CHAPTER-III

DATA AND METHODOLOGY

The main objective of this chapter is to outline this empirical framework employed so as to achieve the specific objectives of the study. This study adopts descriptive statistics, ratio analysis, and econometric method to achieve the objectives of the study. The descriptive statistics is used mainly to analyze the banking sector development in Ethiopia in terms of financial deepening, deposit mobilization and loans and advances to the public and private sector as well as economic sectors; to investigate the trend of credit to the private sector in pre-reform and reform era; and to examine the trends in sector wise (Agriculture and allied sectors, industry, and service sectors) disbursement of funds in pre-reform and reform periods.

Moreover, the study uses two econometrics methods namely - the Johansen multivariate cointegration model and Granger causality test to examine the impact of bank credit on economic growth and direction of causality between bank credit and economic growth in Ethiopia. The Johansen multivariate cointegration model shall predict the cumulative effects taking into account the dynamic response among financial variables (bank credit and liquid liabilities of the banking system) and other control variables.

The chapter divided into five sections. In section 3.1, the data used in this study and the sources of data are presented. Section 3.2 illustrate the descriptive statistics and mean difference analysis of major banking sector development indicators. Section 3.3 deals with the empirical model specification of the Johansen multivariate cointegration models namely the growth model and domestic capital model. Section 3.4 presents the
techniques or procedures in the estimation of the long-run and short-run dynamic growth model and domestic capital model. Section 3.5 describes the bivariate Granger-causality model used for identifying the direction of causality between bank credit and economic growth. Finally, section 3.6 presents the summary of the chapter.

3.1. Data type and sources

The data used in this study are annual time series data covering the period from 1971-72 to 2010-11 for Ethiopia regarding 1999-2000 as a base year. The data were sourced from the Ministry of Finance and Economic Development-MoFED\(^1\) (2010-11), NBE\(^2\) (2011), World Development Indicators (WDI)\(^3\) (2011), and IMF\(^4\)-International Financial Statistics CD-ROM (2012).

3.2. Descriptive Statistics and Mean Difference Analysis

This study uses descriptive financial ratio, trend, and mean difference analysis to measure, describe and analyse the development of the banking system in Ethiopia during the reform period (1991-92 to 2010-11) compared to the pre-reform period (1971-72 to 1990-91). The financial measures used in this study address the stock-flow problem of financial intermediary balance sheets items being measured at the end of the year, while nominal GDP is measured over the year. To circumvent any inconsistency when employing a ratio of a stock and a flow variable, a number of authors have attempted to deal with this problem by calculating the average of the financial development measures.

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\(^2\) Fiscal year in Ethiopia begins July 1 and ends June 31
in year $t$ and $t-1$ and dividing by nominal GDP in year $t$ (King and Levine, 1993a). Thus, the financial measures are converted into flow using the following formula:

$$X_t = 0.5 \times (X_{t-1} + X_{t-2}) / GDP_t$$

(3.1)

Where, $X_t$ is financial variable under consideration and $t$ is the time period. The financial variables include financial deepening indicators, bank credit, and components of deposit.

After converting the financial variables into flow, they are analysed using trend and descriptive statistics analysis techniques. Besides, in examining whether the difference in banking sector development (measured by financial deepening, deposit mobilization, bank credit to the private sector as a ratio of GDP, and bank credit by borrowers and sector wise credit to total outstanding loans and advances) in 1991-92 to 2010-11 (reform period) is statistically different from that of 1971-72 to 1990-91 (pre-reform period) $t-$ test is employed to test the hypothesis that the means of the two periods are the same (or the mean of the two periods are zero) on the financial deepening indicators, bank credit, and deposit variables. Hence, the following hypothesis has been tested:

$$H_0 : \mu_r = \mu_{pr}, \text{ against the alternative hypothesis}$$

$$H_1 : \mu_r \neq \mu_{pr}$$

(3.2)

Where, $\mu_r$ is the mean for 1991-92 to 2010-11 (reform period) and $\mu_{pr}$ is the mean for 1971-72 to 1990-91 (pre-reform period). Inferences about the hypothesis are made by looking at test statistics and critical values ($\alpha$) associated with the mean. If $t-$ value $\leq \alpha$, we do not reject the null hypothesis. If $t-$ value $> \alpha$, we reject the null hypothesis or accept the alternative hypothesis. The selection of the mean difference
analysis method for comparing the banking system development indicators in pre-reform and reform is motivated by the fact that from the method gives clear picture whether the change during reform period is statistically significance or not. The statistical significance of mean differences of variables in reform and pre-reform period were done using Stata version 10.

3.3. Multivariate Regression Model Specification

A number of recent studies have used growth accounting framework to investigate the relationship between financial development and economic growth. The general idea consists of assuming that financial development improves the efficient allocation of resources, which in the context of endogenous model, implies higher long-run economic growth. The multivariate vector autoregressive (VAR) model considered below for empirical analysis capitalizes the role of bank credit on economic growth in Ethiopia through Total Factor Productivity (TFP) growth and capital accumulation equations determining domestic capital along with GDP growth.

The objective of growth accounting is to decompose the economic growth rate of a country into contributions from different factors. Even though growth accounting is an empirical tool, it is not devoid of theory. Specific assumptions need to be made at the beginning, which provide a framework, a perspective from which economic data can be interpreted. The basic version of growth accounting using \( t \) to denote time period (years) is provided by Cobb-Douglas aggregate production function:

\[
Y_t = A_t (K_t^d)^\beta (L_t)^{1-\beta} \tag{3.3}
\]
The aggregate production function links real output (GDP) \( Y \) in period \( t \) to two factors of production, the domestic capital stock \( K^d_t \) and the size of the labor force \( L_t \), as well as to total factor productivity (TFP) \( A_t \). Where as \( \beta \) is a parameter of the production function. Growth accounting can also be carried out if the underlying data come in per worker terms. Heston et. al\(^6\) (2012) Penn World Table Version 7.1 provides information on real GDP per worker and the capital stock per worker, but not the size of the labor force. In this case, the strategy is to transform the production function (3.3) into a per-worker production function by dividing by the actual working force \( N_t \) on both sides:

\[
\frac{Y_t}{N_t} = \frac{A_t (K^d_t)^\beta N_t^{1-\beta}}{N_t} = A_t (K^d_t)^\beta N_t^{-\beta} = A_t \left( \frac{K^d_t}{N_t} \right)^\beta \tag{3.4}
\]

