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Nonlinear Effect of Financial Development on Income Inequality: The Case of Ivory Coast

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Abstract

From the mid-1980s until the 1990s, many developing countries, particularly the countries of the West African Economic and Monetary Union, undertook major reforms of their financial systems in order to free them from numerous internal constraints that limited their development, such as interest rate ceilings, high reserve requirements, administrative credit allocations, etc. This financial liberalisation will promote rapid financial development in these countries. Thus, in most of these countries, there is a relative deepening of the financial sector and an improvement in financial policies. The economic and financial literature suggests that a well-functioning financial system can promote the accumulation of physical capital, improve economic conditions and thus promote long-term growth (Demetrides and Andrinova, 2004), and thus reduce inequality between rich and poor (Anand & Segal, 2017). However, studies conducted so far indicate that the effects of financial development on income inequality remain mixed. Thus, the objective of this study is to analyse the effect of financial development on the reduction of income inequality in Côte d'Ivoire. To do so, we used annual data from the World Bank (2018) and the IMF (2018) covering the period 1986-2016. From the estimation of the ARDL and NARDL models, the results show that financial development reduces income inequality in the short run. However, in the long run financial development increases income inequality in Côte d'Ivoire. The results also show that financial development has an asymmetric effect on income inequality in the short and long run in Côte d'Ivoire.

Keywords: financial development, income inequality, ARDL and NARDL model, asymmetric effect

1. Introduction

The rapid increase in income inequality in recent decades has been one of the most worrying issues for the international community (UNCTAD, 2014). Income inequality refers to relative income gaps in the population as a whole (Burgundy, 2004). A significant increase in these income gaps within society can reduce economic growth (Khan et al., 2018). Moreover, according to Meltzer and Richard (1981), as inequality increases, citizens will want more redistribution, which could reduce incentives to work and thus slow economic activity. Excessive inequality could lead to socio-political instability that could threaten property rights, as noted by Alesina and Perotti (1996). In turn, this threat to property rights could discourage investment and slow down economic activity. Apart from these factors, income inequality can be detrimental to economic growth. For his part, Putnam (2000) points out that income inequality can degrade social cohesion. In this case, the reduction of social cohesion would reduce the financing of public goods, which would be unfavorable to economic growth. At the same time, however, in a situation of income inequality, only the redistribution of the fruits of growth can reduce crime and anti-social activities (Barro, 2000).

The issues raised by income inequality are economic. As such, some economists suggest that financial sector development could play an important role in reducing inequality. For example, Galor and Zeira (1993) and Banerjee and Newman (1993) argue that there is a negative linear relationship between financial development and income inequality. For these authors, the imperfections of financial markets, namely information asymmetries and transactions costs, prevent low-income people from having access to credit to invest in physical and human capital. Under these conditions, only the development of the financial sector can reduce these imperfections and enable a large proportion of the population to take advantage of investment opportunities, which would result in lower income inequality. On the other hand, other economists predict a positive linear

relationship between financial development and income inequality, such as Rajan and Zangales (2003), who argue that financial intermediaries only transact with the rich because of their ability to provide sound collateral. Thus, financial development benefits only the rich and increases income inequality. In contrast to these views, Greenwood and Jovanovic (1990) postulate a non-linear, inverted U-shaped relationship between financial development and income inequality. This theory implies that income inequality increases in the early stages of financial development because of access costs that discourage the poor, and then decreases as more and more agents access financial services.

While there are still controversies at the empirical level, a global consensus has been built in favor of reducing income inequality by 2030. It is in this context that the State of Ivory Coast has implemented several policies to reduce income gaps. One of the strategies adopted by the government was to accelerate the financial inclusion of the poor population excluded from the formal financial system. Moreover, a national strategy to promote microfinance was adopted in 2007 and the gradual construction of a social protection system to strengthen basic social security guarantees for the most vulnerable populations.

Despite these numerous policies, income inequalities are only increasing in Ivory Coast. Indeed, from 1988 to 2003, income inequalities increased. The GINI index rose from 0.37 in 1988 to 0.40 in 2003 (World Bank, 2018). Over the same period, the Financial Development Index fell from 0.18 in 1988 to 0.15 in 2003 (IMF, 2018). From 2003 to 2016, inequality increased sharply as the GINI index rose from 0.40 to 0.44. However, during the same period, the financial sector shows an upward trend. Indeed, the financial development index rose from 0.15 in 2003 to 0.22 in 2016. The relationship between financial development and income inequality appears ambiguous in Ivory Coast. In light of these findings, we ask the fundamental question: To what extent does financial development contribute to the reduction of income inequality in Ivory Coast?

Thus, the general objective of this study is to analyse the effect of financial development on the reduction of income inequalities in Ivory Coast. More specifically, the study aims, on the one hand, to analyse the influence of financial development on the reduction of income inequality in Ivory Coast and, on the other hand, to show that the effect of financial development on income inequality is not symmetrical.

In achieving these specific objectives, the following two assumptions are made. The first is that there is a negative relationship between financial development and income inequality in Ivory Coast. The second is that financial development has an asymmetric effect on income inequality in Ivory Coast.

To do so, we use an empirical formulation using data from the World Bank and the International Monetary Fund over the period 1986-2016. The study adopts two econometric approaches, namely, a staggered lagged autoregressive model (ARDL) to test the first research hypothesis and, a non-linear staggered lagged autoregressive model (NARDL) to test the second research hypothesis.

Econometric estimates show that financial development reduces income inequality in the short run. In the long run, however, financial development increases income inequality in Ivory Coast. The NARDL model sheds light on these results as financial development has an asymmetric effect on short- and long-term income inequality in Ivory Coast.

Most developed countries and some developing countries have used the financial system to reduce income inequality. According to Galor and Zeira (1993) and Banerjee and Newman (1993), inequality is expected to decline as the financial sector develops.

