Determinants of savings in Sudan using Autoregressive- Distributed- Lag Model (ARDL) during period 2000-2022

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Abstract

This study examines the effects of national income and inflation on savings in Sudan and investigates the nature of the relationships among these variables in both the short and long run over the period 2000–2022. It hypothesizes the existence of statistically significant relationships between national income, inflation, and savings. To achieve its objectives, the study adopts both descriptive-analytical and econometric approaches. It analyses the trends in savings, national income, and inflation in Sudan and uses annual data for the period under investigation to examine the nature and direction of the relationships among these variables. The Autoregressive Distributed Lag (ARDL) model is employed to estimate both short-run and long-run relationships. The findings reveal a positive relationship between national income and savings, indicating that an increase in national income is associated with higher levels of savings. This finding is consistent with economic theory, as higher income increases disposable income after consumption and, consequently, the capacity to save. The study also identifies a positive relationship between inflation and savings, a finding that differs from the predictions of some traditional economic theories. This relationship may be explained by the precautionary saving hypothesis, according to which economic uncertainty and rising prices may encourage individuals to increase their savings in anticipation of future financial obligations and higher living expenses.

Keywords: Savings, Inflation, Precautionary Savings, National Income, ARDL.

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محددات الإدخار في السودان باستخدام نموذج الانحدار الذاتي ذي الإبطاء الموزعة خلال الفترة 2000-2022م

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الملخص

هدفت هذه الدراسة إلى قياس أثر كل من ارتفاع الدخل والتضخم على مستويات الادخار، وتحديد طبيعة العلاقة بين هذين المتغيرين على المديين القصير والطويل. افترضت الدراسة وجود علاقة ذات دلالة إحصائية بين الدخل القومي والتضخم والادخار خلال الفترة 2000-2022. استخدمت الدراسة منهجًا وصفيًا تحليليًا ومنهجًا قياسيًا اقتصاديًا، بما يتناسب مع طبيعة مشكلة البحث وأهدافه ومعاييره. حللت الدراسة تطور الادخار والدخل القومي والتضخم في السودان خلال الفترة 2000-2022. استخدمت الدراسة المنهج القياسي الاقتصادي لقياس أثر الدخل القومي والتضخم على الادخار في السودان، ولاختبار طبيعة واتجاه العلاقة بين المتغيرات قيد الدراسة، باستخدام بيانات سنوية للفترة المحددة. كما استُخدمت منهجية الانحدار الذاتي ذي الفترات الزمنية الموزعة لقياس العلاقة بين المتغيرات. ومن أهم نتائج الدراسة وجود علاقة طردية بين الدخل القومي والادخار، حيث تؤدي زيادة الدخل القومي إلى زيادة مستويات الادخار. تتفق هذه النتيجة مع المنطق الاقتصادي الذي يفترض أن ارتفاع الدخل يزيد من القدرة على الادخار نتيجةً لزيادة الدخل المتاح بعد الاستهلاك. كما وجدت الدراسة علاقة طردية بين التضخم والادخار، وهي نتيجة تخالف التوقعات التقليدية لبعض النظريات الاقتصادية. مع ذلك، يمكن تفسير ذلك بفرضية الادخار الاحترازي، حيث يدفع عدم اليقين الاقتصادي وارتفاع الأسعار الأفراد إلى زيادة مدخراتهم لتغطية التزاماتهم المستقبلية ونفقاتهم المتزايدة.

الكلمات المفتاحية: الادخار ، التضخم، الادخار الاحترازي ، الدخل القومي ، نموذج ARDL.

Interdiction

Savings is a crucial macroeconomic variable in the economic development process, given its fundamental role in providing the necessary financial resources to fund investment and capital formation, thereby supporting economic growth and increasing the economy's productive capacity. Economies with high and stable levels of savings are generally better able to mobilize domestic resources and direct them towards productive investments. This reduces dependence on external financing sources and contributes to strengthening long-term economic stability. Therefore, analysing the determinants of savings has become an important topic in economic studies, especially in developing countries Facing limited financial resources and high investment needs, savings are influenced by a range of economic, social, and financial factors.

However, national income and inflation are among the most prominent economic determinants that can directly and indirectly affect saving behaviour. National income reflects the level of economic activity and the overall capacity of the economy to generate income. The higher the income level, the greater the potential for allocating a portion of it to savings after covering basic consumption needs, according to the relationship between income and savings discussed in economic literature. Conversely, inflation is one of the factors that can affect savings by impacting the purchasing power of income and the real value of cash balances and savings. High inflation rates may also compel individuals and businesses to reallocate their resources between Consumption, savings, and various assets.

National income is a key determinant of savings in Sudan, as the ability of individuals, institutions, and the public sector to accumulate savings is directly linked to income levels. An increase in income, assuming other factors remain constant, can lead to an increased capacity to save, while a decrease in real income reduces the surplus available after consumption spending,

thus limiting the ability to accumulate savings. This factor is particularly important in Sudan given the reliance of large sectors of economic activity on income related to agriculture, pastoralism, services, and other activities that are affected by economic fluctuations. Inflation is another constraint on saving in Sudan, given that a rise in the general price level leads to a decrease in the purchasing power of money and real incomes. Continued price increases drive up the cost of living, potentially forcing households to allocate a larger share of their income to current consumption at the expense of savings. Furthermore, high inflation can Negatively impact the attractiveness of savings.