Using lower-case letters for income and capital per worker (i.e., \( y_t = \frac{Y_t}{N_t} \) and \( k^d_t = \frac{K^d_t}{N_t} \), we have:

\[
y_t = A_t (k^d_t)^\beta \tag{3.5}
\]

Taking log transformation and denoting logs of real output per worker, TFP, and domestic capital per worker yields

\[
\log y_t = \log A_t + \beta \log k^d_t \tag{3.6}
\]

Literature on financial economics indicates that bank credit can influence growth rate of GDP per worker through two channels, namely TFP growth and capital accumulation. The banking system play a role in the growth process because it integral to the provision of funding for capital accumulation and for the diffusion of new technologies. The micro-economics rationale for financial system is based largely on the existence of frictions in the trading system. In a world in which written, issuing, and
enforcing contracts consume resources and in which information is asymmetric and its acquisition is costly, properly functioning financial sector can provide such services that reduce these information and transaction costs (Pagano\textsuperscript{7}, 1993 and Levine\textsuperscript{8}, 1997). This process brings together severs and investors more effectively in the credit market and ultimately contributes to economic growth through capital accumulation and TFP growth via efficient resources allocation and diffusion of technology.

According to Ahmed and MaliK\textsuperscript{9} (2009), there are two different approaches for constructing the model that capture the two channels mentioned above through which finance can influence economic growth. The first approach is to estimate the effects of financial indicators along with other control variables on each of the two variables; namely TFP and domestic capital then substituting the estimated equations in the growth accounting equation specified above. The other approach is to substitute the algebraic expressions indicating the relationship of TFP with financial and other variables into the growth accounting equation before estimating the latter. Following the second approach, we specify the following linear relationship to determine TFP.

\[
\ln TFP = \beta_0 + \beta_1 \ln psc_t + \beta_2 \ln dp_t + \beta_3 \ln sse_t + \beta_4 \ln p_t + \beta_5 \ln gc_t + \beta_6 \ln op_t + e_t
\]

\[\text{(3.7)}\]

Where \(\ln sse_t, \ln psc_t, \ln dp_t, \ln p_t, \ln gc_t, \text{ and } \ln op_t\) are the natural logarithm of bank credit to the private sector to GDP ratio, deposit liabilities to GDP ratio, gross secondary school enrollment, price inflation, government final consumption to GDP ratio, and trade openness (the ratio of exports and imports to GDP), while \(\beta_i\) and \(e_t\) indicate is parameter estimates and random error term, respectively.
Substituting equation (3.7) into (3.6) for $A_i$ and rearranging for the order of the variables yields the following log-liner estimable equation for the determinants of economic growth

$$\ln y_i = \beta_0 + \beta_1 \ln k_i^d + \beta_2 \ln psc_i + \beta_3 \ln dp_i + \beta_4 \ln sse_i + \beta_5 \ln p_i + \beta_6 \ln gc_i + \beta_7 \ln op_i + \varepsilon_i$$

----- (3.8)

The seven variables used in the growth model (3.8) are described as follows

**Real GDP per worker** ($y_i$): This is the proxy for economic growth. As mentioned earlier, it is obtained by dividing real GDP by work force. As mentioned earlier the data on real GDP per worker was obtained from Heston et. al\textsuperscript{10} (2012) Penn World Table Version 7.1.

**Net domestic capital per worker** ($k_i^d$): This series is constructed from gross capital formation using the perpetual inventory assumption with depreciation rate set equal to 5 per cent (Wang and Yao\textsuperscript{11}, 2003). The per capita capital stock series is then obtained by dividing the net capital stock series by work force. The data on net domestic capital was computed from Heston et. al\textsuperscript{12} (2012) Penn World Table version 7.1. Increase in net domestic capital overtime implies increase in investment or capital accumulation. It follows from economic literature domestic capital accumulation will have positive impact on TFP and economic growth. Hence, the expected sign of domestic capital per worker on economic growth is positive (i.e. $\beta_i > 0$).

**Private sector bank credit to GDP ratio** ($psc_i$): This variable is a proxy for bank credit. Private sector credit equals the value of credit by domestic commercial banks and other banking institutions to GDP ratio. The flow value of private credit is computed
using equation (3.1) following King and Levine\textsuperscript{13} (1993a). The data for private sector credit is obtained from NBE\textsuperscript{14} (2010-11).

The reason behind using private sector credit to GDP ratio as a proxy for bank credit is that this ratio is a measure of financial sector activity or the ability of the banking system to provide finance-led growth. The supply of credit to the private sector is important for the quality and quantity of investment (Demetriades and Hussein\textsuperscript{15}, 1996). This ratio also stresses the importance of the role played by the financial sector, especially the deposit money banks, in the financing of the private economy. It isolates credit issued to the private sector from credit issued to governments, government agencies, and public enterprises. Also, it excludes credits issued by the Central Bank (Levine et. al\textsuperscript{16}, 2000). Financial economics highlights that the increase in private sector credit by the banking system as opposed to credit to the government and public enterprises overtime means improved efficient allocation of financial resources. This in turn will affect TFP and economic growth positively. Thus, the expected sign of private sector credit to GDP ratio in equation (3.8) is positive (i.e. $\beta_2 > 0$).

The underlying assumption is that credit provided to the private sector generated increases in investment and productivity to a much larger extent than the credits to the public sector. It is also argued that loans to the private sector are given under more stringent conditions and that the improved quality of investment emanating from financial intermediaries’ evaluation of project viability is more significant for private sector credits (Levine and Zervos\textsuperscript{17}, 1998).

**Deposit liabilities of banking sector to GDP ratio** ($dep_t$): It includes liquid liabilities of commercial banks and other bank financial institutions as a share of GDP,
which measures the size of financial intermediation. The data on deposit liabilities is obtained from IMF\textsuperscript{18} (2012) IMF-IFS CD-ROM.