Our study is linked to at least two strands of the economic literature, but it remains one of the few to examine the asymmetric effects of financial development on income inequality in a Sub-Saharan African country. Empirically, our contribution is in line with the literature on the positive effects of financial development on the real economy, filling the gap. Our study adds to the existing body of knowledge on the relationship between financial development and inequality reduction. Indeed, several studies (Adams and Klobodou, 2016; Seven and Coskun, 2016; Liu et al, 2017; Meniago & Asongu, 2018) have addressed the relationship between financial development and income inequality, emphasizing a symmetrical effect of the former on the latter. So far, the most notable contributions have been to consider, on the one hand, the linear relationship between financial development and income inequality and, on the other hand, the existence of a non-linear relationship between financial development and income inequality. Using panel data from 1982 to 2012 for India, Sehrawat and Giri (2015) find that financial development increases income inequality in India in the short run and also in the long run. In the case of China, Liu et al (2017) studied the relationship between financial development and income inequality, using a panel of 23 Chinese provinces covering the period 1996 to 2012. Adopting the generalized method of moments (GMM), the results reveal that financial development reduces income inequality in China. Jung and Vijverberg (2019) obtain the same results using the technique of spatial econometrics. Adams and Klobodou

(2016) conducted a study over the period 1985-2011, covering a sample of 21 sub-Saharan African countries. Using the PMG estimator, the results indicate that financial development increases income inequality. Using the GMM estimator, in a study of 48 African countries covering the period 1996 to 2014, Meniago and Asongu (2018) find that financial development reduces income inequality. Jobarteh and Kaya (2019) used annual data from 23 African countries covering the period 1990 to 2014. Using a regime-switching model, the results indicate that financial development increases income inequality in the African countries studied.

Concerning to the non-linear approach to this relationship, most of this empirical work has been testing the paradigm of Greenwood and Jovanovic (1990), according to which financial development increases income inequality in the early stages of development and then reduces it after it reaches maturity. In this context, the relationship between financial development and income inequality may be conditioned by the quality of institutions. Law et al (2014) studied the relationship for 81 developed and developing countries covering the period 1985-2010. Using a threshold model, the results show that the effects of financial development on the reduction of income inequality depend on institutional quality. Financial development is an effective means of reducing income inequality only in countries with quality institutions. Over the period from 1985 to 2013, for the Euro area, Baiardi and Morana (2016) confirm the hypothesis of Greenwood and Jovanovic (1990), implying that income inequality tends to increase at the beginning of financial development and then decrease when the level of financial development reaches a certain maturity threshold. Similarly, Shahbaz et al (2017) showed that the relationship between financial development and income inequality is non-linear in an inverted U-shape in Kazakhstan in a study covering the period 1990 to 2014. The study by Younsi and Bechtini (2018), covering the BRICS countries from 1995 to 2015, also reveals this non-linear relationship in the form of an inverted U shape for the BRICS countries.

In Africa, in a study of South Africa, using annual data from 1990 to 2012, Kapingura (2017) finds, using an ARDL model, that there is no non-linear relationship between financial development and income inequality. Instead, the results show a negative linear relationship between financial development and income inequality in South Africa. In addition, Tita and Aziakpono (2016) conducted their study on time-series data from 15 African countries covering the period 1985-2007. Using the GMM estimator, the results show that the relationship between financial development and income inequality is non-linear, taking an inverted U-shape and a normal U-shape, depending on the measure of financial development used.

In the end, we note that the results of this empirical work are contradictory. On the linear relationship between financial development and income inequality, some work confirms a positive effect while others conclude that there is a negative effect. In addition, some studies confirm theoretical predictions of a possible non-linear relationship between financial development and income inequality. Remarkably, however, these studies have some limitations. Indeed, most of these studies have used indicators such as private domestic credit as a percentage of GDP, market capitalization as a percentage of GDP, and the monetary aggregate M2 as a percentage of GDP to measure financial development. However, as Svirydzenka (2016) points out, financial development is multidimensional, and using a few indicators as measures of financial development does not capture all aspects of financial sector development. Apart from measurement shortcomings, these studies do not highlight the effects of positive and negative shocks to financial development on income inequality. They are limited only to the symmetric (linear) effects of financial development on income inequality. While there may be shocks such as financial crises, economic crises can alter the trajectory of financial sector development and have different effects on income inequality. In other words, positive and negative changes in the financial sector can have asymmetric effects on income inequality. Our contribution is therefore to analyse the effect of financial development on income inequality using recent modeling, highlighted by Shin et al. (2014), adapted to small sample sizes. Our methodology is therefore based on this new econometric approach.

The remainder of this document is structured as follows. The second section details the econometric methodology adopted. The third section is devoted to details on the data, variable definitions and descriptive statistics. The fourth section presents the main results of this study. The conclusion is the subject of the last section.

2. Methodology and Model

In this section, the specification of the basic model on which this study is based, on the one hand, and the estimation process, on the other hand, will be presented.

2.1 Model Specification

Our study is based on Ahmed and Masih's (2017) study in Malaysia. The authors used only three explanatory variables, which seems to us very little to explain income inequality. To compensate for this shortcoming, we add

three other variables, namely the inflation rate, the secondary school enrolment rate and the population growth rate. However, per capita income is removed from the list of explanatory variables because of its strong correlation with financial development. Thus, our specified model takes the following functional form:

$$GINI = f(DFIN, INFL, OCOM, TXSSEC, TCPOP) \quad (1)$$

The regression model takes the following explicit form:

$$GIN_t = \alpha_0 + \alpha_1 DFIN_t + \alpha_2 INFL_t + \alpha_3 OCOM_t + \alpha_4 TXSSEC_t + \alpha_5 TCPOP_t + \varepsilon_t \quad (2)$$

Where GIN is income inequality; DFIN is financial development; INFL is the inflation rate; OCOM is the openness rate of the economy; TXSSEC is the school enrolment rate; TCPOP is the population growth rate; and ε_t is the residual term of the model.

We can now move on to the choice of study model and the appropriate estimation technique.

2.2 The Estimation Process

In the following, we will successively present the preliminary tests and the estimation procedure.

2.2.1 Preliminary Economic Tests

Before using any time series to perform econometric regressions, it is essential that they be stationary to avoid spurious regressions. To test the stationarity of our series, we will use two tests, namely the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron test. The former is more effective in the presence of error autocorrelation and the latter is recommended in the presence of heteroscedastic errors (Kuma, 2018). After the various tests, if the series studied are not stationary, then the cointegration tests can be performed. Remember that two series are said to be cointegrated if they have a common long-term trend. Several tests exist to check whether the series studied are cointegrated, notably, those of Engel and Granger (1987), Johansen (1988), Johansen and Juselius (1990) and Pesaran al. The first two have limitations in that they are not suitable for situations where the series are integrated of different orders (I (0), I (1)). This is why we use the cointegration test, Pesaran et al. (2001) called "bounds cointegration test". This test is appropriate here because the series are integrated of different orders and our sample size is small.

