Chapter 1
Does Economic Growth Increase Inequality?: An Empirical Analysis for ASEAN Countries, China and India

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Abstract Even though 10 member countries of the Associations of Southeast Asian Nations (ASEAN), People's Republic of China and India (ACI) have adopted polices for archiving more pro-poor or inclusive growth. However, income and non-income inequality in ACI have witnessed an increasing trend in recent years. In view of rising inequality in fast growing Asian developing countries, it is important to study the relationship between economic growth and income inequity which could assist policy makers to adopt appropriate policy action for more inclusive growth. This paper undertakes an empirical analysis to examine if economic growth increases income inequality for ACI. The objectives of the paper are: (i) to develop a simple model of policy-induced growth which shows a nonlinear and wave-like relationship between growth and inequality; (ii) to provide an empirical support to the above model to establish that the intention to use economic growth and inequality as policy instruments to shape economic development can backfire since the possibility of a wave-like function receives an empirical support from ACI data; and (iii) to exhibit that the nonlinear relationship between growth and inequality

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within ACI nations is mainly driven by the availability of foreign direct investment (FDI). In addition, the paper finds other interesting elements in the relationship between growth and inequality which has profound policy implications for the ACI Economies.

Keywords Growth · Inequality · Foreign direct investment · Poverty ASEAN People's Republic of China and India

JEL Classifications H21 · O11 · O15 · O41

1.1 Introduction

During the past five decades one of the critical changes of paramount significance in the global economy is a gradual and continual transfer of the production capacity of the global economy from the West to the East Asian nations—namely Japan, Taiwan, South Korea and finally to the People's Republic of China (PRC),[1] India and Association of Southeast Asian Nations (ASEAN) nations.

Economies of ASEAN nations, PRC and India are collectively known as the ACI economies and our focus in this paper is the dynamics of growth and inequality within the ACI economies. The significant change in Asian development with the advent of the PRC and India in the 1990s is the remarkable economic growth attended by equally spectacular rising inequality in the region. All ACI economies are expected to see strong economic growth, leading to a fourfold expansion of the region's gross domestic product (GDP) by 2030. The region's share of global output is expected to rise from 15% today to nearly 30% (in 2010 constant prices) over the next two decades. By then, the size of ACI economy will be larger than those of the United States and Europe combined in terms 2010 constant prices GDP.[2] The major challenge for policymakers in the ACI economies is to create adequate wealth for around 3 billion people in an equitable fashion, which should promote income equality, thereby mitigating social heat. Achieving the goal of socially inclusive growth, however, is a formidable task for the ACI economies (Gangopadhayay and Bhattacharyay 2011).

The interrelationships between inequality and economic growth of a nation, or groups of nations, have been extensively studied in economics while an apparent

[1]This region has grown into the economic powerhouse of the global economy. In 1955 China, Japan, South Korea and Taiwan encompassed over one quarter of the global population but generated only 9% of the gross domestic product (GDP) of the globe. Within a span of five decades East Asia's population, measured against the world's total, had fallen to 23.24% while its share of the global GDP had shot up nearly threefold to 25%. During the five decades since 1955 these East Asian economies grew from among the poorest to among the richest in the world.

[2]In purchasing power parity terms, ACI's GDP is projected to be larger than the GDP of the US and Europe combined.

inconclusiveness of the literature has become one of the classic examples of the most enduring economic debates in macroeconomics (see Barro 2000; Dollar and Kraay 2002; Easterly 1999; Forbes 2000; Kraay 2005; Lopez 2004; Ravallian 1997, 2004). In an important contribution Banerjee and Duflo (2003) questioned the tenability of the assumed *linear* relationship between growth and inequality in the existing literature by establishing an inverted U curve between growth and inequality.[3]

The main goal of our paper is threefold: first, we develop a simple model of policy-induced growth in order to establish a nonlinear and wave-like relationship between growth and inequality. Second, we provide empirical support to our model to establish that the intention to use economic growth and inequality as policy instruments to shape economic development can backfire since the possibility of a wave-like function receives an empirical support from ACI data, though a more rigorous analysis is called forth. Third, we show that the nonlinear relationship between growth and inequality within ACI nations is mainly driven by the availability of foreign direct investment (FDI).

The plan of the paper is as follows: in Sect. 1.2 we provide a brief literature review. Section 1.3 also introduces the baseline model, economic data and the modelling framework. Section 1.4 provides the estimation procedure and basic results to show the nonlinear relationship between growth and inequality in ACI. Section 1.5 applies the threshold analysis to determine the role of FDI to explain the growth can bear a nonlinear relationship with inequality. Section 1.6 concludes.

1.2 Modelling Growth and Inequality: Related Literature

Several interesting and important issues are at stake in the context of growth and inequality: first and foremost, an extensive literature exists on the policy framework and institutional details that promote equitable growth (see Kanbur 2005 for a review). Second, some attempts have been made to understand the dynamics of choice of a society of those specific policies and institutions that are responsible for creating, fueling and driving equitable growth. The rational choice models of political economy provide some insights into the success, or failures, of a society in choosing appropriate institutional structures and relevant policies for promoting equitable growth.[4] There are obvious difficulties in isolating precise links between

[3]Banerjee and Duflo (2003) marshalled evidence and offered a political economy model to explain why there is little theoretical salience to the assumed linear, or even monotonic relationship between growth and inequality. From the cross-country data they established that changes in inequality and growth rate bear an inverted U-shaped relationship, which may either be caused by measurement errors or by their model. The inverse U curve can explain the divergence of estimates of the previous studies on the impact of inequality on growth.

[4]See Besley and Case (2003), Besley and Coate (2003), Case (2001), Drazen (2000), Persson and Tabellini (2000, 2003).

economic policies and their impacts on economic growth, as highlighted by Easterly (2001). Thirdly, the role of equitable growth is adequately reflected in the United Nations' strategy to reduce the incidence of global poverty by half, under the Millennium Development Goals (MDGs), by creating equitable growth by the year 2015. There is a convergence of views, or opinions, on two related themes: first, increasing economic growth holding inequality unchanged is good for a society. Admittedly, there is little discussion on the impacts of economic growth on environment. Second, inequality holding the rate of economic growth unchanged is bad for a society. However, once inequality and growth both vary, the statistical results are inconclusive about their interrelationship. Though, economists tend to still get influenced by the 'Kuznets curve', in an early work, Anand and Kanbur (1993) showed that the cross-country data cannot establish any precise relationship. Our work will try to establish the *raison-d'etra* for this finding, which was confirmed by others in subsequent work (e.g. Deininger and Squire 1998, 1999; Li et al. 1998 among others).

1.2.1 Growth, Inequality and Their Interrelationships

An extensive literature has already explored how distribution of income affects the GDP growth (see early work by Persson and Tabellini 1994; Alesina and Rodrik 1994). Note that the direction of causality is postulated to run opposite to the much-celebrated Kuznets' Hypothesis that argues that income inequality first rises and then falls during the course of economic development, or economic growth (Kuznets 1955). Alesina and Rodrik (1994) find a negative relationship between inequality and growth in a political-economy model of endogenous growth, if government spending is devoted entirely to production. Persson and Tabellini (1994) confirm the result as Alesina and Rodrik (1994) in a two-period overlapping-generations model. On the other hand, Li and Zou (1998) came to the opposite conclusion by examining the relationship between income inequality and economic growth in an endogenous growth model with distributive conflicts among agents. They find that when the household utility function is logarithmic in public consumption and exhibits a higher-than-unity degree of risk aversion in private consumption, a more equal distribution of income causes a higher rate of capital taxation in a majority voting mechanism. An increase in the rate of capital taxation lowers economic growth, which shows that income inequality can foster faster economic growth. Empirical results based on the cross-country evidence, undertaken by Li and Zou (1998), Clarke (1995), Benabou (1996), Deininger and Squire (1998, 1999), Li et al. (1998, 2000a, b), Barro (2000), Savvides and Stengos (2000), Forbes (2000), Banerjee and Duflo (2003), Chen (2003), among many others, are somewhat inconclusive.