Gelb\textsuperscript{19} (1989) uses the ratio of broad money (M2) to GDP for financial depth. In principle, the increase in the ratio means the increase in financial depth. But, in developing countries, M2 contains a large proportion of currency outside banks. As a result, the rise of M2 will refer to monetization instead of financial depth (Demetriades and Hussein\textsuperscript{20}, 1996). Hence, the amount which is out of the banking system, that is currency, should be extracted from the broad money. So the ratio of deposit liabilities to nominal GDP is more relevant variable for Ethiopia and computed using equation (3.1). The increase in deposits means more loanable fund available for credit. Thus, we expect that deposit liabilities of the banking sector to have positive effect on TPF and hence economic growth (i.e. $\beta_3 > 0$)

The vector of control variables that are assumed to affect TFP and hence economic growth includes variables commonly used in the literature (Beck et. al\textsuperscript{21}, 2000; Levine et. al\textsuperscript{22}, 2000) such as gross secondary school enrollment, to control for the level of human capital; inflation and government size as a share of GDP both used as indicators of macroeconomic stability; and volume of trade as share of GDP, to capture the degree of openness.

**Gross secondary school enrollment ($sse_i$):** Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject or
skill-oriented instruction using more specialized teachers. Easterly and Sewadeh\textsuperscript{23} (2001) and WDI\textsuperscript{24} (2011)

Romer\textsuperscript{25} (1986) noted than gross secondary school enrollment is a human capital indicator and it obviously affects TFP through accumulation of knowledge, learning ability, and general increase productivity of resources. We expect the coefficient on secondary schooling to be positive. Lucas\textsuperscript{26} (1993) argued that a better-educated population augments a country’s ability to absorb and adopt new technologies and to innovate; therefore, it is an important factor of growth. Hence the expected sign of secondary school enrollment on economic growth is positive (i.e. $\beta_4 > 0$)

**Price inflation** ($p_t$): Price inflation is proxied by GDP deflator. It is computed by dividing real GDP by nominal GDP. Price inflation can adversely affect TFP by causing uncertainty and short-term distortions in resource allocation. According to Barro and Sala-i-Martin\textsuperscript{27} (1995), this variable indicates macroeconomic stability. Hence, the expected sign of inflation on TFP and economic growth is negative (i.e. $\beta_5 < 0$).

**Government final consumption to GDP ratio** ($gc_t$): Since government final consumption is part of GDP and is flow rather than stock it is simply deflated by GDP unlike the financial variables, which are stock. Data on government final consumption is obtained from MoFED\textsuperscript{28} (2010-11). Government final consumption indicates the size of the public sector in an economy and its effect is generally regarded negative unless it is specifically meant to improve productivity. Thus, the expected sign of government final consumption to GDP ratio is ambiguous. That is, if it improves productivity by spending more on government’s key areas such as by improving education and health service, eradication of illiteracy, employing more workers, maintaining law and order, protecting
property right, keeping crime low etc, as suggested by Deverajan et. al\textsuperscript{20} (1993) then the sign will be positive (i.e. $\beta_6 > 0$). However, if government final consumption is more on unproductive areas other than mentioned above then it will have adverse effect on TFP and economic growth and hence $\beta_6 < 0$.

**Trade openness** ($op_t$): Trade openness is measured as the sum total of exports and imports of goods and services to GDP ratio. Trade openness is expected to raise productivity through increased competition and transmission of technology from the rest of the world (Edwards\textsuperscript{30}, 1993 and Levine and Zervos\textsuperscript{31}, 1998). Thus, its expected sign is positive (i.e. $\beta_7 > 0$).

Now to specify the determinants of domestic capital, the following log-liner econometric equation is proposed

\[
\ln k_t^d = \rho_0 + \rho_1 \ln psc_t + \rho_2 \ln dp_t + \rho_3 \ln y_t + \rho_4 \ln p_t + \rho_5 \ln gc_t + \rho_6 \ln op_t + \nu_t - \ln
\]

------- (3.9)

The financial variables included in the equation of net domestic capital equation are the same as in the growth equation (3.8). Both financial variables are expected to exert favorable influence in the capital accumulation by facilitating the channeling of resource allocation from savers to higher-return activities and increasing the quantity of fund available for domestic investment as explained earlier. According to Mohammed\textsuperscript{32} (2000), the significant relationship between the investment ratio and the financial indicator may be a good reason to consider that the nature of the finance-growth link hinges on the investment behavior of the private sector in each economy. In other words, the insignificant correlation between financial development and economic growth may be explained by the lack of innovative entrepreneurial activity in developing countries.
Real GDP per worker expected to affect capital accumulation through accelerator channel. Empirical evidence is consistent with the accelerator effect and shows that high output growth are associated with higher investment rate (Fielding, 1997). The ratio of government final consumption to GDP is included in the equation to determine whether government spending is conducive to or crowds out capital accumulation. Inflation rate may have positive or negative effect on domestic investment. High and unstable inflation is likely to affect domestic investment adversely by increasing the degree of uncertainty about macroeconomic environment (Fisher, 1993).

However, moderate inflation may promote capital accumulation by shifting portfolio of assets from financial to real components and by providing signals of rising aggregate demand (Tobin, 1965). Finally, trade openness can affect domestic capital both through exports and imports. An increase in exports leads to an increase in the supply of foreign exchange necessary for the purchase of imported capital goods and also expands the market for domestic products. An increase in imports can accumulate domestic capital if it implies greater access to investment goods. But imports can also negatively affect domestic capital if it predominantly consists of consumer goods, which may discourage domestic production.

The above Johansen cointegration VAR models (equation 3.8 and 3.9) provide integrated approach for understanding how financial systems and domestic capital affect long-run rates of economic growth through TFP and capital accumulation. This framework captures financial economics view of finance and growth that highlighted the impact of financial systems on productivity growth and technological change. All computations in this thesis were done using Givwin/PcGive software version 12.0.
3.4. Estimation technique

This section deals with the estimation procedures followed sequentially in this study in order to estimate the cointegration VAR models (equation 3.8 and 3.9). Subsection 3.4.1 defines stationary and non-stationarity and outlines the procedures for the estimation of unit root of the variables in the growth and domestic capital models. On the other hand, sub section 3.4.2 defines cointegration, discusses the different methods of cointegration, provides justification for choosing the Johansen maximum likelihood method, and outlines the vector autoregressive (VAR) model used in this study. Since the long-run equilibrium may rarely be observed, the procedure for short-run dynamics of the variables under consideration is presented under sub-section 3.4.3. Finally, the Granger causality test aiming at examining the direction of causation between bank credit and economic growth is presented in section 3.5.