2.2.2 The Technique Procedure

The econometric tests presented above will condition the choice of the estimation technique. If we can prove that cointegration relationships exist, then the coefficients of equation (2) can be estimated from an autoregressive lag model (ARDL) developed by Pesaran et al. (2001). This is a dynamic model in which past values of the explained variable and those of the explanatory variables are included among the explanatory variables. It is less constraining in that it is applicable even if the series is not integrated in the same order (I (1), I (0)). In addition, it allows better estimates to be obtained on small samples. It takes account of time dynamics, i.e. expectations and adjustment lags in the explanation of a time series. It also provides the possibility of dealing simultaneously with long-run dynamics and short-term adjustments. In this way, it improves forecasts and the effectiveness of economic policies, in contrast to the old static models. Our equation 2 can be rewritten as follows:

$$\Delta GINI_t = \beta_0 + \sum_{i=1}^{p} b_i \, \Delta GINI_{t-i} + \sum_{i=0}^{q_1} c_i \, \Delta DFIN_{t-i} + \sum_{i=0}^{q_2} d_i \, \Delta INFL_{t-i} + \sum_{i=0}^{q_3} e_i \, \Delta OCOM_{t-i} + \sum_{i=0}^{q_4} f_i \, \Delta TXSSEC_{t-i} + \sum_{i=0}^{q_5} g_i \, \Delta TCPOP_{t-i} + hGINI_{t-1} + iDFIN_{t-1} + jINFL_{t-1} + kOCOM_{t-1} + lTXSSEC_{t-1} + mTCPOP_{t-1} + \varepsilon_t \quad (3)$$

Where β_0 is the constant; Δ is the difference operator; p, q_1, q_2, q_3, q_4 and q_5 are the optimal delays; ε_t is the error term; b, c, d, e, f and g are the coefficients of the short-term dynamics; h, i, k, l and m are the coefficients of the long-term dynamics.

As presented, our model does not take into account the direction of evolution of our explanatory variables. In other words, there may be potential asymmetric effects of positive and negative changes in the explanatory variables on the explained variable. This model indicates that the effects of the explanatory variables on the explained variable are linear. This does not overly reflect the reality of economic relationships. Thus, the shortcomings of the ARDL model led to the development of the NARDL model by Shin et al. (2014). It is an extension of the ARDL model because it keeps the same conditions of application as the ARDL model, however, its particularity is that it allows testing the effect of positive or negative modifications of the explanatory variables on the explained variable. Thus, unlike the ARDL model, which tests the symmetrical effect, the NARDL model tests the short- and long-term asymmetrical effect of positive or negative variations in the explanatory variables on the explained variable. The evolution of economic variables is not linear. Certain circumstances, such as economic, financial and political crises, can change the trajectory of economic variables.

Therefore, the application of the NARDL model is more appropriate to accurately reflect the complexity of the real world (Gritli & Charfi, 2019). It makes it possible to highlight the asymmetric effect of an explanatory variable on an explained variable. Thus, to verify whether financial development has an asymmetric effect on income inequality in Ivory Coast, this study will use the NARDL approach.

By incorporating our data into the initial model of the asymmetric cointegration relationship developed by Shin et al. (2014), we obtain:

$$GINI_t = \beta^+ DFIN_t^+ + \beta^- DFIN_{t_t^{\mp u}} \quad (4)$$

With$DFIN_t$which is decomposed into $DFIN_t = DFIN_0 + DFIN_t^+ + DFIN_t^-$where $DFIN_t^+ \; and \; DFIN_t^-$ are partial sum processes of positive and negative changes in $DFIN_t$; β^+ and β^- are the asymmetric parameters, is the error term. Note that the decomposition of the explanatory variable $DFIN_t$ into its positive and negative partial sums makes it possible to distinguish the effects of a positive and negative change in $DFIN_t$ on the explained variable$GINI_t$. The sums of the positive and negative variations are formulated as follows:

$$DFIN_t^+ = \sum_{j=1}^{t} \Delta DFIN_j^+ = \sum_{j=1}^{t} \max(\Delta DFIN_j, 0) \quad (5)$$

$$DFIN_t^- = \sum_{j=1}^{t} \Delta DFIN_j^- = \sum_{j=1}^{t} \max(\Delta DFIN_j, 0) \quad (6)$$

Where $\Delta DFIN_j^+$ and $\Delta DFIN_j^-$are the positive and negative variations in financial development respectively.

Following equation (3), the specification of our NARDL model to be estimated is as follows:

$$\Delta GINI_t = \beta_0 + \sum_{i=1}^{p-1} \phi_i \, \Delta GINI_{t-i} + \sum_{i=0}^{q-1} \phi_i^+ \, \Delta DFIN_{t-i}^+ + \sum_{i=0}^{q-1} \phi_i^+ \, \Delta DFIN_{t-i}^{\mp \rho GINI_{t-1}} + \theta^+ DFIN_{t-1}^+ + \theta^- DFIN_{t-1}^- + \varepsilon_t \quad (7)$$

Where $\phi_i \; is$ the autoregressive effect of short-term income inequality; coefficients φ_i^+ and φ_i^- are the respective short-term asymmetric effects of positive and negative changes in financial development on income inequality; ρ is the long-term autoregressive effect ; $-\theta^+ / \rho$ and $-\theta^- / \rho$ are the respective long-term asymmetric effects of positive and negative changes in financial development on income inequality; ε_t is the error term. $DFIN_t^+$ and $DFIN_t^-$ are the respective positive and negative partial sums of changes in financial development.

Equation 7 is used to check for short- and long-term asymmetry. In other words, the NARDL approach will test the effect of a rise or fall in the Financial Development Index on the reduction of income inequality in Ivory Coast. This is done in four steps. The first step is to test the order of integration of time series. Indeed, it is necessary to ensure that none of the series is integrated in order two (I (2)). The second step is to check for the existence of a long-term relationship. To do this, as in the symmetric case (ARDL), two tests can be used, namely the F-statistics introduced by Pesaran et al. (2001) and the t-statistics proposed by Banerjee et al. (1998). The third step is to test the symmetry in the long term and also in the short term by comparing the sum of the positive and negative dynamic coefficients ($\sum_{i=0}^{q-1} DFIN_{t-i}^+ = \sum_{i=0}^{q-1} DFIN_{t-i}^-$). If the asymmetry case is confirmed, then the last step is to test the dynamic asymmetric effects of financial development on income inequality.

3. Data Sources and Descriptive Statistics of Variables

We present, successively, the data sources, the definition of the variables and some descriptive statistics

3.1 Data Sources and Key Variable Definitions and Indicators

For this study, we use annual data from the World Bank (WDI) and IMF databases. The study data covers the period 1986-2016. The data sources, study variables and expected signs are recorded in Table 1.