Cash saving, especially when the rate of return on savings is lower than the rate of price

increases, leads to a decrease in the real value of savings over time, therefore, study the

determinants of savings in Sudan during period 2000-2022, focusing on national income and inflation, allows for an analysis of the impact of changes in the level of economic activity and income, as well as changes in the general price level, on saving behaviour in the Sudanese economy. the study also helps explain some aspects of the weakness in mobilizing domestic savings and provides a basis for formulating economic policies aimed at promoting domestic

Saving is a crucial macroeconomic variable due to its fundamental role in financing investment, capital formation, and promoting economic growth and financial stability. Savings levels are influenced by a range of economic determinants, primarily the level of national income and Inflation rates.

Theoretically, an increase in national income is expected to lead to a rise in the saving capacity of individuals and institutions, resulting from improved income levels and increased disposable income. Conversely, high inflation rates can lead to a decline in the purchasing power of real income, which can negatively impact saving capacity. However, inflation in some unstable economic conditions may encourage individuals to increase precautionary savings to cope with uncertainty Given the challenges facing the Sudanese economy, namely structural imbalances, price volatility, and fluctuating economic growth rates, it is essential to study the nature of the relationship between savings, national income, and inflation, and to determine the direction of this relationship and the extent to which each variable affects savings levels. Therefore,

The study problem is represented by the following main question:

- To what extent do national income and inflation affect savings rates in Sudan?

- To is the nature of the relationship between inflation and savings rates in Sudan during period 2000-2022?

- Does a rise in inflation rate lead to an increase or a decrease in savings?

The hypotheses can be formulated as follows:

- There is a statistically significant positive relationship between national income and savings in Sudan during period 2000-2022.

- There is a statistically significant positive relationship between inflation and savings in Sudan during the study period.

- Inflation has a significant impact on savings levels in Sudan, and the direction of this impact is determined according to prevailing economic condition.

The importance of studying the determinants of savings in Sudan during the period 2000–2022 stems from the economic importance of savings as a primary source of capital formation and investment financing. The importance of this study can be summarized in the following

aspects:

- the study contributes to clarifying the economic factors affecting savings, particularly the impact of national income and inflation on the level of savings is Sudan.

- domestic savings represent a significant resource for financing investments therefore studying its determinants helps in understanding the Sudanese economy's ability to mobilize its internal – the study helps in analysing the extent to which savings respond to changes in the level of national income and determining the nature of the relationship between them in the Sudanese economy.

- the study's findings can assist policymakers in designing economic and monetary policies that contribute to strengthening domestic savings and improving their capacity to finance

Investment.

- The study adds to the economic literature related to the determinants of savings in developing economies, particularly the Sudanese economy, by Analysing the relationship over a specific period.

- the period 2000-2022 provides a suitable timeframe for analysing the evolution of savings income, and inflation and observing the changes that have occurred in the relationship between them during the study period.

The study primarily aims to analyze the determinants of savings in Sudan during the period focusing on the impact of both national income and inflation on the level of ,2022-2000

Savings this study also aims to achieve the following objectives.

- to define the concept of saving, its economic importance, and its theoretical determinants.

- to examine the evolution of saving in Sudan during the period 2000-2022.

- to analyse the evolution of national income in Sudan during the study period.

- to analyse the evolution of inflation rates in Sudan during the period 2000-2022.

The study topic, "Determinants of Savings in Sudan: National Income and Inflation during the Period 2000–2022," was chosen due to the economic importance of savings as a primary source of capital formation and investment financing, and its role in supporting economic growth and development. The topic's significance also stems from the limited domestic savings in Sudan and the need to enhance the capacity to mobilize internal resources and direct them toward investment and productive uses. The topic was chosen because national income is a key determinant of savings, as the ability to save is linked to the level of income achieved in the economy. Inflation, on the other hand, is a significant economic factor that can affect savings by impacting the purchasing power of income and the real value of savings. The importance of studying these two variables in Sudan is heightened by the economic and

Monetary changes the economy witnessed during the period 2000-2022.

The study period was selected because of the transformations and changes in income levels economic activity, and prices that occurred during this time. This allows for the analysis of the evolution of savings and the nature of the relationship between savings, national income, and inflation over an extended period. The study also aims to contribute to filling a research gap related to the econometric analysis of the determinants of savings in the Sudanese economy and to provide findings that can be used in formulating economic policies aimed at encouraging Domestic savings.

Literature review

Imam (2025) examined the determinants of private savings in the Egyptian economy by analysing the economic and financial factors that influence private sector saving behaviour. The study considered private savings a primary source of investment financing and economic growth. The research problem focused on identifying the economic determinants that control

the level of private savings in Egypt and examining how changes in income, prices, interest rates, and other economic variables affect saving decisions.

The study aimed to identify the most important factors influencing private savings in Egypt, examine the relationship between savings and the economic variables that explain them, and determine how savings respond to economic changes. It employed a descriptive-analytical approach and an econometric approach based on the analysis of economic data and the examination of relationships between the study variables. The findings identified the variables with the greatest influence on private savings and measured the nature of their effects, providing insights that may help develop economic policies to increase private savings.