1.2.2 The 95% Theory of Kuznets' Inverted U Hypothesis: Just a Glorified Speculation?

Growth and inequality and their mutual feedbacks on each other can hardly escape the tyranny of the oft-repeated 'iron law of empirical regularity' popularly known as the inverted U hypothesis of Kuznets. The hypothesis posits that economic growth is initially accompanied with an increasing inequality till a point, which is the hilltop of the inverted U curve, and then they bear an inverse relationship. The causality is believed to run from growth to inequality. There is no gain saying to the fact that Kuznets' inverted U hypothesis has played an important role in the continuing debate on the interrelationship between inequality and growth since his class is the work published in 1955. In his own opinion, yet, Kuznets underscored the inverted U as a 95% speculation and 5% 'empirical verification'. Moreover, his 'empirical verification' was centered on three advanced nations Germany, England and the US. The inverted U hypothesis proposes two mutually exclusive phenomena: first, at lower levels of economic development, increasing economic growth promotes rising inequality. The rising inequality is caused by economic growth since economic growth results in an important transition of an economy, at a lower level of economic development, from predominantly agrarian to an industrial society. The fundamental assumption is that the industrial sector is richer and also more 'unequal' than the agrarian sector. The rising weights and importance of the industrial sector thus cause the inequality to rise until a critical point. Secondly, economic growth beyond this critical point lowers inequality due to another important transition in the society—namely the organization of industrial workers into powerful lobbies and unions to advance their self-interests. Kuznets (1955) was cautious in labelling his own hypothesis as 'speculation' since such transitions are neither guaranteed nor sacrosanct. If there are forces within the society that thwart, or cause multiple recurrences of, these transitions the Kuznets-inverted U will never materialize.

In what follows we show the possibility of a wave function, instead of an inverted U-shape, between economic growth and inequality with significant implications.

1.2.3 The Exalted Status of the Interrelationships Between Growth and Inequality: The Immortal Triangle of Growth-Inequality-Poverty

In their important initial work Kakwani et al. (2004), Ravallion and Chen (2003), and Ravallion (2004), and subsequent finessing, they have provided the foundation for the important goal of maximizing the *reduction of poverty* via finetuning economic growth and equity. For the reduction of poverty, they have tended to agree that both faster economic growth and greater equity should be the policy priorities of national governments and international agencies.[5] The essence of the argument of the pro-poor growth (PPG) of Ravallian and Chen (2003) requires that as an inequality index; say the Gini coefficient, increases, the rate of PPG will decline relative to the actual rate of growth. Similarly, if the index falls, the rate of PPG will rise relative to the actual rate of growth. The definition of Kakwani et al. (2004) is known as the poverty equivalent growth (PEG) that is the product of the actual growth rate and the poverty elasticities with respect to income growth and income inequality. If the PEG exceeds the actual growth rate then growth is pro-poor, otherwise not.[6] Both these definitions are based on the effects of growth and inequality in reducing poverty. In simple terms, both theories seek to maximize the 'Total Poverty Elasticity' (with respect to both the growth of income and changes in inequality), by assuming a *complementarity* between economic growth and income equality in reducing poverty. However, the problem is that the cross-country regressions have not provided empirical support to the complementarity between growth and equity.

1.3 Our Modelling Framework

In our analysis X represents economic growth while x is the change in economic growth over time. In a similar vein, Y is economic inequality and y is the change in inequality over time. We posit that the policy maker receives a positive return R that is predicated on economic growth and given by[7]:

$$[R(X)/X] = a - bX,\ a > 0,\ b > 0,\ \text{and}\, X > (b/a) \tag{1.1a}$$

[5]It is well known in the literature that Kakwani et al. (2004) and Ravallian (2004) had different definitions of 'Pro-Poor Growth'. Kakwani et al. unequivocally noted the importance of identifying a *relative* improvement in the condition of the poor, which convinced them to argue that "the incomes of the poor grow faster than those of the non-poor". On the other hand, Ravallion's original position recognized that more rapid growth is 'pro-poor' if it is more poverty-reducing in terms of headcount ratios.

[6]The PEG is given by the percentage change in the poverty headcount relative to the percentage change in income per capita. The 'Total Poverty Elasticity' (TPE) combines both the 'Poverty Elasticity of Growth' and the 'Poverty Elasticity of Inequality' (PEI). The PEI is the percentage change in the poverty headcount relative to the percentage change in the Gini Coefficient. Hence, if the 'Total Poverty Elasticity' exceeds the 'Poverty Elasticity of Growth', then the reduction in inequality is reducing poverty and, by definition, the Poverty Equivalent Growth Rate exceeds the actual growth rate.

[7]One can argue governments seek economic growth since growth reduces poverty. Kraay (2005) showed that 70% short-run changes in poverty are propelled by growth in average incomes of nations.

We assume that economic inequality imposes a cost on the policy maker[8] and the policy cost, C, depends both on X and Y and given as

$$C(X, Y) = c(Y/X)^2/2, \; c > 0 \tag{1.1b}$$

Note $\partial C/\partial X < 0$ and $\partial C/\partial Y > 0$. The higher the growth the lower is the cost of inequality. The policy cost increases with increased inequality, ceteris paribus. Some of the policy costs may be purely pecuniary such as social security payment, unemployment benefits while others may be purely social like conflicts, jealousy, social deprivation, etc.

We further entertain the notion prevalent in the policy community that inequality and growth will have impacts on the time profile of the change in growth x and we express the relationship as

$$X = F(Y, X) \tag{1.1c}$$

We assume that increase in inequality induces growth and hence $\partial F/\partial y > 0$.[9] We also assume $\partial F/\partial X < 0$. The higher is the initial growth X, the lower is the change in growth rate x. We express (1.1c) as a simple linear function[10]:

$$X = hy - mX \,\text{with}\, h > 0 \,\text{and}\, m > 0 \tag{1.1d}$$

It is imperative that we carefully explain Eq. (1.1d) and our model of agent behaviour here before making any further progress: we postulate that the policy maker and all economic agents have 'learned to believe' the economist's model that there is a linear and positive relationship between inequality and growth. It is important to note that the so-called "threshold effects" offer a theoretical justification in terms of political economy models for higher inequality at a point in time to slower future economic growth. Banerjee and Duflo (2003) examine some of these threshold effect models and develop an overarching model to capture various

[8]There are various ways one can rationalize the cost of inequality on policy makers and one possibility is due to Ravallian (1997, 2004) who established that the effectiveness of growth in reducing poverty depends on the initial level of inequality. His 2004 estimates show that 1% increase in average income will result in a decline of 4.3% of poverty for very low inequality nations, or as little as 0.6% for high inequality nations.