Table 1. Variables, expected effects and data sources

Variables	Description	Expected effects	Source of data
Dependent variable			
GINI	Inequality		WDI (2018)
Explanatory variables			
DFIN	Financial development	Negative (-)	IMF (2018)
INFL	GDP deflator	Positive (+)	WDI (2018)
OCOM	Rate of trade openness	Positive (+)	WDI (2018)
TXSSEC	Secondary school enrolment rate	Negative (-)	WDI (2018)
TCPOP	Population growth rate	Positive (+)	WDI (2018)

Source: Author, based on economic literature.

To describe our variables properly, we adopt a dependent and independent variable categorization. Concerning the endogenous variable, inequality, it is measured by the GINI index. The GINI index is between 0 and 1, and when it is close to 0, it reflects a situation of perfectly egalitarian distribution where all incomes, wages and standards of living are equal. On the other hand, when it is close to 1, it reflects a situation of totally unequal distribution. This index is commonly used in the literature as an indicator of income inequality. It measures the extent of inequality in the distribution of a country's income.

Regarding explanatory variables, let us start with financial development (DFIN), which is defined as a process by which the financial system becomes deeper, more accessible and more efficient (Levine, 2005). To measure financial development, most empirical studies since the 1970s have used two measures of financial depth, namely private credit as a share of GDP and market capitalization as a percentage of GDP. However, these measures have limitations in that they only consider the depth dimension without taking into account other dimensions, such as accessibility and efficiency. Indeed, a financial system that is not accessible to a large proportion of the population and inefficient in the allocation of resources cannot benefit the economy.

In addition, financial systems have evolved and become multifaceted. Thus, Svirydzenka (2016) has developed a new approach taking into account the three main dimensions presented, namely depth, access and efficiency. It is therefore this composite indicator that we use as a financial development indicator. This indicator is between 0 and 1, with a value close to 1 reflecting a good level of financial development. On the other hand, a value close to 0 reflects a low level of financial development.

As for the control variables, we select four. The first is inflation (INFL), which is an increase in the general price level. It is measured here by the GDP deflator. Theoretically, inflation could reduce the purchasing power of households and discourage savings. A situation that would not allow financial intermediaries to further mobilize the savings of surplus agents to allocate them efficiently to productive uses. This would lead to increased unemployment and income inequality. Several studies have shown that inflation increases income inequality ((Nicoloski, 2013; Law et al. 2014; Seven and Coskun, 2016). Therefore, we expect a positive sign of the coefficient of this variable. Next, we have the trade openness rate (OCOM), which is an indicator of the measure of a country's foreign trade. It indicates a country's dependence on the outside world. It is obtained by applying the following formula:

$$OCOM = \frac{Export + import}{2 * GDP}$$

This variable is used by several authors (Hamori & Hashiguchi, 2012, Seven & Coskun, 2016, Khan et al., 2018) to capture the effect of trade openness on income inequalities. In small economies where the still embryonic industrial sector cannot face international competition, high trade openness can lead, all other things being equal, to the disappearance of nascent firms, thus increasing unemployment and income inequality. Therefore, a positive sign of the coefficient of this variable is expected. Next, as an explanatory variable, we have the secondary school enrolment rate (TXSSEC), which represents the total enrolment in secondary education, without distinction of age, expressed as a percentage of the population officially able to attend school at the same level for a given school year. It is the ratio of the number of students enrolled in secondary education who are in the official secondary school age group to the population of the same age group multiplied by 100. In theory, a high school enrolment rate can reduce income inequality, as those who have received the required education will have the opportunity to have stable and well-paid employment. Studies such as Law et al (2014), Mansur and

Wendel (2015) and Casti (207) have shown the beneficial effects of education in reducing income inequality. Therefore, a negative sign of the coefficient of this variable is expected. Finally, the last control variable is the labor force growth rate (LFGG), which is a demographic indicator measuring the evolution of the population aged 15-64 at a given point in time. It is calculated as follows:

$$TCPOP = \frac{Population\ \ (15-65\ \ years)}{Overall\ \ population}$$

A large increase in the labor force can lead, all other things being equal, to an imbalance between supply and demand in the labor market. This could lead to unemployment and further increase income inequality. According to Brockerhoff and Brennan (1998), income inequality in developing countries is caused by high population growth. Thus, a positive sign of the coefficient of this variable is expected.

After defining our variables, we can now make a brief descriptive statistic to better understand the evolution of the data.

3.2 Descriptive Statistics of the Variables

The descriptive statistics of the data are recorded in Table 2 below. The aim is to get an idea of the mean, minimum, maximum and standard deviation of the variables.

Table 2. Descriptive statistics

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
GINI	31	0.408	0.021	0.369	0.446
DFIN	31	0.179	0.018	0.149	0.221
INFL	31	3.958	8.668	-4.523	46.386
OCOM	31	37.850	6.115	27.674	47.535
TXSSEC	31	25.047	7.272	18.426	40.132
TCPOP	31	53.262	0.623	52.122	54.635

Source: Author, based on World Bank (2018) and IMF (2018) data.

Analysis of Table 2 shows that income inequality averaged 0.41 in Ivory Coast over the 31 years of observation. This increase in income inequality ranges from 0.37 to 0.45. The small standard deviation of 0.02 indicates that income inequalities have not fluctuated significantly in Ivory Coast.

As for the financial development index, it averages 0.18 with a maximum value of 0.22 over the study period. Furthermore, the dispersion of the financial development index of 0.018 shows that financial development has not varied significantly over the period 1986 to 2016.

The inflation rate averages 3.9, reflecting the low increase in the prices of goods and services over the study period. However, the standard deviation of 8.668 shows that inflation has fluctuated widely.

Concerning trade openness, there is an average opening rate of 37.85 with a minimum value of 27.67 and a maximum value of 47.53. It follows that Ivory Coast is a small open economy. Here again, the high dispersion of 6.115 indicates that the openness rate fluctuated sharply over the study period.

As for the secondary school enrolment rate, the average is 25.05 with a minimum value of 18.42 and a maximum value of 40.13. It follows that the number of Ivorians having received secondary education has increased during the 31 years of observation.

Concerning to the growth rate of the active population, its average level is 53.26 with a minimum value of 52.12 and a maximum value of 54.63. As a result, the active population in Ivory Coast has increased sharply during the period 1986 to 2016.

We complete the descriptive statistics by presenting the correlation matrix of the variables. The results in Table 3 indicate that financial development is positively related to income inequality.