Mofi and Abu El-Ela (2020) examined the impact of fiscal and monetary policies on domestic savings in the Egyptian economy. The study analysed the role of fiscal and monetary policy instruments in influencing domestic savings levels and their contribution to mobilizing savings and directing them towards investment. The research problem focused on assessing the effectiveness of these policies in influencing domestic savings and determining the extent to which economic policy instruments can contribute to increasing savings levels.

The study aimed to analyse the impact of fiscal and monetary policies on domestic savings, determine the relationship between fiscal and monetary variables and savings levels, and identify the policy instruments that have the greatest influence on saving behaviour. It employed a descriptive-analytical approach and an econometric approach to examine the relationship between fiscal and monetary policies and domestic savings. The findings emphasized the importance of coordination between fiscal and monetary policies in influencing domestic savings. They also highlighted the role of fiscal and monetary variables in determining saving trends and mobilizing domestic savings.

Boulkour (2020) examined the determinants of household savings in Algeria by analysing a set of economic variables expected to influence household saving behaviour during the period 1970–2016. The research problem focused on identifying the most important economic variables affecting household savings and understanding the nature of the relationship between these variables and savings levels in Algeria.

The study aimed to identify the economic factors affecting household savings and measure the impact of GDP, inflation rate, money supply, interest rate, private consumption, and direct taxes on household savings. It employed an econometric approach using the Autoregressive Distributed Lag (ARDL) model. The analysis included unit root tests, bounds cointegration tests, an error correction model, diagnostic tests, and structural stability tests.

The findings showed that narrow money supply, direct taxes, private consumption, GDP, and inflation rate were the most important determinants of household savings in Algeria. The study also found that the adjustment period from short-term to long-term savings took approximately eight and a half months. This study is related to the current research in its focus on analysing the determinants of savings and using macroeconomic variables to explain saving behaviour. It also shares the use of modern econometric methods. However, it differs from the current research in terms of the economic environment studied and the type of savings examined.

Mason, Bayoumi, and Sami (1998) examined the determinants of private savings in a wide range of industrialized and developing countries by analysing the effects of various economic, demographic, and financial variables on private savings rates. The study aimed to explain differences in saving behaviour across countries. Its research problem focused on identifying the factors that explain variations in private savings rates among countries and determining the extent to which government savings, external savings, economic growth, population structure, interest rates, and terms of trade influence private saving behaviour.

The study aimed to identify the most important economic and demographic determinants of private savings, analyse the relationship between private and public savings, and measure how

private savings respond to changes in macroeconomic variables. It employed an econometric approach using cross-sectional and time-series data from a group of industrialized and developing countries to estimate the relationships between private savings and their various determinants.

The findings revealed a partial substitution relationship between private and government savings, meaning that an increase in government savings is accompanied by a partial decrease in private savings. The results also demonstrated the importance of demographic factors and economic growth rates in explaining private savings rates. Interest rates and terms of trade were found to have a positive influence on private savings, although this effect was not equally strong across all estimates.

The study also showed that higher GDP leads to increased savings at lower income levels, while it may lead to decreased savings at relatively higher income levels. These results indicated that the effects of savings determinants vary according to the economic development level of the countries studied. This study is related to the current research because it analyses the determinants of private savings and the economic factors influencing them. It also provides an important basis for understanding the relationship between income, economic growth, and savings. However, it differs from the current research in its broader geographical scope and its reliance on a sample of industrialized and developing countries.

Several observations can be drawn from the review of previous studies. First, the studies agreed on the importance of macroeconomic variables in explaining saving behaviour and determining savings levels. They also emphasized the role of income and GDP in influencing the saving capacity of individuals, households, and the private sector.

Furthermore, some studies examined the effects of inflation, interest rates, money supply, and fiscal and monetary policies on savings. However, the studies differed in the types of savings they investigated. Some focused on domestic savings, while others examined private or household savings. They also differed in their research methods. Some employed modern econometric techniques, particularly the ARDL model, while others relied on cross-sectional and time-series data analysis.

The Current Research in Relation to Previous Studies

The current research draws on previous studies in developing its theoretical framework on the determinants of savings, selecting the economic variables used to explain saving behaviour, and identifying an appropriate econometric methodology for analysing the relationship between savings and their determinants.

However, the current research differs from previous studies in its focus on the relationship between national savings, national income, and inflation in Sudan during the period 2000–2022. It also examines the nature of the short-term and long-term relationships between these variables and determines the speed of adjustment towards equilibrium following economic shocks.

The Concept of Saving

Savings refers to the portion of income that is not spent on consumption. It is usually held in current bank accounts or placed in short-term financial instruments, such as time deposits. Saving may also involve holding cash for short-term needs, including unexpected expenses, travel, and furniture purchases. The concept of saving is also associated with several other meanings, which can be summarized as follows (Abbas, 1996, p. 13).

Saving is closely related to wealth accumulation. This involves regularly setting aside a portion of income and investing it in ways that increase its value over time. Such practices can contribute to improving the social well-being of both individuals and society.

Savings are also defined as the difference between income and consumption. In other words, it represents the portion of income that is not spent on consumption (Areeqa, 2004, p. 139). However, not all savings are necessarily used for investment. Saving may also refer to the portion of net national product or national income that is not spent on consumption but is directed towards building productive capacity, which helps increase or maintain the level of income (Roger, 1981, p. 3).