[9]Following the unanimity of the empirical literature, we posit that growth does not impact on inequality (see Dollar and Kraay 2002; Easterly 1999).

[10]First, it is widely recognized and empirically verified that increases in inequality promote economic growth (see Banerjee and Duflo 2003; Li and Zou 1998; Arellano and Bond 1991). In contrast, Barro (2000) and Lopez (2004) did not find *strong* dependence of growth on inequality. Lopez (2006) and Lopez and Serven (2006) reversed their earlier findings. Secondly, impacts of X on x represent an implicit condition for convergence of growth paths.

causal links running from inequality to growth.[11] Banerjee and Duflo (2003) suggested the possibility of an inverted U curve as an empirical association between economic inequality and economic growth. The problem is that there are various causal links by which inequality impacts on growth and empirical verification of each is a serious problem (see Kanbur 2005). This problematic issue is pithily outlined by Kanbur (2005) as:

> The jury is still out, and the literature swings between combinations of papers that claim to show causality from high inequality to low growth, to those that claim to show no causality - or even that more inequality leads to higher growth (p. 226).

It is instructive to note that the choice of (1.1d) is robust, which can easily incorporate the “threshold effect” by altering the signs of the coefficients to h (<0) and m (<0), which will not change. These changes in signs will have no effect on the subsequent equilibria X_i* and their stability properties. Our model is thus capable of generating wave-like functions even when $h < 0$ and $m < 0$, which are likely to be the case for threshold effect models. What is also important is that we postulate that the linear relationship is not only the “shared mental model” but also the correct model. However, the problem starts the very moment the policy maker tries to exploit this linear relationship to achieve a desirable mix of inequality and growth. What we will show is that the attempt to influence changes in growth by changing inequality by the policy maker will create the wave-like relationship between growth and inequality. Let us now get back to the basics of the model.

The policy-induced growth model is represented by a policy maker who solves the following present value problem:

Maximize $V(x) = \int_0^T \mathrm{e}^{-\mathrm{rt}}[R(X) - C(Y, X)]\mathrm{d}t$

Subject to

$$[R(X)/X] = a - bX,\ a > 0,\ b > 0,\ \text{and}\, X > (b/a)$$

$$C(X, Y) = c(Y/X)^2/2,\ c > 0$$

$$x = hy - mX$$

$$X(0) = a$$

[11]These models postulate that there are threshold effects in the return to human capital in the sense that substantial returns are generated only after a critical threshold of human capital is reached by decision-makers. If capital market is imperfect then these decision-makers will have to self-finance their building of human capital. In such a scenario, under a set of conditions, increase inequality will cause the accumulation of human capital to decline, which will thereby lower labour productivity and thereby reduce future economic growth.

The Hamiltonian–Jacobi–Bellman (HJB) equation is given by

$$rV(x) = \mathrm{Max}[R(X) - C(X,\ Y) + V'(x)x] \tag{1.2a}$$

Proposition 1.3.1 *If X* represents the steady state economic growth, the Hamiltonian–Jacobi–Bellman equation is reduced to:*

$$X^*\left[h^2 aX^*/(cr) - h^2 bX^{*2}/(cr) - m\right] = X^* M(X^*) = 0 \tag{1.2b}$$

M is a quadratic function of X. Thus there are three possible steady state equilibria*:

$$X_1{}^* = 0 \tag{1.2c}$$

$$X_2{}^* = a + \mathrm{SQRT}\left[\left(a^2 - 4bmcr\right)/2b\right] \tag{1.2d}$$

$$X_3{}^* = a - \mathrm{SQRT}\left[\left(a^2 - 4bmcr\right)/2b\right] \tag{1.2e}$$

Proof By definition X^* is given by

$$x = hy - mX = 0 \tag{1.3a}$$

From the HJB equation, we have

$$V(X^*) = \left[R(X^*) - cy^2 \Big/ (2X^*)^2\right] \Big/ r \tag{1.3b}$$

$$V(X^*) = \left[R(X^*) - cm^2/\left(2h^2\right)\right]/r \tag{1.3c}$$

Hence

$$V'(X^*) = R'(X^*)/r \tag{1.3d}$$

The Left-Hand Side (LHS) of the HJB is:

$$\mathrm{LHS} = rV(X^*) = R(X^*) - \left(cm^2\right)/\left(2h^2\right) \tag{1.3e}$$

The Right-Hand Side (RHS) of the HJB is:

$$\mathrm{RHS} = \max_{\{y\}}\left[R(X^*) - (cm^2)/(2h^2) + xR'(X^*)/r\right] \tag{1.3f}$$

The first-order condition requires:

$$\frac{\partial\left[(R(X^*) - cm^2/(2h^2) + (hy - mX^*)R'(X^*)/r\right]}{\partial y} = 0 \tag{1.4a}$$

Note that (1.4a) yields:

$$Y = h(a - bX^*)/(c^*r) \tag{1.4b}$$

Substituting (1.4b) into (1.3a) yields:

$$X^*\left[\left(h^2a\right)/(c^*r)X^* - \left(h^2b\right)/(c^*r)\,X^{*2} - m\right] = 0 \tag{1.4c}$$

Equation (1.4c) has three roots as given by Eqs. (1.2c), (1.2d) and (1.2e) that are the three steady states.

The above equilibria can be depicted in Fig. 1.1.

1.3.1 Discussion of the Theoretical Findings

In Fig. 1.1, we plot economic growth along the horizontal axis and the change in growth along the vertical axis and Eq. (1.2b) is drawn as $M(X)$ that intersects the horizontal axis at X_1*, X_2* and X_3* that are the three equilibrium growth rates, or steady states, and their stability is described arrows: X_3* is the unstable equilibrium that separates the other two stable equilibrium. We note that X_1*, X_2* and X_3* can be Pareto-ranked from the standpoint of growth. X_1* is the Pareto-worst, X_2* is the Pareto-best and are the extremal equilibria (see Milgrom and Roberts 1990 and Vives 2005) and X_3* acts as a separatrix between the extremal equilibria. If the

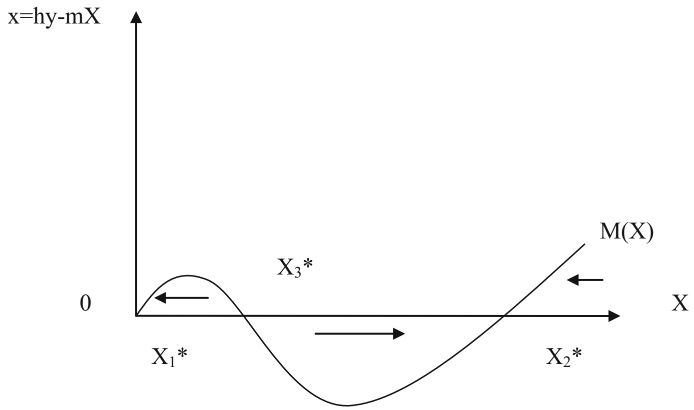

Fig. 1.1 Multiple growth equilibria

initial rate of growth $X < X_3*$, the system monotonically converges to the Pareto-worst equilibrium X_1*. If the initial economic growth exceeds X_3*, $X > X_3*$, then the system monotonically converges to the Pareto-dominant equilibrium X_2*. It is also important to note that the dynamics of growth will bring the growth rates $X*$ within ($X_1* < X* < X_2*$) as the mixed strategy outcomes, correlated equilibria and rationalization equilibria will lie in the zone ($X_1* < X* < X_2*$). Any kind of adaptive dynamics will take the system monotonically to either of the extremal equilibria (see Vives 1990). One can also impose an explicit dynamics to generate cyclical fluctuations within the extremal equilibria (see Vives 2005: pp. 430). Furthermore, properly mixed equilibria can also be shown to be unstable with respect to a general adaptive dynamics (see Echenique and Edlin 2004).