Table 3. Correlation Matrix

Variables	GINI	DFIN	INFL	OCOM	TXSSEC	TCPOP
GINI	1.000					
DFIN	0.563***	1.000				
INFL	0.049	-0.225	1.000			
OCOM	0.537***	-0.042	0.053	1.000		
TXSSEC	0.861***	0.606***	-0.119	0.429***	1.000	
TCPOP	0.736***	0.374**	0.173***	0.302*	0.726***	1.000

Note: *** significance at 1%, ** significance at 5% and * significance at10%.

Source: Author, based on World Bank (2018) and IMF (2018) data.

The correlation coefficient is 0.56. There is also a positive correlation between the control variables and income inequality. Income inequality is strongly related to secondary school enrolment and labor force growth rates. The correlation coefficients are 0.86 and 0.74, respectively. The inflation rate is weakly related to income inequality. The correlation coefficient is 0.05.

There is a strong correlation between the secondary school enrolment rate and financial development. Similarly, the growth rate of the labor force is strongly related to the secondary school enrolment rate. There is therefore a presumption of multicollinearity between these two variables. This leads us to perform the multicollinearity test, using Variance Inflation Factors (VIF). The results of the test, shown in Table 4 below, indicate that the VIF values are all below 5, which means that there is no multicollinearity. As a result, regressions can be performed using our model.

Table 4. Multicolinearity test result

Variables	VIF	1/VIF
TXSSEC	4.09	0.244
TCPOP	2.50	0.399
DFIN	1.99	0.503
OCOM	1.50	0.665
INFL	1.22	0.817

Source: Author, based on World Bank (2018) and IMF (2018) data.

At this stage of our study, it is appropriate to present the results of our estimates.

4. The Results of the Estimates

This section is reserved for the presentation of results. To do so, we start first with the results of the stationarity and cointegration tests. Then, the results of the ARDL modeling and finally, the results of the NARDL modeling.

4.1 Stationarity and Co-integration Test Results

Here we present and interpret the results of the unit root test and the cointegration test.

- **Unit Root Test**

To test the stationarity of the series studied, the augmented Dickey Fuller (Dickey and Fuller, 1979) (ADF) test and the Phillips and Perron (1988) test are used in this study. The rationale for choosing these two tests is that they are easy to apply and are commonly used. In addition, the ADF test is effective in the presence of error autocorrelation and the PP test is recommended in the presence of heteroskedastic errors. The results are shown in Table 5 below. The results show that the calculated statistics are significant for all series, as the associated probabilities are less than 1% and 5%. Therefore, the null hypothesis of the presence of unit root is rejected. The series are stationary. Thus, the GINI, INFL and TCPOP series are stationary in level (I (0)). As for the DFIN, OCOM and TXSSEC series, they are stationary in first difference (I (1)). Therefore, no variables are integrated in second-order I (2). These results support the choice to use the ARDL and NARDL approaches. However, it is not possible to limit the application of these two approaches to these results alone. Only the results of the cointegration test can confirm the use of these two approaches.

Table 5. Unit Root test results

	At level		In First Difference		Decision
Variables	ADF	PP	ADF	PP	I(0)
	(p-value)	(p-value)	(p-value)	(p-value)	
GINI	-4.081**	-4.118**	-	-	I(0)
	(0.016)	(0.015)			
DFIN	-0.516	-0.514	-6.296***	-6.240***	I(1)
	(0.874)	(0.875)	(0.000)	(0.000)	
INFL	-4.021***	-4.019***	-	-	I(0)
	(0.004)	(0.004)			
OCOM	-1.160	-0.369	-4.737***	-4.767***	I(1)
	(0.678)	(0.543)	(0.001)	(0.001)	
TXSSEC	0.382	0.073	-8.402***	-8.593***	I(1)
	(0.979)	(0.958)	(0.000)	(0.000)	
TCPOP	-5.881***	-5.856***	-	-	I(0)
	(0.000)	(0.000)			

Note: *** significance at 1%, ** significance at 5% and * significance at10%.

Source: Author, based on World Bank (2018) and IMF (2018) data.

- **Cointegration test**

After the results of the stationarity tests, the cointegration test is the one that validates or not the use of the ARDL and NARDL models. For this purpose, to verify cointegration, we apply the bounds-tests of Pesaran et al (2001), because the variables are integrated of a different order (I (0) and I (1)). This test is performed in two steps. First, we determine the optimal lag using the information criterion (AIC SC and HQ). The optimal delay is 2 (Table A1 in the Appendix). Second, we use the File test to test the null hypothesis of the absence of a cointegrating relationship against hypothesis 1 of the existence of a cointegrating relationship. Table 6 below presents the results of the cointegration test. The results show that the calculated F-statistic (8.75) is above the upper bound (4.68) at the 1% threshold. Therefore, the null hypothesis of the absence of a cointegrating relationship is rejected at the 1% threshold. The variables are therefore cointegrated and it follows that there is a long-term relationship between the variables. These results confirm the choice of using the ARDL and NARDL models.

Table 6. Cointegration test results

Bounds test		
Variables : DFIN, INFL, OCOM, TXSSEC, TCPOP		
	F-stat calculated : 8.750751	
Critical threshold	Lower limit	Upper limit
1%	3.41	4.68
5%	2.62	3.79
10%	2.26	3.35

Source. Author, based on World Bank (2018) and IMF (2018) data.

After all these precautions, we can present and interpret the estimation results of the ARDL and NARDL models.

4.2 ARDL Modelling Results

The results of the model validation tests, namely the Jarque-Bera (1980) residual normality test, the Breusch-Pagan-Godfrey heteroskedasticity test, the Breusch-Godfrey serial correlation test and the Ramsey functional form test confirm the absence of serial correlation, the absence of heteroskedasticity and the normality of the residuals (Table A2 in the Appendix). The model is statistically satisfactory because the probability associated with the F-stat is less than 5%. In addition, the fitted statistic is equal to 0.91, implying that the model is good. The results can be interpreted. We provide successively the econometric and economic interpretations of the results of the ARDL model.

Tables 7 and 8 below present the estimation results of the ARDL model. The results for the short-term dynamics

are presented in Table 7 and those for the long-term dynamics are presented in Table 8.

In the short run, an examination of Table 7 reveals that financial development negatively influences income inequality at the 5% threshold. In terms of inflation, there is a negative relationship between lagged value and income inequality at the 1% threshold in the short run. Similarly, the delayed enrolment rate has a negative influence on short-term income inequality at the 1% threshold. On the other hand, trade openness and the population growth rate have a positive influence on income inequality at the 1% and 5% thresholds respectively in the short term.