According to classical economists, saving involves sacrificing current consumption to provide for future consumption. From this perspective, the real interest rate represents the price of this sacrifice. Keynes, on the other hand, defined saving as abstaining from consumption and considered it the portion of income that is not allocated to consumption.

Household savings are among the important economic concepts discussed in economic thought. They represent the difference between disposable income (income after taxes) and expenditure on various forms of consumption (Al-Ajamiya, 2006, p. 198). Savings can also be classified into different types according to several criteria.

Savings can be classified according to the identity of the saver into three main types: individual savings, corporate savings, and government savings.

They can also be classified according to their nature into two types: voluntary savings and compulsory savings. Voluntary savings include household savings, private sector savings, and bank time deposits. Compulsory savings, on the other hand, include the public budget surplus and the surplus of the public business sector, which is also known as the planned economic surplus.

The importance of saving is highlighted by its contribution to improving living standards and social well-being. It also supports social development, encourages rational consumption, and helps achieve economic stability for both individuals and society (Al-Thiyan, 2016).

Japan provides an example of the importance of saving in economic and social life. The country has long been known for its high savings rates compared with other industrialized countries, reflecting the strong saving habits of Japanese households. Japanese families have traditionally maintained high savings rates, with savings accounting for approximately 30% of monthly income (previous reference). This has enabled Japanese households to increase their consumption while simultaneously accumulating substantial savings. In comparison, approximately 75% of Arab households save very little, if anything, from their monthly income.

Theories Explaining Saving Behaviour

Keynesian Theory of Saving

Keynesian analysis of saving is linked to the consumption function, which assumes a relationship between consumption and current income. According to this view, income is the primary determinant of consumption expenditure, and the portion of income remaining after consumption represents savings. Therefore, an increase in income, assuming all other factors remain constant, leads to an increase in the amount available for saving, provided that the increase in consumption is smaller than the increase in income. This behaviour is known as the marginal propensity to save, which refers to the increase in savings resulting from a one-unit increase in income.

The Keynesian approach focuses on current income as a key determinant of consumption and saving. Later theories, however, have emphasized the importance of expected income, wealth, age, and future circumstances. Therefore, the relationship between income and saving remains one of the fundamental relationships examined in empirical studies of the determinants of saving.

Friedman's Permanent Income Hypothesis

The permanent income hypothesis, associated with Milton Friedman, developed the traditional analysis of consumption and saving by distinguishing between current income and permanent income. According to this hypothesis, consumption does not depend entirely on an individual's current income but is more strongly influenced by the income they expect to receive over a longer period. Therefore, a temporary increase in income is more likely to be allocated to saving, while a permanent increase in income may lead to a greater increase in consumption.

This hypothesis is particularly important when studying the relationship between national income and saving, because an increase in national income does not necessarily result in a corresponding increase in savings. Its effect depends on whether individuals consider the increase in income temporary or permanent. Empirical studies have shown that temporary changes in income may have a greater impact on saving than permanent changes.

Modigliani and Brumberg's Life-Cycle Hypothesis

The life-cycle theory developed by Modigliani and Brumberg is one of the most important theories explaining saving behaviour. It suggests that individuals do not base their consumption and saving decisions solely on their current income. Instead, they seek to distribute their resources across different stages of life to maintain a relatively stable level of consumption. Accordingly, individuals tend to save during their working years, when their income is relatively high, and use these accumulated savings after retirement, when their income declines.

Therefore, the age structure of the population can influence the national savings rate. A higher proportion of the working-age population may increase the capacity for saving, while a higher proportion of elderly people may lead to greater withdrawals from accumulated savings. This relationship is also influenced by factors such as life expectancy, retirement age, family size, and the proportion of the working-age population.

Determinants of Savings

National Income

National income is one of the most important economic indicators, as it reflects the level of economic activity and the productive capacity of an economy. It refers to the total income received by individuals, institutions, and factors of production as a result of their participation in the production process during a specific period, usually one year.

National income is a fundamental determinant of saving, since savings are primarily generated from disposable income after meeting consumption needs. The higher the national income, the greater the potential for individuals and economic sectors to allocate a portion of their income to saving, if consumption does not increase at the same rate as income. From a theoretical perspective, a direct relationship is expected between national income and savings, meaning that an increase in national income is expected to lead to an increase in the volume of savings, if other factors remain constant.

Income is considered one of the most important factors determining saving behaviour. An increase in income generally leads to an increase in savings (Ahmad & Asghar, 2004, p. 80). Keynes also emphasized the role of income in determining saving behaviour by considering saving a function of income (Mikes & E. Zinser, 1973, p. 3).

Inflation

Inflation is defined as a sustained increase in the general price level over a specific period, leading to a decline in the purchasing power of money and a reduction in the real value of income and monetary savings. It is one of the most important macroeconomic variables affecting consumption and saving behaviour because of its effects on the purchasing power of income, the rising cost of living, and the declining real value of monetary assets.

Inflation affects savings through several economic channels, including the decline in the real value of savings, changes in consumer decisions, and its effects on real interest rates and economic expectations. It also affects savers' expectations by creating uncertainty about future income flows, which may encourage individuals to increase their savings for precautionary reasons (Saeed, 2014).