3.4.1. Stationarity Test

Empirical research in economics is based on time series. Therefore, it is standard to view time series as the realisation of a stochastic process. Model builders can use statistical inference in constructing and testing the equations that characterise relationships between economic variables. The two central properties of many economic time series are non-stationarity and time-volatility (Wei, 2006). Recent development in econometrics has shown that there are problems associated with time series analysis due to non-stationarity.

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3 The problem associated with non-stationary series is that all conventional techniques and statistical tests are spurious. Spurious in a sense the regression estimation will yield high $R^2$, statistically significant coefficients, and low Durbin-Watson’s’ statistics (Gujarati, 1995:724).
Non-stationarity is a property common to many applied time series. This means that a variable has no clear tendency to return to a constant value or linear trend. It is generally correct to assume that economic processes have been generated by a non-stationary process and follow stochastic trends. One major objective of empirical research in economics is to test hypotheses and estimate relationships derived from economic theory, among other such aggregated variables. It can originate from various sources but the most important one is the unit root (Pfaff, 2006). With regards to stationary time series data, Harris (1995:15) noted that “… a data series is said to be stationary if its error term has zero mean, constant variance, and the covariance between any two-time periods depends only on the distance or lag between the two periods and not on the actual time at which it is computed.”

The classical statistical methods used in building and testing large simultaneous equation models, such as Ordinary Least Squares (OLS), were based on the assumption that the variables involved are stationary. The problem is that the statistical inference associated with stationary processes is no longer valid if time series are a realisation of non-stationary processes. If time series are non-stationary it is not possible to use OLS to estimate their long-run linear relationships because it would lead to spurious or nonsensical regression.

Spurious regression is a situation in which there appears to be a statistically significant relationship between variables but the variables are unrelated. A Spurious or nonsensical relationship may result when one non-stationary time series is regressed against one or more non-stationary time series. A few decades ago the difficulty of non-stationarity was not well understood by econometricians. However, this is no longer the
case because the technique of cointegration has been introduced according to which models containing non-stationary stochastic variables can be constructed in such a way that the results are both statistically and economically meaningful (Gujarati\textsuperscript{39}, 1995). The best way to guard against spurious regressions is to check for cointegration of the variables used in time series modeling. Hence, prior to the estimation of the long run models the time series properties of the variables concerned should be distinguished between stationary and non-stationary variables.

3.4.1.1. Unit root

Any sequence that contains one or more characteristic roots that are equal to one is called a unit root process. The simplest model that may contain a unit root is the AR(1) model. Consider the autoregressive process of order one, AR (1), below:

\[
Y_t = \phi Y_{t-1} + \varepsilon_t \\
\]

(3.10)

Where \( \varepsilon_t \) denotes a serially uncorrected white noise error term with a mean of zero and a constant variance. If \( \phi = 1 \), equation 3.6 becomes a random walk without drift model, that is, a non-stationary process. When this happens, we face what is known as the unit root problem. This means that we are faced with a situation of non-stationarity in the series. If, however, \( \phi < 1 \), then the series \( Y_t \) is stationary. The stationarity of the series is important because correlation could persist in non-stationary time series even if the sample is very large and may result in what is called spurious (or nonsense) regression (Gujarati\textsuperscript{40}, 2004). The unit root problem can be solved, or stationarity can be achieved, by differencing the data set.
3.4.1.2. The augmented Dickey-Fuller (ADF) test

In section 3.4.1.1, it was stated that, if $\phi = 1$, equation 3.10 becomes a random walk model without drift, which is known as a nonstationary process. The basic idea behind the ADF unit root test for nonstationarity is to simply regress $Y_t$ on its (one period) lagged value $Y_{t-1}$ and find out if the estimated $\phi$ is statistically equal to 1 or not. Equation 3.10 can be manipulated by subtracting $Y_{t-1}$ from both sides to obtain

$$Y_t - Y_{t-1} = (\phi - 1)Y_{t-1} + \varepsilon_t \tag{3.11}$$

which can be written as

$$\Delta Y_t = \sigma Y_{t-1} + \varepsilon_t \tag{3.12}$$

where $\sigma = (\phi - 1)$, and $\Delta$ is the first difference operator.

In practice, instead of estimating equation 3.10, we shall estimate equation 3.12 and test for the null hypothesis of $\sigma = 0$ against the alternative of $\sigma \neq 0$. If $\sigma = 0$, then $\phi = 1$, meaning that we have a unit root problem and the series under consideration is non-stationary. It should be noted that under the null hypothesis $\sigma = 0$, the t-value of the estimated coefficient of $Y_{t-1}$ does not follow the t-distribution even in large samples. This means that the t-value does not have an asymptotic normal distribution. The decision to reject or not to reject the null hypothesis of $\sigma = 0$ is based on the Dickey-Fuller (DF) critical values of the $\tau$ (tau) statistic. The DF test is based on an assumption that the errors of term $\varepsilon_i$ are uncorrelated.

However, in practice, the errors of the term in the DF test usually show evidence of serial correlation. To solve this problem, Dickey and Fuller have developed a test known as the Augmented Dickey-Fuller (ADF) test. In the ADF test, the lags of the first
difference are included in the regression equation in order to make the error term \( \varepsilon \), white noise and, therefore, the regression equation is presented in the following form:

\[
\Delta Y_t = \varpi Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t
\]  

To be more specific, the intercept may be included, as well as a time trend \( t \), after which the model becomes

\[
\Delta Y_t = \beta_0 + \beta_1 t + \alpha \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t
\]  

The testing procedure for the ADF unit root test is applied to the following model

\[
\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \alpha \sum_{j=1}^{\rho} \sigma_j \Delta y_{t-j} + \varepsilon_t
\]  

Where \( \alpha \) is a constant, \( \beta \) the coefficient on a time trend series, \( \delta \) the coefficient of \( Y_{t-1} \), \( \rho \) is the lag order of the autoregressive process, \( \Delta y_t = y_t - y_{t-1} \) are first differences of \( y_t, y_{t-1} \) are lagged values of order one of \( y_t, y_{t-1} \) are changes in lagged values, and \( \varepsilon_t \) is the white noise.