Table 7. Estimation of the ARDL Model

Dependent variable = GINI inequality				
Short-term dynamics				
Variables	Coefficient	Standard deviation	T-statistic	Probability
D(DFIN)	-0.529*	0.251	-2.105	0.057
D (DFIN (-1))	-0.487**	0.189	-2.579	0.024
D(INFL)	0.0001	0.000	0.652	0.527
D (INFL (-1))	-0.001***	0.000	-3.177	0.008
D(OCOM)	0.002***	0.001	3.124	0.009
D (OCOM (-1))	-0.001	0.001	-1.504	0.158
D(TXSSEC)	0.000	0.000	0.095	0.926
D (TXSSEC (-1))	-0.002***	0,001	-3.458	0.005
D(TCPOP)	0.070**	0.023	3.053	0.010
D (TCPOP (-1))	-0.035	0.022	-1.555	0.146
Coefficient of Adjustment	-1.358***	0.192	-7.083	0.000
R^2	0.961			
R^2 adjusted	0.910			
F-stat	18.749			
Probability (F-stat)	0.000			

Note. *** significance at 1%, ** significance at 5% and * significance at10%.

Source. Author, based on World Bank (2018) and IMF (2018) data.

In the long run, the examination of Table 8 below reveals that there is a positive and statistically significant relationship at the 10% threshold between financial development and income inequality. At the level of the control variables, the coefficients for inflation, trade openness and secondary school enrolment are all positive and statistically significant at the 5% threshold for inflation and 1% for the other two. There is thus a positive relationship between these variables and long-term income inequality.

Table 8. Long-term dynamics

Variables	Coefficient	Standard deviation	T-statistic	Probability
DFIN	0.303*	0.167	1.811	0.014
INFL	0.001**	0.000	2.863	0.014
OCOM	0.001***	0.000	5.169	0.000
TXSSEC	0.002***	0.000	5.329	0.000
TCPOP	0.005	0.003	1.731	0.109
C	-0.046	0.171	-0.272	0.790

Note. *** significance at 1%, ** significance at 5% and * significance at 10%.

Source. Author, based on World Bank (2018) and IMF (2018) data.

Regarding the economic interpretations of the results, it should be noted that in the short term, there is a negative relationship between financial development and income inequality. In the long run, however, this relationship becomes positive. It follows that in the short run, financial development reduces income inequality and in the long run, it increases income inequality in Ivory Coast. Indeed, the decrease in income inequality in the short

term could be explained by the access of a large proportion of the population to financial services. Indeed, when financial services become accessible to a large proportion of the population, all other things being equal, many people have access to bank credits, which they can use for projects, thus reducing income inequalities. This relationship is consistent with the predictions of Galor and Zeira (1993) and Banerjee and Newman (1993), for whom inequality should continue to fall as the financial sector develops. But the positive effect observed in the long term could have two explanations. The first could be the result of unproductive investments linked to a misallocation of resources. Borrowers who are poorly equipped at the managerial level may engage in projects with little return on investment. The second is that defaulted loans sometimes force banks to ration credit in the long run. Our results are contrary to those of Shahbaz and Islam (2011) for Pakistan, Ahmed and Masih (2017) for Malaysia and Haffejee and Masih (2018) for South Africa. This divergence in results is likely due to the indicators used to measure financial development. In these studies, indicators such as domestic credit to GDP, market capitalisation to GDP and money supply M2 as a percentage of GDP are used as indicators of financial development.

At the level of control variables, in the short term, the inflation rate makes it possible to reduce income inequalities in Ivory Coast, but with a time lag. On the other hand, in the long term, the inflation rate increases income inequality. The monetary policy of the BCEAO could explain this decrease in income inequality in the short term and also the increase in income inequality in the long term. Indeed, an expansionary monetary policy leads, all other things being equal, to a decrease in the cost of credit, the real interest rate. In this case, investments become profitable and the resulting economic growth is favorable to the reduction of inequality. Tobin (1965) already had such a channel where rising inflation was favorable to capital accumulation. In this case of WAEMU countries, Esso (2009) shows that an increase in the general price level of one percentage point increases GDP per capita by 0.003 percent in Ivory Coast. Consequently, this increase in GDP per capita can lead, all other things being equal, to a decrease in income inequality. On the other hand, in the long run, the increase in income inequality could be explained by the adoption of a non-accommodating monetary policy that increases the cost of credit and discourages borrowing for investment and reduces inequality.

As for the secondary school enrolment rate, in the short term, it is latently reducing income inequalities in Ivory Coast. This could be explained by the fact that the beneficial effects of education are not immediate. It is over time that the returns on investment in education positively affect income. Education enables individuals to acquire skills and benefit from opportunities in the labor market. In the long run, however, it increases income inequality. The possible reason is the mismatch between the training offered and the increasingly sophisticated needs of companies. As a result, the greater the number of Ivorians with secondary education, the greater the wage gap with high school graduates will be. According to human capital theory (Becker, 1962), labor is regarded as a heterogeneous production factor and, consequently, wage dispersion is merely a reflection of the hierarchy of skills. The best paid employees are those who invest more in training, which leads to wage inequality and thus to increased income inequality.

Concerning the population growth rate, it increases income inequalities in the short term and also in the long term in Ivory Coast. Indeed, when the active population increases, this increase can lead, all other things being equal, to an imbalance between labor supply and demand in the labor market. Thus, the unemployed active population increases, which translates into an increase in income inequality. According to the INS (2015), out of an active population that represents 62.8% of the total population, there are 36.4% employees. In this case, an increase in the population would, all other things being equal, lead to an increase in income inequality. This result is consistent with the work of Casti (2017) who also found a positive relationship between population growth and income inequality.

About trade openness, it increases income inequality in the short and long term. This result could be explained by the fact that a high degree of trade openness could have negative effects on local businesses and thus on employment. Indeed, Ivory Coast industrial sector is still in its infancy and cannot face international competition. Ivorian companies still have very high production costs and do not yet benefit from economies of scale compared to foreign companies. Thus, the opening up of trade, leading to a massive influx of foreign products that compete with local products, could lead to the closure of local companies. The resulting unemployment rate is likely to increase income inequality. Our results are similar to those of Hamori and Hashiguchi (2012) carried out on a sample of 126 countries including Ivory Coast.