1.3.2 Empirical Foundation to the Nonlinear Relationship Between Growth and Inequality

We will estimate Eq. (1.4c) by using a set of panel data including observations for six ACI nations covering the period 1991–2012. Our panel consists of data for China, India and eight ASEAN nations, except Singapore, for which relevant data is available, namely, Cambodia, Laos, Indonesia, Malaysia, Myanmar, Thailand, the Philippines, Vietnam. The intuition is to use inequality as a dependent policy variable, which depends on economic growth and a set of other regressors. We consider the following variables for each country:

INQ_{it}: A measure of inequality in country i at date t,

$GROWTH_{it}$: Annual growth rate of real GDP of country i at date t,

Ω_{it}: Set of control variables including (ignoring the time and country subscripts):

1. Country EXPORT measures the internalization of the economy and is captured through annual value of exported goods and services (not scaled by GDP).
2. Country FOODP is a proxy for the cost of living with significant impacts on inequality and is captured by the index of food prices.
3. Proxy for country's available productive capacity is ENERGYO and is captured by the value of energy output.
4. Annual country PCGDP is the per capita GDP at constant prices and used as a proxy for economic development of the country.
5. Annual foreign direct investment (FDI) is a proxy for internationalization of the economy as well as a measure of the productive capacity of the country.
6. Annual value of private capital formation (KFORM) at constant prices is a proxy for the additional capital goods available for production purposes in the country.
7. The ratio of debt to GDP, DEBTGDP, is a proxy for financial deepening and the financial vulnerability of the country.
8. POPG is the annual increase in the size of the population of a country, which is used as a proxy for the expansion of the labour input as well as an indicator of budgetary needs of government to keep inequality low.

1.3.3 Inequality and Growth Data: A Small Note

The real income growth data are from the GDP figures reported in the Penn World Table 6.1. The inequality data is drawn from the Estimated Household Income Inequality Data Set (EHII)—a global dataset derived from the econometric relationship between UTIP-UNIDO, other conditioning variables, and the World Bank's Deininger and Squire data set (see http://utip.gov.utexas.edu/about.html). The UTIP-UNIDO data set source computes inequality measures for nearly 3200 country/year observations, covering over 150 countries during the period 1963–1999. Inequality is linked to a number of mathematical concepts such as skewness, variance, and dispersion. Consequently, there are several methods to compute inequality, for example the McLoone Index, the coefficient of variation, range, range ratios, the Gini Coefficient and Theil's T statistic. The main justification for choosing Theil's T statistic is that it offers a more flexible structure that often makes it more suitable than other measures.[12] If we had permanent access to all necessary individual-level data for the population of interest, measures like the Gini coefficient or the coefficient of variation would be generally satisfactory for describing inequality. Yet, in the real world, individual data is hardly ever reachable, and researchers make do with aggregated data. The rest of the dataset came from the Asian Development Bank.

1.4 Empirical Results: Panel Analysis of Determinants of Inequality

To model potential nonlinear effects of economic on inequality, we use a cubic polynomial of INQ as a function GROWTH in our econometric model. Our benchmark regression model is a model of panel estimation based on GMM estimates. In this section determinants of inequality are analyzed through panel estimations based on GMM regressions. This approach addresses the problem of potential endogeneity of all the regressors and also incorporates fixed effects. The two variants of this approach that are used are (1) the difference—GMM estimation arising from Arellano and Bond (1991) and (2) the system—GMM estimation arising from Blundell and Bond (1998). Both approaches rely on first-differencing and usage of lagged values of endogenous variables as instruments, for identification. In the Arellano–Bond estimator, lagged levels are used to instrument for the differenced right-hand side variables. In the Blundell-Bond estimator, the estimation system comprises the difference equation instrumented with lagged levels as in the Arellano-Bond estimator as well as the level equation which is estimated using

[12]Pedro Conceição and Pedro Ferreira provide a much more detailed analysis of these issues in their UTIP working paper 'The Young Person's Guide to the Theil Index: Suggesting Intuitive Interpretations and Exploring Analytical Applications'.

lagged differences as instruments. As neither estimator is perfect and has idiosyncratic limitations, results utilizing both procedures are reported.

1.4.1 The Panel Estimation Equation

Following the approach of Baele et al. (2007), the regression (analytical) model is constructed to examine the determinants of inequality in a panel set of 10 countries over 22 years (1990–2012). It is specified as:

$$\mathrm{INQ_{it}} = \beta_1\,\mathrm{INQ_{it}} + \beta_2\,\mathrm{GROWTH_{it}} + \beta_3\,\mathrm{GROWTH_{it}^2} + \beta_4\,\mathrm{GROWTH_{it}^3} + \beta_5\,\Omega_{\mathrm{it}} + \varepsilon_{\mathrm{it}} \cdots \quad (1.5\mathrm{a})$$

where,

$\mathrm{INQ_{it}}$	A measure of inequality in country i at date t,
$\mathrm{GROWTH_{it}}$	Annual growth rate of real GDP of country i at date t,
Ω_{it}	Set of control variables (ignoring the time and country subscripts) as explained in Sect. 1.4.2, pp. 10.

1.4.2 GMM Estimation Results

Table 1.1 outlines the panel summary statistics. Table 1.2 presents the panel estimation results corresponding to the estimation specification of the previous section. The results in Table 1.2 are obtained from the Arellano–Bond procedure, the Blundell-Bond procedure. Both procedures report the results obtained from using

Table 1.1 Descriptive statistics

	Mean	STD	Min	Max
GROWTH	5.58	3.81	−13.2	14.2
Ln FDI	6.74	2.45	1	11.87
Ln PCGDP	5.48	1.09	2.83	8.33
Ln IMPORT	9.31	2.09	5.09	13.88
Ln ENERGYO	9.66	2.15	4.85	13.4
Ln INQ	3.7	0.14	3.29	4.05
Ln EXPORT	9.49	1.99	4.37	13.8
Ln KFORM	9.25	2.48	3.27	160.3
DEBTGDP	66.4	74.1	9.83	578.17
Ln FOODP	5.07	0.68	3.45	6.83
POPG	1.81	0.9	−1.11	5.49
Observations	220	220	220	220