The ADF test can be tested on at least three possible models:

(i) A pure random walk without a drift. This is defined by using the constraint \( \alpha = 0, \beta = 0, \delta = 0 \) in equation 3.15. This leads to the equation

\[
\Delta y_t = \Delta y_{t-1} + \varepsilon_t
\]  

Equation 3.12 is a nonstationary series because its variance grows with time (Wei\textsuperscript{41}, 2006).

(ii) A random walk with a drift. This is obtained by imposing the constraint \( \beta = 0, \delta = 0 \) in equation 3.15, which yields to the equation
\[ \Delta y_t = \alpha + \Delta y_{t-1} + \varepsilon_t \]  

(iii) A deterministic trend with a drift. For \( \beta \neq 0 \), equation 3.15 becomes the following deterministic trend with a drift model

\[ \Delta y_t = \alpha + \beta t + \Delta y_{t-1} + \varepsilon_t \]  

The sign of the drift parameter (\( \alpha \)) causes the series to wander upward if positive and downward if negative, whereas the size of the absolute value affects the steepness of the series (Pfaff\(^2\), 2006).

Therefore, the discussion above entails that the pre-requisite of cointegration test is the stationarity of each individual time series over the sample period. Ever since the seminal paper by Engle and Granger\(^3\) (1987), cointegration analysis has increasingly become the favored methodological approach for analyzing time series data containing stochastic trends. Hence, before turning to the analysis of the long-run relationships between the variables the unit root properties of the single series is checked, as non-stationary behavior is a prerequisite for including them in the cointegration analysis. The modelling procedure of unit root test of the series at their level is described as follows:

\[ \Delta Y_t = \alpha_0 + \alpha_2 Y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \varepsilon_t, \]  

Where \( Y \) is the variable of choice; \( \Delta \) is the first-difference operator; \( \alpha_i \) (for \( i = 1 \) and 2) and \( \delta_i \) (for \( i = 1,2,\ldots,p \)) are constant parameters; and \( \varepsilon_t \) is a stationary stochastic process. \( p \) is the number of lagged terms chosen by Akaike Information Criterion (AIC) to ensure that \( \varepsilon_t \) is white noise. The hypotheses of the above equation form are:

\[ H_0 : \alpha_2 = 0, \text{ i.e., there is a unit root – the time series is non-stationary.} \]
$H_1: \alpha_2 \neq 0$, i.e., there is no unit root – the time series is stationary.

If the calculated ADF test statistic is higher than McKinnon’s critical values, then the null hypothesis ($H_0$) is accepted this means that a unit root exists in $Y_{t-1}$ and $\Delta Y_{t-1}$, implying that the series are non-stationary or not integrated of order zero, i.e., $I(0)$. Alternatively, the rejection of the null hypothesis implies stationarity of the underlying time series. Failure to reject the null hypothesis leads to conducting the test on the difference of the time series, so further differencing is conducted until stationarity is achieved and the null hypothesis is rejected (Harris, 1995). Hence, in order to determine the order of integration of a particular series, equation (3.19a) has to be modified to include second differences on lagged first and $k$ lags of second differences. This is as follows:

$$\Delta^2 Y_t = \psi_1 \Delta Y_{t-1} + \sum_{i=1}^{p} \theta_i \Delta^2 Y_{t-i} + \xi_t \text{--------------------------} (3.19b)$$

In this case, the hypotheses to be tested are:

$H_0 = \psi_1 = 0$, i.e., there is a unit root – the time series is non-stationary.

$H_1 = \psi_1 \neq 0$, i.e., there is no unit root – the time series is stationary.

If the time series are stationary in their first differences(that is $\psi_1 = 0$), then they can be said integrated of order one, i.e., $I(1)$; if stationary in their second differences, then they are integrated of order two, i.e., $I(2)$. The order of integration of the variables in equations (3.19a) and (3.19b) is investigated using the standard Augmented-Dickey-Fuller (ADF) [Dickey and Fuller, 1981] and Phillips-Perron (PP) [Phillips and Perron, 1988] unit-root tests for the presence of unit roots.
An important aspect of empirical research based on VAR is the choice of the lag order, since all inference in the VAR model depends on the correct model specification. Hence, the optimal lags required in the cointegration test were chosen using the most common traditional information criteria being the Akaike Information Criteria (AIC), Schwarz Criterion (SC), Hannan and Quinn’s (HQ) and the likelihood ratio (LR).

3.4.2. Cointegration Test

The necessary criterion for stationarity among non-stationary variables is called cointegration. Testing for cointegration is the necessary step to check whether the empirical modelling has meaningful relationships (Gutierrez et al. 2007). In economics, two variables are said cointegrated when they have long-term or equilibrium relationship between them (Engle and Granger 1987).

Cointegration is an econometric concept which mimics the existence of a long-run equilibrium among economic time series. If two or more series are themselves non-stationary, but a linear combination of them is stationary, then they are said to be cointegrated (Wei 2006). In applied econometrics analysis researchers are concerned about cointegration because it is a possible solution to non-stationarity found in many economic time series, and if time series are non-stationary the assumptions upon which OLS estimation rest are violated, rendering its application inappropriate.

Previously, the usual procedure for testing hypotheses concerning the relationship between non-stationary variables was to run OLS regressions on data which had initially been differenced. Data are differenced in order to reduce non-stationary series to stationarity. Although this method is correct in large samples, it may give rise to
misleading inferences or spurious regressions in small samples. Moreover, estimation of a single equation framework with integrated or non-stationary variables tends to create the following problems: non-standard distribution of the coefficient estimates generated by the process not being stationary, explanatory variables generated by the process that display autocorrelation, the existence of more than one cointegrated vector and tendency to weak exogeneity.

On the basis of the theory that integrated variables of order one, \( I(1) \), may have a cointegration relationship, it is crucial to test for the existence of such a relationship. If a group of variables are individually integrated of the same order and there is at least one linear combination of these variables that is stationary, then the variables are said to be cointegrated. The cointegrated variables will never move far apart, and will be attracted to their long-run relationship. Testing for cointegration implies testing for the existence of such a long-run relationship between economic variables.

The remedy for problematic regressions with integrated variables using OLS is to test for the Johansen multivariate cointegration approach and to estimate a vector error-correction model to distinguish between short-run and long-run responses, since cointegration provides more powerful tools when the data sets are of limited length.