The relationship between inflation and saving can be explained through two main aspects. First, an increase in the general price level leads to a decline in the purchasing power of money, meaning that the cash held by individuals loses part of its real value over time. When inflation rates exceed the returns on bank deposits, the real return on savings becomes negative, resulting in a decline in their purchasing power.

Second, although inflation often reduces the real value of cash savings, the uncertainty associated with high inflation rates may encourage some individuals to increase their precautionary savings to protect themselves against future economic risks. Precautionary savings refer to the portion of income that individuals set aside to deal with unexpected circumstances, such as job losses, rising living costs, declining real incomes, and economic instability. Economic literature suggests that greater uncertainty may encourage individuals to increase their precautionary savings. However, the findings of empirical studies vary depending on economic conditions and the level of development of financial markets (Lugilde, 2019, 33(2), p. 515).

From a theoretical perspective, an inverse relationship is expected between inflation and monetary savings, mainly due to the decline in the purchasing power of savings and the increase in consumption costs.

The expected relationship between inflation and savings can be expressed as follows:

Where:

This relationship represents a theoretical expectation rather than a fixed outcome. Its direction may change when economic uncertainty increases and individuals become more likely to hold precautionary savings.

The Relationship Between National Income, Inflation, and Savings

Studying the relationship between savings, national income, and inflation requires examining how these variables interact within the broader macroeconomic framework rather than considering each one separately. National income determines the financial resources available to individuals and economic sectors, while inflation affects the real value of income and the purchasing power of savings. Therefore, an increase in national income may lead to higher savings. However, when this increase is accompanied by high inflation, its positive effect on savings may decline because of reduced purchasing power and increased consumption expenditure (Lugilde, 2019, 33(2), p. 515).

Furthermore, high inflation combined with low real income may lead to a decline in savings, while the economic uncertainty associated with inflation may encourage some groups to increase their precautionary savings. Thus, the relationship between these three variables depends on prevailing economic conditions and the degree of stability in prices and income (Lugilde, 2019, 33(2), p. 515).

Application of the Theoretical Framework to the Sudanese Economy (2000–2022)

Studying the relationship between savings, national income, and inflation is particularly important in the context of the Sudanese economy during the period 2000–2022, given the economic, structural, and monetary changes that took place during these years and their effects on income levels, consumer spending, and monetary stability. During this period, the Sudanese economy faced several challenges that affected economic activity, including fluctuations in economic growth rates, structural changes resulting from the secession of South Sudan in 2011, high inflation rates, exchange rate fluctuations, and financial and monetary imbalances.

Regarding the relationship between national income and savings, declining economic activity and real income levels can limit the ability of individuals and economic sectors to generate savings, particularly when expenditure on basic consumption needs increases. As for inflation, rising general price levels reduce the purchasing power of income and the real value of monetary savings, thereby affecting the consumption and saving decisions of individuals and institutions.

However, unstable economic conditions may encourage some individuals to increase their precautionary savings or shift towards other forms of preserving the value of their wealth. Therefore, the relationship between inflation and savings in Sudan requires empirical investigation rather than relying solely on theoretical expectations.

Accordingly, this study examines the determinants of savings in Sudan during the period 2000–2022, focusing on the short-term and long-term relationships between savings, national income, and inflation. It also seeks to determine the extent to which these variables influence saving behaviour in the Sudanese economy.

Methodology

The study employs a descriptive-analytical approach and an econometric approach, which are appropriate to the nature of the research problem and its objectives. The descriptive-analytical approach is used to address the concepts and theories related to savings and its determinants, and to analyse the evolution of savings, national income, and inflation in Sudan During the period 2000-2022.

This study employs an econometric approach to measure the impact of national income and inflation on savings in Sudan, and to examine the nature and direction of the relationship between the variables under study using annual data over the specified period.

The primary variables of the study are savings as the dependent variable, and national income and inflation as the independent variables. The relationship between the variables can be expressed as a savings function as follows:

$S_t = f(Y_t, INF_t)$

The initial econometric model for the study can then be formulated as Follows:

$S_t = \beta_0 + \beta_1 Y_t + \beta_2 INF_t + \varepsilon_t$

where S represents savings, Y represents national income, INF represents, the inflation rate, and represents the random error.

The study relies on annual secondary data for the Sudanese economy, obtained from official sources, primarily the Central Bank of Sudan, the Central Bureau of Statistics, and the Ministry of Finance and Economic Planning, in addition to reliable international economic databases when needed.

The study consists of three main sections. The first section contains the methodological framework and a review of previous studies. The second section is the theoretical framework, comprising savings, income, and inflation. The third section presents the Applied study and its result.

Theoretical Framework of the Autoregressive Distributed Lag (ARDL)

The Autoregressive Distributed Lag (ARDL) model is a modern standard method used to analyse economic relationships between variables in the short and long run. It has gained significant importance in applied economic studies, particularly those examining the determinants of savings, investment, economic growth, and inflation This methodology

combines the effects of past values of the dependent variable with the present and future values of the independent variables. This allows for the analysis of the dynamic relationship between economic variables and the determination of the direction of the relationship and the magnitude of the explanatory variables' influence on the development variable.