Table 1.2 GMM regression results

Variable	Model 1 (Arenallo-Bond)	Model 2 (system GMM)	Model 3 (fixed effect estimate)	Model 4 (FGLS estimate)
Lagged INQ	−0.074 (−0.41)	0.62 (6.05)*		
EXPORT	−0.0001 (−1.71)**	−6.59 e07 (−0.18)	−2.71e06 (−0.51)	−0.000014 (1.53)***
ENERGYO	0.0005 (2.56)*	2.28e−06 (0.61)	4.84e−06 (1.07)	0.000007 (4.90)*
PCGDP	0.013 (2.66)*	0.002 (1.57)***	0.0003 (0.16)	0.013 (2.66)*
GROWTH	−0.4 (1.66)**	0.11 (−0.57)	−0.24 (−0.80)	−0.55 (−2.86)*
$GROWTH^2$	0.002 (1.41)	−0.011 (−1.16)	−0.024 (−1.66)**	0.011 (0.90)
$GROWTH^3$	0.02 (1.49)***	0.0004 (0.37)	0.0016 (0.87)	0.003 (1.89)**
FDI	−0.0003 (−0.07)	−0.0006 (−1.07))	−0.0016 (−1.86)**	−0.006 (−1.10)
KFORM	−0.01 (−1.30)	−0.013 (1.92)**	0.01 (1.08)	−0.005 (−0.70)
DEBTGDP	−0.04 (1.91)**	0.015 (1.36)	0.031 (1.86)**	−0.044 (−2.43)*
POPG	0.11 (0.05)	1.23 (0.99)	−1.63 (−1.15)	2.35 (1.53)***
FOODP	0.06 (1.66)***	0.007 (0.62)	0.031 (2.81)*	−0.0021 (−0.18)
CONSTANT	29,2 (4.35)*	14.66 (2.99)*	42.85 (13.44)*	31.96 (9.75)*
			R^2 within = 0.18 between = 0.92 overall = 0.43 Wald chi2 = 38.1	Sigma u = 11.91, Sigma e = 2.57, Rho = 0.96, $F(5, 44) = 12.75$, Prob > F = 0.0
Observations	220			
Number of groups Sargan test	10	Prob > Chi^2 = 0.048		
GMM estimation method	Difference	Difference	Difference	Difference

Dependent variable is a measure of inequality (INQ) within a country
*Significant, for double-sided critical value, at the 0.05 level, **Significant, for one-sided critical value, at the 0.05 level, ***Marginally (one-sided) significant

the "xtabond2" Stata utility6. There are four different specifications of the basic model: Model 1 captures the Arellano-Bond estimation, Model 2 captures the GMM estimate, Model 3 is the fixed effect and the Model 4 is the model of FGLS.

1.4.3 Panel Estimation Results and Findings

In Table 1.2, we summarize the panel regressions.

Panel estimation through the GMM procedure gives mixed results. The system GMM's over-identified restrictions are valid as the Sargan test result confirms. All the variables seem to play important roles in determining INQ in at least one specification of the panel regression. First and foremost, we can dichotomize determinants of INQ in ACI nations into 3 groups: first and foremost, in all specifications in which these variables are statistically significant, ENERGYO, PCGDP, FOODP & POPG are found to increase inequality, INQ. Second, EXPORT, GROWTH, and FDI are found to lower inequality for ACI nations. This is true only for those specifications in which these 3 variables are statistically significant. It is also important to note that the lagged value of INQ also lowers INQ. Third; the variable DEBTGDP has an ambiguous effect, though statistically significant, on INQ.

It is important to note that for the cubic specification, GROWTH and $GROWTH^3$ are statistically significant for two of the four specifications. $GROWTH^2$ is one-sided significant. GROWTH and $GROWTH^2$ bear an inverse relationship with INQ and are also found to be statistically significant determinants of INQ. However, $GROWTH^3$ bears a positive relationship with INQ. The non-linear relationship between GROWTH and INEQUALITY is plotted on Fig. 1.2.

Figure 1.2 illustrates the interrelationships changes in real growth rates and inequality in the ACI economies. On the basis of the available data, we are able to isolate three stages: in Stage 1, an increase in the real growth rate (GROWTH) increases inequality (INQ). We note that in Stage 1 is feasible if the real growth rate is negative, or in a contracting economy. In other words, there is a positive relationship between GROWTH and INQ in Stage 1.

As the real growth rate (GROWTH) reaches a critical value of −5.5% Stage 1 is replaced by Stage 2. In Stage 2 economic growth (GROWTH) has a dampening effect on inequality (INQ), which gives rise to an inverse relationship between growth and inequality. When the real growth rate exceeds the critical value of 10.11%, once again, the real growth rate (GROWTH) bears a positive relationship with inequality (INQ), which we call Stage 3. In Stage 3, economic growth seems to promote inequality.

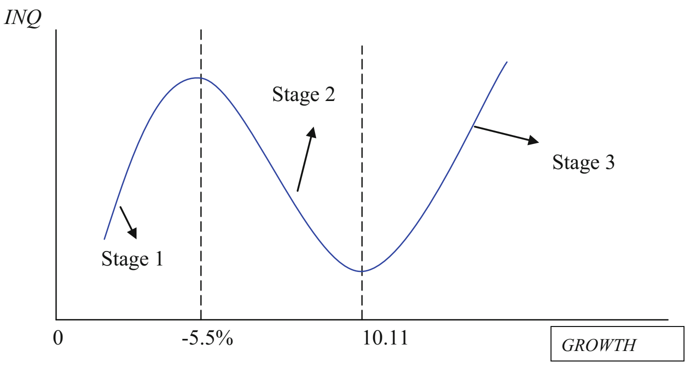

Fig. 1.2 Growth and inequality: a wave-like interrelationship

1.5 Sources of Nonlinear Relationship Between Growth and Equity: Methodology and Findings

Our point of departure from the standard models of economic growth and inequality has straightforward and testable implications: if policy makers attempt to influence one variable by choosing another, the relationship between INQ and GROWTH can turn out to be nonlinear. From the panel estimates, we found some support for our theoretical model of a wave-like relationship between INQ and GROWTH. We also explained the economic determinants of INQ in ACI nations in terms of various specifications of the panel analysis. In simple terms, we found three stages in the relationship between INQ and GROWTH, our three stages as explained in Fig. 1.2, if the policy makers seek to determine one of them by controlling the other. In this section, our focus is to explain the causes of these apparent thresholds in the relationship between INQ and GROWTH. In order to undertake the analysis of endogenous thresholds, we choose GROWTH as the dependent variable and INQ as the independent variable along with a set of regressors. The intuition is to understand how external factors like FDI impact on the growth experience of a country. As in most specifications of the previous analysis, FDI has no significant relationship with INQ. In Model 3, the specification shows some significance once we exclude the lagged variable of INQ.

1.5.1 Methodology: Reversal of Roles and Threshold Model in Terms of FDI

In this section, we attempt to understand how economic growth is impacted on by the choice of INQ and use FDI as the threshold variable. If optimally chosen, inequality can promote economic growth. At the same time, the possibility exists for the INQ to have little effects, or even ill-effects, unless they are chosen appropriately. Which of these outcomes correctly describes the relationship between INQ and GROWTH will possibly depend on other economic variables. We can describe these relationships more formally as follows:

$$\text{GROWTH}_i = \theta_{10} + \theta_{11}{}^*\text{INQ}_i + \theta_{1j}{}^*Z_j + \varepsilon_i \text{ for FDI}_i < \tau \quad (1.6a)$$

$$\text{GROWTH}_i = \theta_{20} + \theta_{21}{}^*\text{INQ}_i + \theta_{3j}{}^*Z_j + \varepsilon_i \text{ for FDI}_i > \tau \quad (1.6b)$$

Where FDI_i is a threshold variable and Z_j, chosen from the set of explanatory variables Ω_{it} as explained on pp. 13. In other words, Z_j is a set of controls, as explained before, except INQ and FDI.[13] While a continuous spline specification may be too restrictive, ideally we would want to allow the coefficients on FDI and INQ as well as the constant term to change.[14] From the explanatory variables, we chose Z_i as PCGDP_i, IMPORT_i, ENERGYO_i for these are the largest number of explanatory variables that allowed us endogenous sample splitting as per the Hansen (2000) process. We drop PCGDP_i in an alternative model of sample splitting due to its potential correlation with INQ. Note that for any given value of τ, (1.6a) is linear in its parameters, thus the simplest way to estimate τ is through conditional least squares (Hansen 2000).[15] In order to test the statistical significance of a threshold effect typically it is customary to test the null hypothesis of "no threshold effect", i.e. H_0: $\theta_{10} = \theta_{20,}$ $\theta_{11} = \theta_{21},$ $\theta_{1j} = \theta_{3j}$ *f*or all *j*. The alternative hypothesis assumes inequality of these coefficients.