The technique of cointegration and the error-correction model have both been used before in modelling a number of studies, for example, Luintel and Khan\(^{50}\) (1999) used a multivariate VAR model for a quantitative reassessment of the finance-growth nexus; Kar and Pentecost\(^{51}\) (2000) used VECM for searching a cointegrating relationship between financial development and economic growth in Turkey over the period of 1963-1995; Jadamba and Terukazu\(^{52}\) (2008) used multivariate cointegration test to examine the
nexus between financial sector development and economic growth- empirical analysis of 112 Countries; and Vazakidis and Adamopoulos\textsuperscript{53} (2009) used a Vector Error Correction Model (VECM) to investigate the relationship between credit market development and economic growth for Italy for the period 1965-2007 among others. In these studies, the multivariate Johansen cointegrating framework was used to ascertain the cointegrating rank.

In economic literature there are three types of cointegration tests, namely the Engle-Granger method commonly known as the two-step estimation procedure, the Phillips-Ouliaris methods and the Johansen's procedure. These cointegration tests are described briefly below.

\subsection*{3.4.2.1. Engle-Granger method}

As stated earlier, the regression of non-stationary series on other series may produce spurious regression. If each variable of the time series data is subjected to unit root analysis and it is found that all the variables are integrated of order one, I(1), then they contain a unit root. There is a possibility that the regression can still be meaningful (i.e. not spurious) provided that the variables cointegrate. In order to find out whether the variables cointegrate, the least squares regression equation is estimated and the residuals (the error term) of the regression equation are subjected to unit root analysis. If the residuals are stationary, that is I(0), it means that the variables under study cointegrate and have a long-term or equilibrium relationship. In the two-step estimation procedure, Engle-Granger considered the problem of testing the null hypothesis of no cointegration between a set of variables by estimating the coefficient of a statistic relationship between
economic variables using the OLS and applying well-known unit root tests to the residuals to test for stationarity. Rejecting the null hypothesis of a unit root is evidence in favour of cointegration.

### 3.4.2.2. Phillips-Ouliaris Methods

Phillips-Ouliaris introduced two residual-based tests namely: the variance ratio test and the multivariate trace statistics. These residual-based tests are used in the same way as the unit root tests, but the data are the residuals from the cointegrating regression. These tests seek to test a null hypothesis of no cointegration against the alternative of the presence of cointegration using scalar unit root tests applied to the residuals. Phillips-Ouliaris methods are based on residuals (differences between the observed and expected values) of the first order autoregression, AR (1), equation.

The multivariate trace statistics has the advantage over the variance ratio test in that it is invariant to normalisation, that is, whichever variable is taken to be the dependent variable the test will yield the same results (Pfaff, 2006). In the literature, there are no studies directly linked to the application of the Phillips-Ouliaris cointegration test only. However, there are only few studies in which cointegration have been tested using other techniques including the Phillips-Ouliaris methods.

### 3.4.2.3 Johansen's procedure

Johansen's procedure builds cointegrated variables directly on maximum likelihood estimation instead of relying on OLS estimation. This procedure relies heavily on the relationship between the rank of a matrix and its characteristic roots. Johansen
derived the maximum likelihood estimation using sequential tests for determining the number of cointegrating vectors. His method can be seen as a secondary generation approach in the sense that it builds directly on maximum likelihood instead of partly relying on least squares. In fact, Johansen's procedure is nothing more than a multivariate generalisation of the Dickey-Fuller test. Consequently, he proposes two different likelihood ratio tests namely the trace test and the maximum eigenvalue test.

The Johansen procedure is a vector cointegration test method. The use of Johansen's method has the advantage over the Engle-Granger and the Phillips-Ouliaris methods in that it is able to detect more than one cointegration relationship, if the data set contains two or more time series.

Despite the above mentioned advantage over the Engle-Granger method and Phillips-Ouliaris methods, the Johansen procedure is not without limitation. The method assumes that the cointegrating vector remains constant during the period of study. In reality, it is possible that the long-run relationships between the underlying variables change. The reason for this might be technological progress, economic crisis, changes in people's preferences and behaviour accordingly, policy or regime alteration and institutional development. This is especially the case if the sample period is long. To take this into account, we have to for cointegration with one and two unknown structural break(s). However, such tests do not form part of this thesis.
Thus, next to the stationarity test, the Johansen maximum likelihood, which nested the original Engel-Granger\textsuperscript{55} (1987) procedure, is adopted for the cointegration tests and estimation of the long-run and short-run relationship between bank credit and economic growth in Ethiopia. The choice for this method is that because it helps us to test whether integrated variables sharing common stochastic trend are cointegrated so that a meaningful long run relationship can be established. The unrestricted vector autoregressive (VAR) model considered in this study to estimate the long run relationship among jointly endogenous variables is:

\[ Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + B X_t + \varepsilon_t \]  \hspace{1cm} (3.20)

Where \( Y_t \) is a \( k \)-vector of non-stationary I(1) endogenous variables; \( X_t \) is a \( d \)-vector of exogenous deterministic variables; \( A_1 \ldots A_p \) and \( B \) are matrices of coefficients to be estimated and \( \varepsilon_t \) is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right hand side variables. Since most economic time series are non-stationary, the above stated VAR model is generally estimated in its first-difference form as:

\[ \Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + B X_t + \varepsilon_t \]  \hspace{1cm} (3.21)

Where, \( \Pi = \sum_{i=1}^{p} A_i \) and \( \Gamma_i = - \sum_{j=i+1}^{p} A_j \)

In the Johansen procedure, determining the rank of \( \Pi \) (i.e., the maximum number of linearly independent stationery columns in \( \Pi \)) provides the number of cointegrating

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\textsuperscript{4} The original Engle-Granger has the following weaknesses among others. 1) this test for cointegration is likely to have lower order against alternatives; 2) its finite samples of long run relationships are potentially biased; and 3) inference can not be drown using standard t-statistics about the significance of the parameters of the static long run model.
vector between the elements in $z$. In this connection, there are three cases worth mentioning. (i) If the rank of $\Pi$ is zero it points that the matrix is null which means that the variables are not cointegrated. In such case the above model (equation 3.21) is used in first difference, void of long run information. (ii) If the rank of $\Pi$ equals the number of variables in the system (say $n$) then $\Pi$ has full rank which implies that the vector process is stationary. Therefore, the VAR can be tested in levels. (iii) If $\Pi$ has a reduced rank (i.e., $1 < r(\Pi) < n$) it suggests that there exists $r \leq (n-1)$ cointegrating vector where $r$ is the number of cointegration (or the co-integrating rank) in the system.