The development of this method was primarily linked to the work of Pesaran and Shin (1999), and it underwent significant development with the study by Pesaran, Shin, and Smith (2001), which introduced the Bounds Testing Approach to detect long-run equilibrium relationships between economic variables. First: The Concept of the ARDL Methodology.

The distributed lag autoregression methodology is a standardized approach that incorporates the lagging values of the dependent variable, along with the current and lagging values of the independent variables into a single regression model.

This methodology is distinguished by its ability to measure the immediate and delayed effects of economic variables. It also allows for the estimation of long-run and short-run coefficients within a unified standard framework (pesaran and shin (1999) p371).

The ARDL methodology is characterized by its applicability when variables are stationary at level I (0), stationary after taking the first difference I (1), or a mixture of both, provided that no variable is a second-order integral I(2) Pesaran and Shin (1999) demonstrated that ARDL models provide a suitable framework for analysing long-run economic relationships, even when variables are not stationary at level I (0).

The Theoretical Basis of the ARDL Methodology:

The ARDL methodology is based on the idea that economic relationships do not necessarily materialize instantaneously. Rather, they may require a period of time for economic variables to respond to changes occurring in other variables. For example, an increase in national .income may lead to higher savings, but this effect may not be fully apparent in the same period ,Rather, it extends to later periods due to changes in consumption levels, disposable income and the savings decisions of individuals and Institutions.

Similarly, changes in the inflation rate can influence savings decisions by affecting the purchasing power of real income, individuals' expectations about the future, and their willingness to hold cash or build up precautionary savings ((pesaran and shin(1999) p371).

precautionary savings this is where the importance of using the ARDL model lies , as it allows for measuring the successive time effects of economic variables, rather than simply measuring their instantaneous relationship.

Savings, national income, and inflation in Sudan 2000-2022

Savings is a key variable in macroeconomic analysis, representing the portion of disposable income not allocated to final consumption. According to the World Bank definition, gross savings is calculated by subtracting gross national income from aggregate consumption and adding net transfers, and is typically expressed as a percentage of GDP. The importance of savings stems from its role in providing the resources necessary to finance investment and .capital formation (World Bank,)

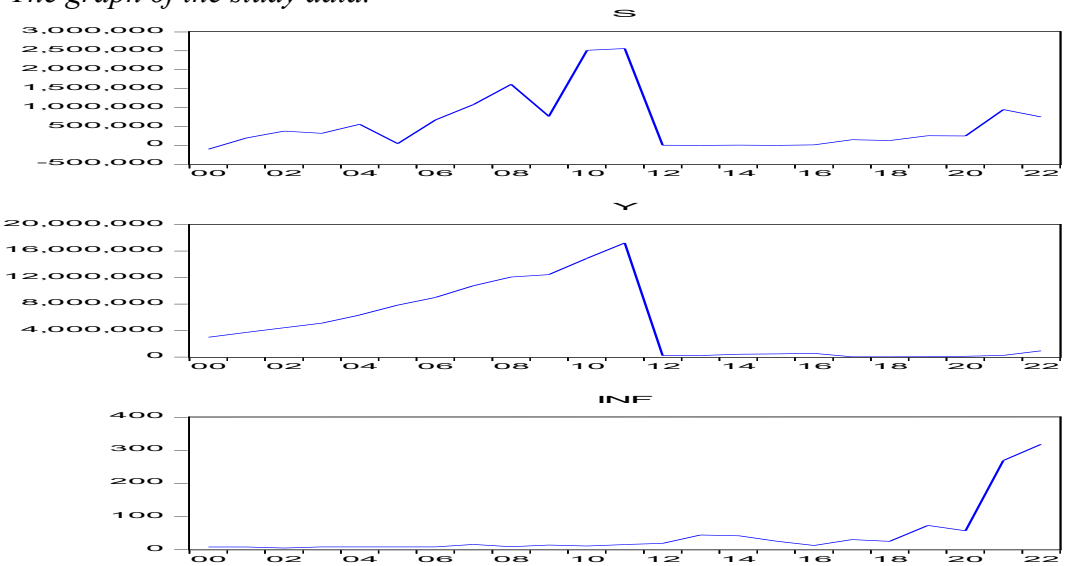
In the Sudanese economy during the period 2000–2022, savings were directly affected by changes in national income, price levels, the exchange rate, and overall macroeconomic conditions. Under normal circumstances, higher real income can increase the ability to save due to the larger portion of income remaining after consumption. Conversely, lower purchasing power and higher inflation put pressure on real incomes, which can limit the ability to save (World Bank Open Data)

Result

Estimating the Determinants of Savings in Sudan Using the ARDL Model During the period 2000-2022 the applied aspect.

Figure 1

The graph of the study data.



Source: prepared by the researcher based on the results of the E-views 10 analysis.

The figure above clearly shows that the study data are non-stationary, and this can be confirmed using unit root tests.

Table 1

The results of the unit root test for the study variables aft he first stage

Method	Statistic	Prob.**%	Sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.19588	0.0007	3	60
Im, Pesaran and Shin W-stat	-1.65426	0.0490	3	60
ADF - Fisher Chi-square	28.5403	0.0001	3	60
PP - Fisher Chi-square	44.4514	0.0000	3	63

Source: prepared by the researcher based on the results of the E-views 10 analysis.