However, since τ is only identified under the alternative, the distributions of classical test statistics, such as the Wald and likelihood ratio tests, are not asymptotically chi-squared. In essence this is because the likelihood surface is flat with respect to τ, consequently, the information matrix becomes singular and standard asymptotic arguments no longer apply. There are methods for handling hypothesis testing within these contexts. In some instances, we are able to bound the asymptotic distribution of likelihood ratio statistics (Davies 1977, 1987),

[13]This specification is quite general in that it imposes no cross-regime restrictions on our parameters. However since our focus is on how the effect of INQ on GROWTH changes, it will be useful to restrict some, or all, other model parameters.

[14]Such a specification assumes a discontinuity at the threshold, as such it is more general than a continuous spline function which is continuous at FDI $= \tau$. While methods exist for estimating τ and for approximating the asymptotic distribution of these estimators in either case, the results for discontinuous threshold models do not specialize to the case of continuous linear spline functions (Hansen 1996, 1999, 2000, 2007; Chan and Tsay 1998). In fact, the asymptotic distribution of $\hat{\tau}$ is highly non-standard in the discrete case. Here we model threshold behaviour by allowing for discrete jumps between regimes because this case imposes less structure on the model.

[15]This involves choosing $\hat{\tau}$ so as to minimize $S(\tau)$, where $S(\tau)$ is the sum of squared residuals for any given value of τ.

alternatively, their asymptotic distribution must be derived by bootstrap methods. Hansen (2000) proposes the later. The appropriate test statistic is:

$$\mathrm{LR}_0 = \frac{S_0 - S_1}{\hat{\sigma}^2} \tag{1.7a}$$

where S_0 and S_1 are, respectively, the residual sum of squares under the null hypothesis and the alternative, and $\hat{\sigma}^2$ is the residual variance under the alternative H_1 of threshold effects. In the presence of heteroscedasticity a "wild bootstrap" is preferable to standard residual bootstrapping (Wu 1986; Davidson and Flachaire 2001). This is done in a number of stages. First, by transforming the residuals, $\hat{\varepsilon}$, from our regression analysis using the following transformation: $f(\hat{\varepsilon}_i) = \frac{\hat{\varepsilon}_i}{(1-h_i)^{1/2}}$, where h_i is the ith diagonal of the projection matrix $X(X'X)^{-1}X$ and X is simply our matrix of regressors in (1.2a). Next, we generate 999 replications of the random error, u_i, where

$$u_i = \begin{cases} 1 & \text{with Probability}^{\;1/2} \\ 0 & \text{with Probability } 0 \end{cases} \tag{1.7b}$$

Finally, we can use the transformed residuals, $f(\hat{\varepsilon}_i)$, and the bootstrap errors, u_i, to create a bootstrap sample under the null as follows:

$$\begin{aligned} \mathrm{GROWTH}_i = \theta_0 + \theta_{11}{}^*\mathrm{INQ}_i + \theta_2{}^*\mathrm{Z}_i + \theta_3{}^*\mathrm{FDI}_i(\mathrm{FDI}_i < \tau) \\ + \theta_4{}^*\mathrm{FDI}_i(\mathrm{FDI}_i > \tau) + f(\hat{\varepsilon}_i)\mathrm{u}_i{}^{17} \end{aligned} \tag{1.7c}$$

In what follows (1.7c) will be decomposed into (1.8a) and (1.8b) for our empirical results. When threshold effects are present, $\widehat{\tau}$ is consistent (Hansen 2000). However, in discontinuous threshold regression models, the asymptotic distribution of $\widehat{\tau}$ is non-standard. Hansen (2000) proposes calculating confidence intervals by forming a "no-rejection region" based on likelihood ratio tests on τ. Specifically, we would want to test the null: $H_0 : \tau = \tau_0$, rejecting for large values of $\mathrm{LR}_1(\tau_0)$, where

$$\mathrm{LR}_1(\tau) = \frac{S_1(\tau) - S_1(\widehat{\tau})}{\hat{\sigma}^2} \tag{1.7d}$$

Hansen (2000) has derived the asymptotic distribution of $\mathrm{LR}_1(\tau_0)$, which while non-standard, requires little additional computation. Below we apply these methods to estimate the effect of corruption on measures of the quality of public infrastructure in a cross-section of countries. Following the rationale for the sequential estimation strategy provided by Hansen (1999), the method for a single-threshold model is first used to estimate, and then the grid search method is applied to find out the threshold value in order to minimize $S^2(h^2)$. One can obtain a second threshold value and more in a sequential fashion. The hypothesis tests for a multi-threshold model are similar to those for a single-threshold model, and are not described here.

Table 1.3 Threshold estimate

Threshold estimate	SSE	TP	Confidence interval	
			UV	LV
8.07 (=ln FDI)	2967	0.050	7.02	6.98

SSE Sum of squared errors, *TP* Trimming percentages, *UV* Upper value, *LV* Lower value, SSE (without threshold): 1973

Hansen (1996) suggested the use of a bootstrap technique to simulate its gradual distribution in order to establish the corresponding *p*-values. This paper uses Hansen's (2007, pp. 155) grid search method to deal with issues of squared residuals and their minimization. Once the threshold value is determined, the slope can then be obtained (Table 1.3).

1.5.2 Findings

The single-threshold model equation, which is found meaningful, is written as:

$$\begin{aligned} \mathrm{GROWTH}_i = {} & \theta_{01} + \theta_{11}{}^{*}\mathrm{Ln\,INQ}_i + \theta_{21}{}^{*}\mathrm{Ln\,PCGDP}_i + \theta_{22}{}^{*}\mathrm{Ln\,IMPORT}_i \\ & + \theta_{23}{}^{*}\mathrm{Ln\,ENERGYO}_i + \varepsilon_i \text{ for } \mathrm{FDI}_i < \tau \end{aligned} \tag{1.8a}$$

$$\begin{aligned} \mathrm{GROWTH}_i = {} & \theta_{02} + \theta_{12}{}^{*}\mathrm{Ln\,INQ}_i + \theta_{31}{}^{*}\mathrm{Ln\,PCGDP}_i + \theta_{32}{}^{*}\mathrm{Ln\,IMPORT}_i \\ & + \theta_{33}{}^{*}\mathrm{Ln\,ENERGYO}_i + \varepsilon_i \text{ for } \mathrm{FDI}_i > \tau \end{aligned} \tag{1.8b}$$

Where τ is the threshold of FDI being estimated by applying the Hansen Procedure and ε_i is the error term. To determine the possibility of a threshold, the threshold effect is analyzed under the null hypothesis there is no threshold in the natural log of trimming percentage and the confidence interval. The threshold estimate is noted to be 8.07 (Ln FDI) and the SSE for the single-threshold value is 37333 as opposed to the SSE of 43983 without a threshold. This shows the possibility of thresholds in investment in IT as a relevant variable for determining profits. The results are summarized in Tables 1.4 and 1.5.