Therefore, the Granger’s representation theorem asserts that if the coefficient matrix $\Pi$ has reduced rank $r < n$, then there exists $n \times r$ matrices of $\alpha$ and $\beta$ each with rank $r$ such that $\Pi = \alpha \beta'$ and $\beta' Y_t$ is $I(0)$ where each column of $\beta'$ is the cointegrating vector (cointegration parameters) with $\alpha$ showing their corresponding feedback (error correction parameters) that measures the speed of adjustment in $\Delta Y_t$ to equilibrium (i.e., it shows the speed with which disequilibrium from the long run path is adjusted).

In identifying the number of cointegrating vectors, the Johansen procedure provides $n$ eigenvalues denoted by $\lambda$ (also called characteristics roots) whose magnitude measures the extent of correlation of the cointegration relations with the stationery elements in the model. In general, to identify the number of cointegrating vectors in the system, the Johansen approach to cointegration test is based on two test statistics, viz., the trace test statistic ($\lambda_{\text{max}}$) and the maximum eigenvalue test statistic ($\lambda_{\text{max}}$) as suggested by Johansen$^{56}$ (1988) and Oseterwald-Lenum$^{57}$ (1992). They are obtained from the following formulas.
**Trace Test Statistic:** The likelihood ratio statistic (LR) for the trace test ($\lambda_{trace}$) can be specified as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{k} \log(1 - \hat{\lambda}_i)$$  \hspace{2cm} (3.22a)

Where, $\hat{\lambda}_i$ is the $i^{th}$ largest eigenvalue of matrix $\Pi$ and $T$ is the number of observations. In the trace test, the null hypothesis is that the number of distinct cointegrating vector(s) is less than or equal to the number of cointegration relations ($r$). In this statistic $\lambda_{trace}$ will be small when the values of the characteristic roots are closer to zero.

**Maximum Eigenvalue Test:** The maximum eigenvalue test ($\lambda_{max}$) examines the null hypothesis of exactly $r$ cointegrating relations against the alternative of $r+1$ cointegrating relations with the test statistic:

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$ \hspace{2cm} (3.22b)

Where $\hat{\lambda}_{r+1}$ is the $(r+1)^{th}$ largest squared eigenvalue. In the trace test, the null hypothesis of $r = 0$ is tested against the alternative of $r + 1$ cointegrating vectors. If the estimated value of the characteristic root is close to zero, then the $\lambda_{trace}$ will be small.

After detecting the number of cointegration, the normalized co-integration coefficients of growth and domestic capital models along with the test of significance of the variables is examined by imposing a general restriction on each variable ($\beta_i = 0$) in the regression models. Finally, the Wald test is applied is applied to examine the joint significance of the financial variables coefficients in the growth and domestic capital accumulation models.
3.4.3. The Short-run Vector Error Correction Model (VECM)

Since the long run equilibrium (steady state) may rarely be observed the short run dynamic/evolution of the variables under consideration is considered. By specifying the long-run determinants of economic growth and domestic capital models in an error correction model, the short-run as well as the long-run effects of all right hand side variables in equation are estimated in one step, which is a major advantage that error correction modeling has in comparison to other estimation.

The dynamic relationship includes the lagged value of the residual from the cointegrating regression \( (ECT_{t-1}) \) in addition to the first difference of variables which appear in the right hand side of the long-run relationship in model (3.8) and (3.9). The inclusion of the variables from the long-run relationship would capture short-run dynamics. For this reason, an ECM is extended to the multivariate scenario by defining all the variables to be potentially endogenous. In order to arrive at the short-run final preferred model, a one period lag of the cointegration vector saved from the long run estimation enters in ECM estimation using OLS.

An error correction model is defined as a dynamic model in which the movement of a variable in any period is related to the previous period's gap from the long-run equilibrium. Although it may be possible to estimate the long-run or cointegrating relationship, \( y_i = \beta x_i + \epsilon_i \), economic systems are rarely in equilibrium, as they are affected by institutional and/or structural changes that might be temporary or permanent. For example, extra income in the form of a birthday bonus may raise someone's expenditure pattern in one or two months and then his/her expenditure gradually goes back to equilibrium. Since equilibrium is rarely observed, the short-run evolution of
variables (short-run dynamic adjustment) is important. A simple dynamic model of a short-run adjustment model is given by

\[ y_t = \alpha_0 + \delta_0 x_t + \delta_1 y_{t-1} + \alpha_1 y_{t-1} + \varepsilon_t \]  \hspace{1cm} (3.23)

where \( y_t \) is the dependent variable, \( x_t \) is the independent variable, \( y_{t-1} \) and \( x_{t-1} \) are lagged values of \( y_t \) and \( x_t \) respectively, \( \alpha_0, \alpha_1, \delta_0, \delta_1 \) are parameters, and \( \varepsilon_t \) is the error term assumed to be \( \varepsilon_t \sim iN(0, \sigma^2) \).

The next step is to specify and estimate a vector error correction model (VECM) including the error correction term to investigate dynamic behaviour of the model. Once the equilibrium conditions are imposed, the VECM describes how the examined model is adjusting in each time period towards its long-run equilibrium state. The dynamic specification of the model allows the deletion of the insignificant variables, while the error correction term is retained. The final form of the vector error-correction model (VECM) was selected according to the general to specific methodology suggested by Harris\(^5^8\) (1995). The size of the error correction term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state (Engle and Granger\(^5^9\), 1987).

