and Levine, R. (1993), "Finance and growth: Schumpeter might be right", *Quarterly Journal of Economics*, Vol. 108 No. 3, pp. 717-37.
- Kuznets, S. (1955), "Economic growth and income inequality", *American Economic Review*, Vol. 45 No. 1, pp. 1-28.
- Levine, R., Loayza, N. and Beck, T. (2000), "Financial intermediation and growth: causality and causes", *Journal of Monetary Economics*, Vol. 46 No. 1, pp. 31-77.
- Li, H., Squire, L. and Heng-fu, Z. (1998), "Explaining international and intertemporal variations in income inequality", *Economic Journal*, Vol. 108 No. 1, pp. 26-43.
- Lucas, R.E. and Stokey, N. (1987), "Money and interest in a cash-in-advance economy", *Econometrica*, Vol. 55 No. 3, pp. 491-514.
- Luintel, K.B., Khan, M., Arestis, P. and Theodoridis, K. (2008), "Financial structure and economic growth", *Journal of Development Economics*, Vol. 86 No. 1, pp. 181-200.
- McKinnon, R.I. (1973), *Money and Capital in Economic Development*, The Brookings Institution, Washington, DC.
- Mookherjee, D. and Ray, D. (2003), "Persistent inequality", *Review of Economic Studies*, Vol. 70 No. 2, pp. 369-93.
- Mookherjee, D. and Ray, D. (2010), "Inequality and markets: some implications of occupational diversity", *American Economic Journal: Microeconomics*, Vol. 2 No. 1, pp. 38-76.
- Nambiar, R.G., Mumgekar, B.L. and Tadas, G.A. (1999), "Is import liberalisation hurting domestic industry and employment?", *Economic and Political Weekly*, Vol. 13 No. 7, pp. 417-24.

- Narayan, P.K. (2005), "The saving and investment nexus for China: evidence from co-integration tests", *Applied Economics*, Vol. 37 No. 17, pp. 1979-90.
- Ng, S. and Perron, P. (2001), "Lag length selection and the construction of unit root tests with good size and power", *Econometrica*, Vol. 69 No. 6, pp. 1519-54.
- Osmani, S.R. (2005), "The impact of globalization on poverty in Bangladesh", Working Paper 65, Policy Integration Department National Policy Group International Labour Office, Geneva.
- Quattara, B. (2004), *Foreign Aid and Fiscal Policy in Senegal*, Mimeo, University of Manchester, Manchester.
- Pesaran, M.H., Shin, Y. and Smith, R.J. (2001), "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, Vol. 16, pp. 289-326.
- Phillips, P.C.B. and Perron, P. (1988), "Testing for a unit root in time series regression", *Biometrika*, Vol. 75, pp. 335-446.
- Rajan, R. and Zingales, L. (2003), "The great reversals: the politics of financial development in the twentieth century", *Journal of Financial Economics*, Vol. 69 No. 1, pp. 5-50.
- Schwert, G.W. (1989), "Tests for unit roots: a Monte Carlo investigation", *Journal of Business and Economic Statistics*, Vol. 7 No. 2, pp. 147-60.
- Shahbaz, M. (2010), "Income inequality economic growth and non-linearity: a case of Pakistan", *International Journal of Social Economics*, Vol. 37 No. 9, pp. 613-36.
- Shahbaz, M. and Aamir, N. (2008), "Direct foreign investment and income distribution: a case study for Pakistan", *International Research Journal of Finance and Economics*, Vol. 21, pp. 7-18.
- Shahbaz, M. and Islam, F. (2011), "Financial development and income inequality in Pakistan: an application of ARDL approach", *Journal of Economic Development*, Vol. 36, pp. 35-58.
- Shahbaz, M., Butt, M.S. and Aamir, N. (2007a), "Rural-urban income inequality under financial development and trade openness in Pakistan: the econometric evidence", *The Pakistan Development Review*, Vol. 46 No. 4, pp. 657-72.
- Shahbaz, M., Lodhi, A. and Butt, M.S. (2007b), "Financial development under the shade of globalization and financial institutions: the case of Pakistan", *Philippine Review of Economics*, Vol. 44 No. 2, pp. 125-48.
- Shaw, E. (1973), *Financial Deepening in Economic Development*, Oxford University Press, New York, NY.
- Singh, N., Laveesh, B., Aoyu, C. and Khare, A. (2003), "Regional inequality in India: afresh look", *Economic and Political Weekly*, Vol. 15 No. 11, pp. 1069-73.
- Stiglitz, J.E. (2004), "Globalization and growth in emerging markets", *Journal of Policy Modeling*, Vol. 26 No. 4, pp. 465-84.
- Sturzenegger, F. (1992), "Inflation and social welfare in a model with endogenous financial adaptation", NBER working paper Series.
- Tiwari, A.K. (2009), "Globalization and wage inequality: an empirical study for a developing country", *Conference Issue of Indian Economic Society*, Vol. 1, p. 914.
- Tiwari, A.K. (2010a), "Globalization and wage inequality: a revisit of empirical evidences with new approach", *Journal of Asian Business Management*, Vol. 2 No. 1, pp. 173-87.
- Tiwari, A.K. (2010b), "Liberalization and wage inequality: evidence from Indian manufacturing sector: a review of literature", *Asian Economic Review*, Vol. 52 No. 3, pp. 565-92.