Table 1.4 reports the F-statistic and *p*-values following the bootstrap simulations for a single threshold. It is found that the threshold effect is statistically significant at

Table 1.4 Threshold effect test

Test	LM test	*p*-value	Critical value		
			10%	5%	1%
Single threshold	32.09*	0.00*	51.1	67.4	137

*Statistically significant at the 95%, *p*-values and critical values are the results of bootstrap simulation for 5000 times

Table 1.5 Single-threshold effect of FDI on the interrelationship between growth and inequality

	Growth	Dependent	Variable
Panel A			
	Regime 1	Regime 2	Regime 3
	OLS	Ln FDI < 8.07	Ln FDI > 8.07
	(1)	(2)	(3)
Constant	14.5 (7.35)	7.8 (8.29)	6. 27 (12.85)
Ln PCGDP	0.53 (0.2)	−0.7 (0.26)	1.28 (0.45)
Ln INQ	−4.46 (0.2)	0.16 (2.54)	−3.48 (2.32)
Ln IMPORT	0.41 (0.13)	−0.35 (0.19)	0.68 (0.28)
Ln ENERGYO	0.081 (0.11)	0.35 (0.16)	−0.10 (0.26)
Threshold	No threshold	Ln FDI < 8.07	Ln FDI > 8.07
95% CI			
Bootstrap *p*-value	(0.00)		
Observations	215	215	215
Joint R^2	0.075	0.22	0.38
SSE	2967	1973	511.7
Residual variance	13.8	13.24	8.38
Bootstrap *p*-value	(0.00)	(0.05)	(0.02)
H—*p* value	0.21	0.21	

the 10% level for a single threshold whose value is reported in Table 1.4. After the threshold effect tests, the value of the single-threshold model is (Eq. 1.5a). According to Hansen's (1999) method for calculating the critical value of the likelihood ratio, at the 10% level of significance, the likelihood ratio test statistic is 51.48.

1.5.3 Discussion of Findings

- From Table 1.5, first and foremost, the threshold effect tests show that there is a threshold in FDI that plays a statistically significant role in determining the interrelationship between inequality and growth in the ACI economies.
- Second, for countries with Ln FDI < 8.07, inequality bears a *positive* relationship with growth and the effect is both economically meaningful and statistically significant. However, for those nations with Ln FDI > 8.07, inequality and growth bear an *inverse* relationship, which is economically and statistically significant.

- Third, we find that the volume of imports (IMORT) exert a negative influence on economic growth for countries with Ln FDI < 8.07 with a reversal of sign for those nations with Ln FDI > 8.07.
- Fourth, we notice similar reversals of signs for Ln PCGDP and Ln ENERGYO, however the effects are not statistically significant.
- Finally, we note that INQ plays a significant role in explaining variations in growth once we consider the endogenous threshold effects and other variables become less important.

1.5.4 Growth and Inequality: A Simplistic Exposition

In what follows in Figs. 1.3 and 1.4 we highlight our findings by plotting Regime 1, Regime 2 and Regime 3. As explained in Fig. 1.3, we represent Ln INQ along the horizontal axis and real growth rates (GROWTH) along the vertical axis and three (3) other regressors, namely, Ln PCGDP, Ln IMPORT, Ln ENERGYO, are pegged at their mean values across countries over 1991–2012.

- The blue-line G1 plots the OLS estimate of GROWTH with respect to Ln INQ for other three regressors fixed at their respective mean values, which is our Regime 1 in Table 1.5. The red-line G2 plots the same relationship between GROWTH and INQ for the countries for which Ln FDI < 8.07 (Regime 2). For those nations for which Ln FDI > 8.07, the green-line G3 plots the predicted relationship between GROWTH and INQ (Regime 3).
- From Fig. 1.3, one can see that the overall estimate (G1) and the estimate for countries with FDI above the threshold (G3), the relationship between GROWTH and INQ are negative, though the slopes are slightly different. From G1 and G3 we know that the growth is identical for Ln INQ = 3.2.

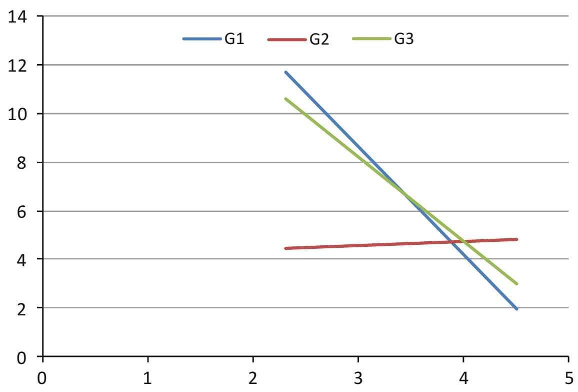

Fig. 1.3 Interrelationship between growth and equity. Note: *Vertical axis* Growth, *Horizontal axis* Ln INQ. *G1* OLS, *G2* FDI < 8.07, *G3* FDI > 8.07. Ln PCGDP, Ln IMPORT, Ln ENERGYO measured at their mean values across countries over time, based on the estimates given in Table 1.5

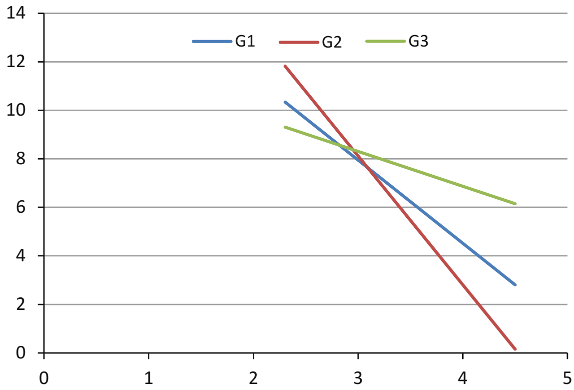

Fig. 1.4 Interrelationship between growth and equity. Note: *Vertical axis* Growth, *Horizontal axis* Ln INQ. *G1* OLS (Regime1), *G2* FDI < 8.07 (Regime 2), *G3* FDI > 8.07 (Regime 3). Ln IMPORT, Ln ENERGYO measured at their mean values across countries over time, based on the estimates given in Table 1.6. The difference between Figs. 1.2 and 1.3 is the absence Ln PCGDP in Fig. 1.4

- The relationship between GROWTH and INQ (G2) undergoes a significant change for nations for which the FDI is below the threshold (Ln FDI < 8.07). For G2, GROWTH and INQ bear an inverse relation. At the critical value of Ln INQ = 4, the growth rates converge on 4.5% for G1, G2 and G3.

1.5.5 Growth and Inequality: An Alternative Specification

In Table 1.6 we repeat the endogenous splitting of the sample, as per Hansen (1999), after dropping the PCGD variable. Everything else is unaltered. We now find a lower value of the threshold, Ln FDI = 6.76 as reported in Table 1.6. What is important is that the INQ and GROWTH bear a negative relationship for all regimes though the slope is different across regimes.

As explained in Fig. 1.4, we represent Ln INQ along the horizontal axis and real growth rates (GROWTH) along the vertical axis and two (2) other regressors, namely, Ln IMPORT, Ln ENERGYO, are pegged at their mean values across countries over 1991–2012.