For the ARDL model, we find that there is a negative linear relationship between financial development and income inequality in the short run and a positive linear relationship in the long run. However, these results do not specify the effects of a negative or positive financial sector shock on income inequality. To better understand the effects of a positive or negative shock at the financial sector level on income inequality in Ivory Coast, let us

interpret the results of the NARDL model.

4.3 NARDL Modelling Results

The estimation results of the NARDL model are presented in Table 9 below.

Table 9. Estimation results of the NARDL model

Dependent variable : Income inequality (GINI						
	Short-term effect [+]			Short-term effect [-]		
Exogenous variables	Coefficient	Probability		Coefficient		Probability
$\Delta DFin$	0.626*	0.069		0.389		0.193
$\Delta DFin_{t-1}$	-0.317	0.249		-0.889**	0.012	
$\Delta DFin_{t-2}$	0.551*	0.054		-1.200***	0.006	
Adjustment coefficient				-2.040***	0.000	
Constant				0.794***	0.000	
Asymmetry statistics:						
	Long-term effect [+]			Long-term effect [-]		
Exogenous variables	Coefficient	F-stat	P>F	Coefficient	F-stat	P>F
DFIN	0.590***	208.9	0.000	-0.280***	25.38	0.000
Long-term asymmetry				Short-term asymmetry		
Wald Test		F-stat	P>F	F-stat		P>F
DFIN		139.4 ***	0.000	5.487**		0.037
Cointegration test: Fpss = 10.299***						
Diagnostic Tests			Stat.		Probability	
Heteroskedasticity test of Breusch/Pagan (chi2)			0.8097		0.3682	
Test of normality of Jarque-Bera (chi2)			2.297		0.3170	

Note. *** significance at 1%, ** significance at 5% and * significance at10%.

[+] and [-] are respectively the positive and negative changes in financial development (Dfin).

Source. Author, based on World Bank (2018) and IMF (2018) data.

Regarding econometric interpretations, the analysis of Table 9 shows that the Fpss statistic (10.299) is above the upper limit of the critical value of Pesaran et al. (2001) (Table A.3 in the Appendix), reflecting the existence of a cointegrating relationship between financial development and long-term income inequality. In addition, the F-statistic calculated (40.93) from the Wald test is statistically significant at the 1% threshold. The symmetry hypothesis is rejected for the short- and long-term relationship. The result is that financial development has an asymmetric effect on income inequality in the short and long term. Caution is taken to verify the absence of heteroskedasticity via the Breush/Pagan test and the Jarque-Bera normality test, which confirms the normality of the residuals.

In the short run, the effect of a decrease in financial development on income inequality is different from that of an increase. An increase in financial development has a positive and statistically significant effect on income inequality, while a decrease in financial development has a negative and statistically significant effect.

In the long run, the effect of a decline in financial development on income inequality is different from that of an increase. Indeed, a decrease in financial development has a negative and statistically significant effect on income inequality at the 1% threshold. On the other hand, an increase in financial development has a positive and statistically significant effect on income inequality at the 1% threshold. Moreover, in absolute terms, the effect of

an increase in financial development is greater than the effect of a decrease. This result verifies hypothesis 2 of the study, which postulates that financial development, therefore, has an asymmetric effect on income inequality in Ivory Coast.

For economic interpretations, the results in Table 9 show that financial development has an asymmetric effect on short- and long-term income inequality in Ivory Coast. This means that the effect of an increase in the financial development index on income inequality is not the same as the effect of a decrease in the short and long run. The effect of financial development on income inequality is non-linear. Figure 1 shows this asymmetric effect of financial development on income inequality. The curve in blue represents the dynamic response of income inequality to a positive or negative change in financial development. It plots the sensitivity of income inequality to positive or negative changes in financial development. The one in red shows the effect of a decline in financial development on income inequality. The green line represents the effect of an increase in financial development on income inequality. It is the linear combination of the last two that gives the curve in blue.

Figure 1 does indeed show that the effect of an increase in financial development on income inequality is different from that of a decrease in Ivory Coast. It is clear that from the 50th year onwards, the effect of an increase in the financial development index on income inequality dominates that of a decrease. The income inequality sensitivity curve remains above the x-axis. It is from this period onward that financial development increases income inequality in Ivory Coast. The graph provides more detail on the ARDL model results discussed above regarding the relationship between financial development and income inequality. The existence of asymmetric effects explains why the relationship between financial development and income inequality in the short run is different in Ivory Coast than in the long run. To this end, it is important to take asymmetry into account in the analysis of this relationship.

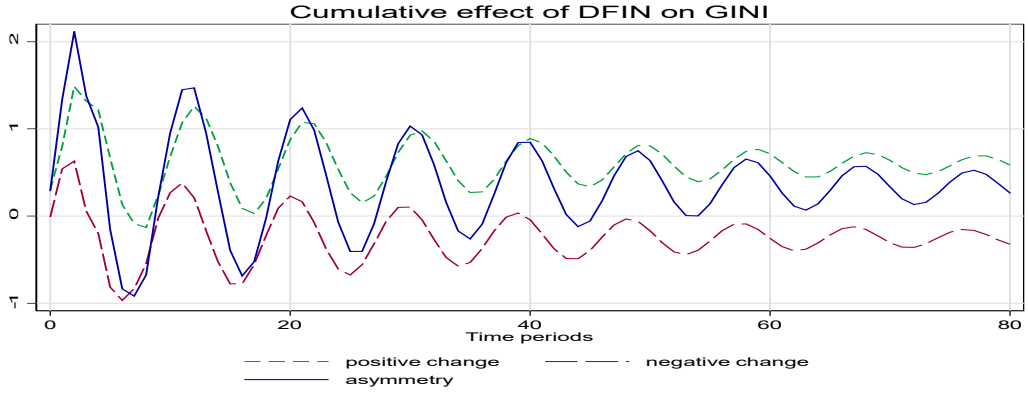

Figure 1. Cumulative effect of financial development on income inequality

Source. Author, based on World Bank (2018) and IMF (2018) data.

The NARDL model is very useful in that it sheds light on effects that appear ambiguous and counter-intuitive at first glance. After the presentation of the results and the different interpretations, we conclude this study with some concluding remarks.