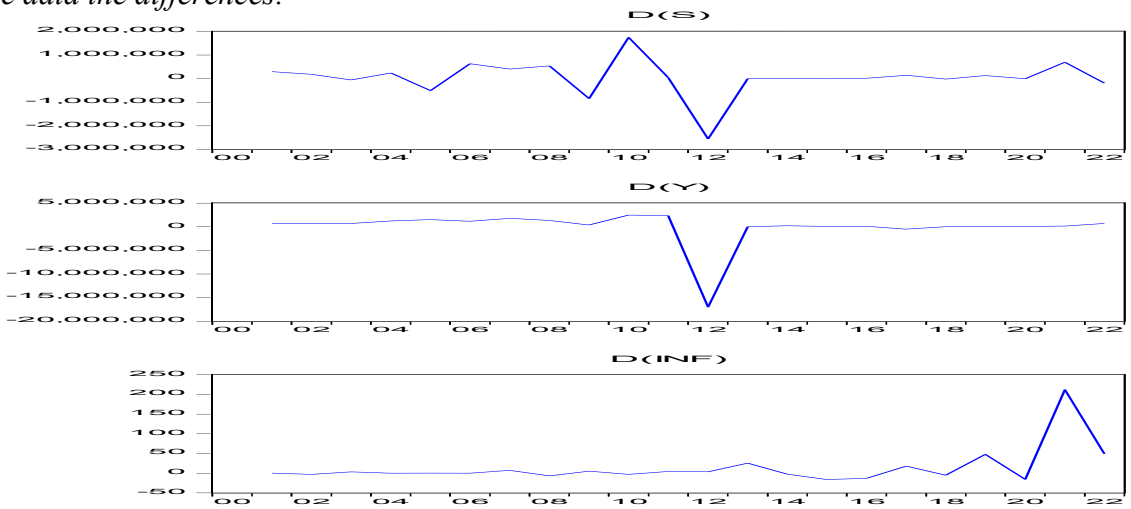
It is noted from Table (2) that the value of (LLC) reached (3.196) and that its probability value at a significance level of 5% is (0.0007), which is less than (0.05). Therefore, we reject the null hypothesis and accept the alternative hypothesis stating that the series of variables is stationary in the first difference, i.e., integrated of order I(I). Similarly, the IPS test yielded a value of 1.65 and a probability value of 0.049, which is less than 0.05. Therefore, we reject the null hypothesis and accept the alternative hypothesis that the series of variables is stationary in the first difference, i.e., integrated of order I(I). Likewise, the ADF test yielded a value of 28.54 and a probability value of 0.0001, which is less than 0.05. Therefore, we reject the null hypothesis and accept the alternative hypothesis that the series of variables is stationary in the first difference, i.e., integrated of order I(I). The PP test yielded a value of and a probability value of 0.0000, which is less than 0.05. Therefore, we reject the null 44.45 hypothesis and accept the alternative hypothesis that the series of variables is stationary in the first difference, i.e., integrated of order I(I). Thus, all the tests (LLC, IPS, ADF, PP) yield probability values less than 5%, which means that the studied variables do not contain the unit root And can be used for estimation.

Therefore, all the tests (LLC, IPS, ADF, PP) yield probability values less than 5%, which means that the studied variables do not contain the unitRoot and can be used for estimation.

Determinants of savings in Sudan using Autoregressive- Distributed- Lag Model (ARDL) during period 2000-2022

Figure 2

The data the differences:



Source: prepared by the researcher based on the results of the E-views 10 analysis.

This can be verified using the cointegration test.

Table 2

Illustrates the Johanson cointegration test:

Variable	Trace Statistic	Critical Value 0.05	Prob.**
S	44.27109	29.79707	**0.0006**
Y	18.13129	15.49471	**0.0196**
Inf	1.536485	3.841466	**0.2151**

Source: prepared by the researcher based on the results of the E-views 10 analysis.

From the table, the initial calculated value of the probability ratio (LR) in the second column .exceeds the corresponding critical value in the third column at a significance level of 5% Therefore, the null hypothesis, which states that there are no cointegrating vectors among the time series of the model variables, is rejected, and the alternative hypothesis, which states that there are at least two cointegrating vectors, is accepted. Consequently, there is cointegration among all the model variables, meaning they are stationary. This implies that they will behave similarly In the long run.

Table 3

Estimating the long – run regression using relationship:

$s_t = B_0 + B_1 y_t + B_2 inf_t + E_t$

Long Run (ARDL Long Run Form and Bounds Test)				
Dependent Variable: D(S)				
Selected Model: ARDL(1, 0, 0)				
Variable	Coefficient	Std. Error	t-Statistic	**Prob**
C	-186383.1	130086.4	-1.432764	**0.1691**
S (-1) *	-0.957876	0.123689	7.744218	**0.0000**
Y**	0.125165	0.018155	6.894426	**0.0000**
INF**	3319.945	1065.748	3.115133	**0.0060**
EC = S - (0.1307*Y + 3465.9457*INF -194579.6810)				
Variable	Coefficient	Std. Error	t-Statistic	**Prob**
Y	0.130670	0.017421	7.500766	**0.0000**
INF	3465.946	1116.907	3.103163	**0.0061**
C	-194579.7	140572.2	-1.384197	**0.1832**
Test Statistic	Value	Signify	I(0)	**I(1)**

Variables	Test statistic	Critical value at 5% significance level		Test type Phillips – perron test	Stability level
E_t	3.94	3.01		pp	at the level
F-statistic	17.80	10%	2.63	**3.35**	
K	1	5%	3.1	**3.87**	
		2.5%	3.55	**4.38**	
		1%	4.13	**5**	

Source: prepared by the researcher based on the results of the E-views 10 analysis.