- Roughly at Ln INQ = 2.8, there is a convergence of growth rates predicted by Regime 1, Regime 2 and Regime 3. The predicted real growth rate is roughly 8.2%.
- As the INQ increases beyond the critical value of Ln INQ = 2.8, ceteris paribus, this increase has a sharp impact on the real growth in countries with the FDI below the endogenous threshold (Ln FDI < 6.76). This is Regime 2 and depicted as G2 in Fig. 1.3.

Table 1.6 A test of single threshold in FDI with an alternative model (without PCGDP)

	Growth	Dependent	Variable
Panel A			
	Regime 1	Regime 2	Regime 3
	OLS	Ln FDI < 6.76	Ln FDI > 6.76
	(1)	(2)	(3)
Constant	14.57 (7.35)	20.65 (13.8)	21 (8.34)
Ln INQ	−3.46 (2.14)	−5.31 (14.24)	−1.44 (1.9)
Ln IMPORT	0.4 (0.13)	0.34 (0.34)	−0.08 (0.18)
Ln ENERGYO	−0.019 (0.12)	0.024 (0.28)	−0.71 (0.16)
Threshold	No threshold	Ln FDI < 6.76	Ln FDI > 6.76
95% CI			
Bootstrap *p*-value	(0.00)		
Observations	215	215	215
Joint R^2	0.05	0.029	0.16
SSE	3031	1359	1189.93
Residual variance	14	14.94	9.38
Bootstrap *p*-value	(0.00)	(0.05)	(0.02)
H—*p* Value	0.39		

- As the INQ increases beyond the critical value of Ln INQ = 2.8, ceteris paribus, this increase has a very moderate impact on the real growth in countries with the FDI above the endogenous threshold (Ln FDI > 6.76). This is Regime 3 and depicted as G3 in Fig. 1.3.
- As INQ declines below the critical value of Ln INQ = 2.8, ceteris paribus, this decrease in INQ has a sharp increase in real growth rates for economies with the FDI below the threshold (Regime 3). On the other hand, for Regime 3, such decrease in INQ has much moderate (positive) impacts on growth.

1.5.6 Discussion

In the existing literature, limited attempts have been made to generate a dynamic theory of income and wealth distribution integrating microeconomic models of accumulation and macroeconomic theories of factors' remuneration (see Stiglitz 1969). In this framework, it is established that the distribution of income and wealth tends asymptotically toward equality if and only if saving functions are either linear or concave. It is Stiglitz who clearly indicated that the distribution of income and wealth can have two attractors, or long-term equilibria, if the saving functions are convex. In Stiglitz's words, the convexity of saving function will generate a "two-class equilibrium". Our paper shows the possibility of multiple equilibria in a dynamic setting for the first time, to our best understanding, without exploiting the non-concavity of saving functions. It is also important to note that the cross-sectional studies point to the possibility that the marginal propensity to save increases with income and/or wealth and this empirical fact is behind the commonly held view that income equality might conflict with growth and aggregate welfare. Our findings are independent of whether saving functions are convex or concave.

In an immensely interesting work, Bourguignon (1981) showed that locally stable inegalitarian equilibria, or "stationary distributions" will exist along with the egalitarian one if the saving function is convex. Bourguignon (1981) also observed important welfare implications of the multiplicity of equilibrium as he showed that the non-egalitarian equilibria are Pareto-superior to the egalitarian equilibrium. Economic inequality in the dynamic neoclassical framework causes not only the generation of higher aggregate income and consumption per capita as could have been expected, but also higher income and consumption for all individuals. This result holds only to equilibria where all individuals have a positive wealth.

Our results confirm the main finding of Bourguignon (1981) that higher inequality (inegalitarian equilibrium) can sustain a Pareto efficient growth equilibrium (X_2*) characterized by higher inequality. Our result also confirms that the egalitarian equilibrium ($X_1* = 0$) is inefficient and characterized by zero inequality. These two equilibria are separated by an unstable equilibrium (X_3*) that creates a threshold effect. In contrast to the earlier papers, our model establishes that there is no monotonic relationship between inequality and growth if policy makers seek to influence economic growth and inequality. From the empirical study, we confirm the theoretical findings. Since growth and inequality have U-shaped and inverted U-shaped relationships, policy makers cannot utilize the interrelationship between growth and equity to achieve a desirable mix of growth and inequality.

1.6 Conclusion

Even though ACI has given high importance in achieving pro-poor or inclusive growth, however, income and non-income inequality have witnessed an increasing trend in recent years. In view of this, it is of utmost importance to study the relationship between economic growth and inequality.

The main goal of this paper is to establish that the desire of a policy maker to *choose* an optimal mix of inequality and growth, given a correctly expected *linear* model of growth and inequality, can lift the lid off the Pandora's box: the linear relationship between growth and inequality will break down to give way to a wave-like relationship, multiple equilibria and resultant complexities will emerge and the pertinence of the linear model to investigate the relationship between growth and inequality will disappear. From the empirical work, we find a statistical support for the wave like the relationship between growth and inequality, which casts a vexing doubt on the possibility of using appropriate policies to achieve a desirable mix of growth and equity.

In other words, the feasibility of using appropriate institutional structures to stimulate equitable growth via suitable economic policies can become untenable. As a result, the millennium goals of eradicating poverty through equitable growth can never be achieved, even if all the underlying growth models are correct and correctly predicted by policy makers. As our theoretical model shows, which is supported by the empirical study, that growth and inequality can have an inverted S-shaped relationship if policy makers try to achieve a desirable mix of growth and equity. In other words, the attempt to influence growth and inequality can give rise to a non-uniform association between growth and equity: there is a critical value of inequality below which the Kuznets curve relationship will hold. We also find another critical value of inequality beyond which the inverse Kuznets curve relationship becomes operational. Our empirical finding is that these critical values of inequality are reasonable values, which can, therefore, create enormous problems for policy makers to use growth and inequality in an instrumental fashion to reduce poverty.

We then examine the relationship between inequality and growth using Hansen's sample splitting methodology for threshold estimation for ten ACI nations over 22 years. The empirical results strongly suggest that FDI plays a crucial role to determine the relationship between growth and equality. Based on the aforementioned data set for ACI nations, we have estimated a threshold model to examine the relationship between growth and inequality. There is clear evidence of a single-threshold effect in terms of FDI for ACI nations. The impact of FDI on the relationship between growth and inequality establishes the following: the threshold analysis enables us to empirically derive a critical level of FDI below which growth and inequality can bear a positive relationship. Once FDI exceeds this critical level, or threshold, growth and inequality bear a negative relationship. From an alternative specification, we are able to observe that the relationship between growth and inequality is predicated on FDI.

ACI Growth has been accompanied by increased income and non-income inequalities. In order to achieving a socially inclusive growth, the ACI economies will not only require high economic growth, but also several major transformations in various domains—such as educational revolution; gender development; land and asset re-distribution; and increased financial inclusion or easy financial access to low-income citizens—will be necessary.

Our theoretical finding is that policy makers cannot successfully exploit the relationship between economic growth and inequality if the level of inequality is high. Thus, from the data on growth and inequality in the ACI economies, we marshal evidence that there exists an impossibility theorem that suggests that policymakers cannot optimally choose economic growth and inequality when inequality crosses a threshold. In other words, simple growth-inducing policies and measures of reducing inequality will not be able to create socially inclusive growth in the ACI economies.

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