5. Concluding Remarks

At the outset of this study, the objective was to analyse the effect of financial development on the reduction of income inequality in Côte d'Ivoire. To do so, we used annual data from the World Bank and the IMF, covering the period 1986 to 2016. Specifically, we had two objectives: The first was to assess the effect of financial development on the reduction of income inequality, and the second was to show that the effect of financial development on the reduction of income inequality is not symmetric. To achieve these objectives, two econometric models were used, namely, the autoregressive distributed lag model (ARDL) developed by Pesaran et al. (2001) and the non-linear staggered lag autoregressive model (NARDL) developed by Shin et al. (2014). The estimation results of the ARDL model revealed that in the short run, financial development reduces income inequality in Ivory Coast, but in the long run, it increases with financial development.

However, the effect of financial development on income inequality is not symmetric using the NARDL model. The effects of positive changes in financial development on income inequality dominate those of negative

changes. Positive shocks to financial development significantly reduce income inequality, while negative shocks have smaller effects.

The decline in income inequality in the short run could be explained by improved access to financial systems for a large proportion of the population. The increase in long-term income inequality could be explained by the use of credit by borrowers. Borrowers who make good use of credit will have a higher income in the long run than those who do not. They will be more creditworthy and will be able to borrow easily from financial institutions to further increase their income.

On the other hand, for control variables, the lagged inflation rate and lagged secondary school enrolment reduce income inequality in the short run, while the growth rate of the labor force increases income inequality. In the long run, inflation, trade openness and secondary school enrolment increase income inequality.

The economic policy implication that we can draw from this study is that financial development can be a means of reducing income inequality in Ivory Coast in the short term. However, for it to be a means of reducing income inequality in the long run, financial education is needed. Borrowers need to be educated on the use of credit so that they can use credit wisely.

This study found that financial development reduces income inequality in the short term, but in the long term, income inequality increases with financial development. About this increase in income inequality in the long run, this could be due to the use of credit. Since the study is conducted at the macroeconomic level, it is not possible to perceive the use of credit. For this reason, further studies at the micro-level can be conducted to deepen the relationship between financial development and the reduction of income inequality.

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APPENDIX

Table A1. Optimal Lag

Var lag Order Selection Criteria
Endogenous variables: GINI DFIN OCOM INFL TCPOP5_15_64_TXSSEC
Exogenous variables: C
Date: 11/03/19 Time: 12 :06
Sample: 1986 2016
Included observations: 29

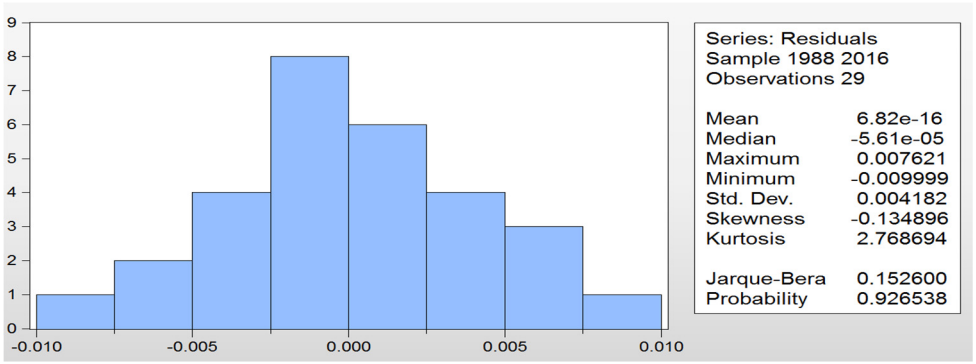
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-117.3472	NA	0.000199	8.506701	8.789590	8.595298
1	5.831333	186.8915	5.17e-07	2.494391	4.474612*	3.114572
2	55.84751	55.19026*	2.80e-07	1.527758*	5.205312	2.679522*

*indicates lag order selected by the criterrion
LR sequential modified LR test statistic (each test at 5% level)
FPE : Final prediction criterion
SC : Schwarz information criterion
HQ : Hannan-Quinn information criterion

Source. Authors Compilation.

Table A2. ARDL Model Robustness Tests

Test of normality



Autocorrelation test

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.410624	Prob.F (2, 10)	0,6739
Obs*R-squared	2.200872	Prob. Chi-Square (2)	0.3327

Heteroskedasticity test

Heteroskedasticity Test Breusch-Pagan-Godfrey			
F-statistic	1.567040	Prob.F(16,12)	0.2179
Obs*R-squared	19.61302	Prob. Chi-Square (16)	0.2382
Scaled explained SS	2.969844	Prob. Chi-Square (16)	0.9998

Source. Authors Compilation.

Test de Ramsey

Ramsey RESET Test
Equation : UNTITLED
Specification : GINI GINI (-1) DFIN DFIN (-1) DFIN (-2) INFL INFL (-1) INFL (-2) OCOM OCOM (-1) OCOM (-2) TCPOP5_15_64_TCPOP5_15_64_(-1) TCPOP5_15_64_(-2) TXSSEC TXSSEC (-1) TXSSEC (-2) C
Omitted Variables : Squares of fitted values

	Value	df	Probability
t-statistic	0.803552	11	0.4387
F-statistic	0.645696	(1, 11)	0.4387
F-test summary	Sum of sq	df	Mean Squares
Test SSR	2.72E-05	1	2.72E-05
Restricted SSR	0.000490	12	4.08E - 05
Unrestricted SSR	0.000463	11	4.21E-05

Source. Authors Compilation.

Table A3. Table of Critical Values of Pesaran (2001)

0.100			0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	6.58	6.58	8.21	8.21	9.80	9.80	11.79	11.79	3.05	3.05	7.07	7.07
1	4.04	4.78	4.94	5.73	5.77	6.68	6.84	7.84	2.03	2.52	2.28	2.89
2	3.17	4.14	3.79	4.85	4.41	5.52	5.15	6.36	1.69	2.35	1.23	1.77
3	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.61	1.51	2.26	0.82	1.27
4	2.45	3.52	2.86	4.01	3.25	4.49	3.74	5.06	1.41	2.21	0.60	0.98
5	2.26	3.35	2.62	3.79	2.96	4.18	3.41	4.68	1.34	2.17	0.48	0.79
6	2.12	3.23	2.45	3.61	2.75	3.99	3.15	4.43	1.29	2.14	0.39	0.66
7	2.03	3.13	2.32	3.50	2.60	3.84	2.96	4.26	1.26	2.13	0.33	0.58
8	1.95	3.06	2.22	3.39	2.48	3.70	2.79	4.10	1.23	2.12	0.29	0.51
9	1.88	2.99	2.14	3.30	2.37	3.60	2.65	3.97	1.21	2.10	0.25	0.45
10	1.83	2.94	2.06	3.24	2.28	3.50	2.54	3.86	1.19	2.09	0.23	0.41