The general form of the vector error correction model (VECM) for the growth model is specified as follows:

\[ \Delta \ln y = \alpha_0 + \sum_{i=1}^{k} \beta_1 \Delta \ln y_{t-i} + \sum_{i=1}^{k} \beta_2 \Delta \ln k_{t-i} + \sum_{i=1}^{k} \beta_3 \Delta \ln sse_t + \sum_{i=1}^{k} \beta_4 \Delta \ln pbc_t + \sum_{i=1}^{k} \beta_5 \Delta \ln dp_t + \sum_{i=1}^{k} \beta_6 \Delta \ln p_t + \sum_{i=1}^{k} \beta_7 \Delta \ln gc_t + \sum_{j=1}^{k} \beta_8 \Delta \ln op_t + \gamma \text{ECT}_{t-1} + \varepsilon_t \]  \hspace{1cm} (3.24)

Moreover, the vector error correction model (VECM) for the determinants of domestic capital is specified as:
\[ \Delta \ln k_i^d = \rho_0 + \sum_{i=1}^{k} \rho_i \Delta \ln k_{i-1}^d + \sum_{i=1}^{k} \rho_i \Delta \ln y_i + \sum_{i=1}^{k} \rho_i \Delta \ln psc_i + \sum_{i=1}^{k} \rho_i \Delta \ln dp_i + \sum_{i=1}^{k} \rho_i \Delta \ln p_i + \sum_{i=1}^{k} \rho_i \Delta \ln gc_i + \sum_{i=1}^{k} \rho_i \Delta \ln op_i + \gamma ECT_{t-1} + \nu_i \]  

(3.25)

Where \( \Delta \) is the first difference operator, \( ECT_{t-1} \) is the error correction term lagged one period, \( \gamma \) is the short-run coefficient of the error correction term \((-1 < \gamma < 0)\), \( \varepsilon \), and \( \nu \) are the white noise terms of respective models. At the end of each short-run models the stability of the parameters is examined using

3.5. The Granger Causality Test

In this sub-section the causality between bank credit and economic growth in Ethiopia is tested using the Granger Causality test. As in the previous sections, under this sub section bank credit to the private sector is used as a proxy variable for bank credit. This study uses Granger Causality test for testing the direction of causation between bank credit and economic growth in Ethiopia.

The Granger procedure is selected because it consists more powerful but simpler way of testing causal relationship (Granger, 1986). Using this test the following null and alternative hypotheses are estimated:

\[ H_0: \text{Bank credit does not granger cause real economic growth} \]

\[ H_1: \text{Bank credit cause real economic growth} \]

The above way of formulating the null and alternative hypotheses is called the finance-led growth or supply leading hypothesis. For testing long-run, the above hypotheses are tested in the context of the VAR of the form:
In examining whether the growth-driven finance or demand following hypothesis holds true in Ethiopia, a variant of equation (3.26a) is formulated as

\[
\ln y_t = \alpha_1 + \sum_{i=1}^{p} \beta_i \ln y_{t-i} + \sum_{i=1}^{p} \delta_i \ln psc_{t-i} + \epsilon_{1t}, \quad \text{------------------------} (3.26a)
\]

The null and alternate hypotheses in this case are

\[H_0 : \text{Economic growth does not granger cause bank credit}\]

\[H_1 : \text{Economic growth causes bank credit}\]

In equation (3.26a) \(y\) is the dependent and \(pbc\) (bank credit to the private sector) is the explanatory variable in log form and \(\epsilon_{1t}\) is the white noise error term in (3.26a) while \(pbc\) is the dependent and \(y\) is the explanatory variable in (3.26b). Moreover, \(t\) is time and \(p\) is the lag length of the unrestricted VAR model. According to Seddighi et al. (2000:310), there exists a unidirectional causality if \(\{\delta_{11}, \delta_{12}, ..., \delta_{1k}\} \neq 0\) and \(\{\psi_{21}, \psi_{22}, ..., \psi_{2k}\} \neq 0\) in equation (3.23a) and (3.23b) and bi-directional causality if both \(\{\delta_{11}, \delta_{12}, ..., \delta_{1k}\} \neq 0\) and \(\{\psi_{21}, \psi_{22}, ..., \psi_{2k}\} \neq 0\) in the two equations, respectively.

The short-run causality between bank credit and economic growth is examined using the difference of the variables in equation (3.26a) and (3.26b).

Both the long-run and short run casual relationship between bank credit and domestic capital accumulation are by substituting the variable for domestic capital \(k^d\) in place of economic growth \(y\). The supply leading and demand following will also be adjusted accordingly.
3.6. Summary

This study uses time series macro data for the period 1971-72 to 2010-11. The data are obtained from different domestic and international secondary sources. The study addresses the stock-flow problem of financial intermediary balance sheets items being measured at the end of the year, while nominal GDP is measured over the year. This chapter presents in depth the methodology adopted to achieve the objectives of the study. First, the study uses trend and mean difference analysis to examine, describe and analyse the development of the banking system in Ethiopia during the period 1971-72 to 2010-11. Then, the Johansen multivariate cointegration approach based on the growth accounting framework is adopted to investigate the relationship between bank credit and economic growth. The general idea consists of assuming that financial development improves the efficient allocation of resources, which in the context of endogenous model, implies higher long-run economic growth. As a result, two log-linear multivariate vector autoregressive (VAR) models – namely the growth model and domestic capital accumulation model are formulated for empirical analysis of the impact of bank credit on economic growth in Ethiopia through Total Factor Productivity (TFP) growth and capital accumulation equations determining domestic capital along with GDP growth, respectively.

The estimation procedure indicates that the existence of a statistical relationship among the variables will be carried out in five steps. Initially the order of integration of the variables will be investigated using standard ADF and PP unit-root tests for the presence of unit roots. The second step involves testing for cointegration rank using the Johansen maximum likelihood approach after determining the appropriate lag length
using AIC. The Johansen-Juselius estimation method is based on the error-correction representation of the VAR model with Gaussian errors. Thirdly, the long-run elasticities of the financial variables and other control variables included in the Johansen multivariate cointegration growth and domestic capital accumulation models will be estimated. Wald-test is also applied to the joint significance of the financial variables in the growth and domestic capital accumulation models. Although cointegration implies the presence of Granger-causality it does not necessarily identify the direction of causality. Thus, the fourth step involves the estimation of the vector error-correction modeling (VECM) in accordance to the Hendry General to specific reduction (Gets) method. A number of authors observed that in the presence of cointegration there exists always a corresponding error correction representation. This implies that changes in the dependent variable are a function of the level of disequilibrium in the cointegrating relationship, captured by the error-correction term (ECT), as well as by changes in other explanatory variables. The non-significance of the ECT is referred to as long-run non-causality, which is equivalent to saying that the variable is weakly exogenous with respect to the long-run parameters. Finally, both the long-run and short-run Granger Causality test between bank credit and economic growth will be performed. A one step recursive CUSUMSQ residuals graphics is carried out in order to examine the stability of the parameters has been estimated at the end of each short-run.
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