Tiwari, A.K. (2011), *Liberalization and Wage Inequality: Evidence From Indian Manufacturing Industry*, Lap Lambert Academic Publishing, Germany.

Tiwari, A.K. and Aruna, M. (2011), "Is direction of trade responsible for wage inequality in India? An empirical analysis", *Indian Journal of Economics and Business*, Vol. 10 No. 1, pp. 73-90.

Further reading

Beck, T., Demircuc-Kunt, A. and Peria, M.S.M. (2007b), "Reaching out: access to and use of banking services across countries", *Journal of Financial Economics*, Vol. 85 No. 1, pp. 234-66.

Kirkpatrick, C. (2000), "Financial development, economic growth, and poverty reduction", *The Pakistan Development Review*, Vol. 39 No. 4, pp. 363-88.

Appendix

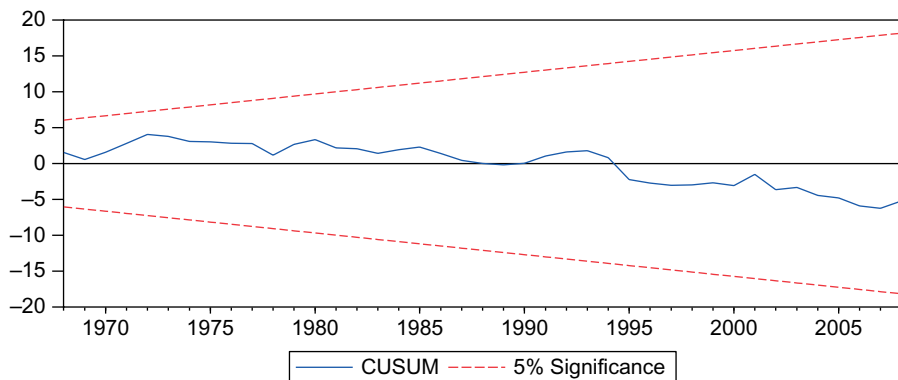


Figure A1.
Plot of cumulative sum
of recursive residuals

Note: The straight lines represent critical bounds at 5 percent significance level

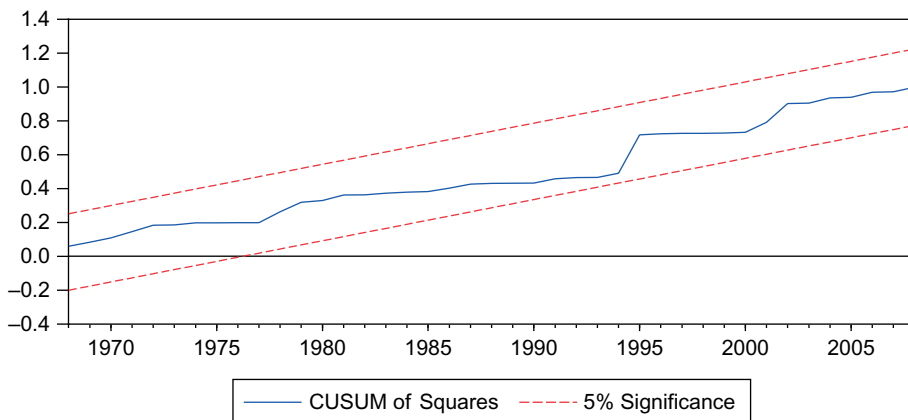


Figure A2.
Plot of cumulative sum of
squares of recursive
residuals

Note: The straight lines represent critical bounds at 5 percent significance level

Table AI.

Descriptive statistics

Variables	$\ln INQ_t$	$\ln GDPC_t$	$\ln FD_t$	$\ln CPI_t$	$\ln TR_t$
Mean	0.6153	7.0808	3.0382	3.0901	- 3.2161
Median	0.6703	6.9649	3.1765	3.0860	- 3.3293
Maximum	1.3496	7.9703	3.9192	4.8035	- 0.4938
Minimum	- 0.0876	6.6332	2.0711	1.3454	- 5.2706
SD	0.3933	0.3866	0.4853	1.1025	1.5013
Skewness	- 0.1313	0.7293	- 0.4260	- 0.0124	0.1625
Kurtosis	1.9374	2.3759	2.2703	1.6649	1.7316
Jarque-Bera	2.4458	5.1390	2.5693	3.6401	3.5004
Probability	0.2943	0.0765	0.2767	0.1620	0.1737

Corresponding authorAviral Kumar Tiwari can be contacted at: aviral.eco@gmail.com