From Table (3) above, we find the short-run relationship, which represents the coefficients of the variables with the slowdown periods. The most important is the current effect of the independent variable (savings) (s(-1), where its parameter value is 0.0000). The negative sign indicates an inverse relationship between slowdown saving and saving, as the probability value .is 0.0024, which is less than 0.05. This means that slowdown saving has an effect on saving We also find that the independent variable (national income) (y), with a coefficient equal to has a positive sign. This indicates a direct relationship between saving and national ,(0.125165 .income in the short run, meaning that the higher the national income, the higher the saving The probability value of the independent variable (national income) is less than 0.05, meaning That it influences saving.

The table in the middle, below the error correction equation, shows that the independent variables (national income and inflation) are the most important determinants of saving and .have high statistical significance, meaning that these determinants have an effect on saving Savings as shown in Table (3), the F-statistic under the Value column reached 17.80, which is ,greater than the critical value at a 5% significance level of the upper bounds test. Therefore the alternative hypothesis stating the existence of cointegration and a long-term equilibrium relationship is accepted.

Figure 3

Illustrates the superiority of the selected models for representing the phenomenon:

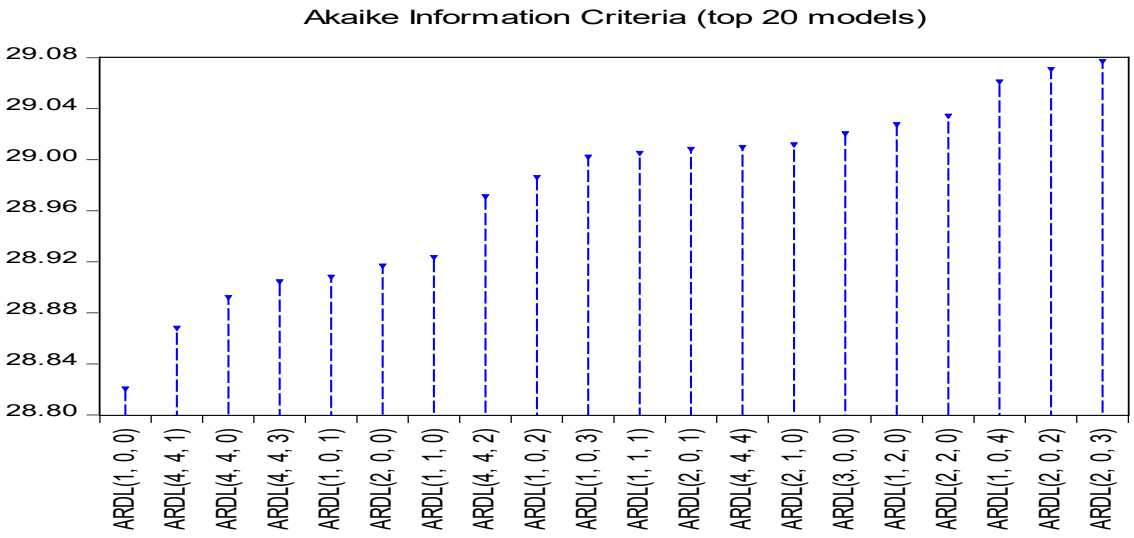


Table 4 shows that the best model for the study based on the selection Criteria is ARDL(1,0,0).

Table 4

The results of the unit root test for the residual series

Determinants of savings in Sudan using Autoregressive- Distributed- Lag Model (ARDL) during period 2000-2022

Model	LogL	AIC*	BIC	HQ	Adj. R-sq	Specification
100	-269.794474	28.820471	29.019300	28.854121	0.752772	ARDL(1, 0, 0)
4	-262.246790	28.868083	29.464571	28.969033	0.760643	ARDL(4, 4, 1)
5	-263.476253	28.892237	29.439018	28.984774	0.761625	ARDL(4, 4, 0)
2	-260.593110	28.904538	29.600440	29.022312	0.718436	ARDL(4, 4, 3)
99	-269.628005	28.908211	29.156748	28.950273	0.739714	ARDL(1, 0, 1)
75	-269.710518	28.916897	29.165433	28.958959	0.737444	ARDL(2, 0, 0)
95	-269.772920	28.923465	29.172002	28.965527	0.735713	ARDL(1, 1, 0)
3	-262.225511	28.971106	29.617302	29.080468	0.721375	ARDL(4, 4, 2)
98	-269.370253	28.986342	29.284586	29.036817	0.727195	ARDL(1, 0, 2)
97	-268.521546	29.002268	29.350219	29.061155	0.729719	ARDL(1, 0, 3)

Date: 09/26/26 Time: 09:29
Sample: 2000 2022
Included observations: 22

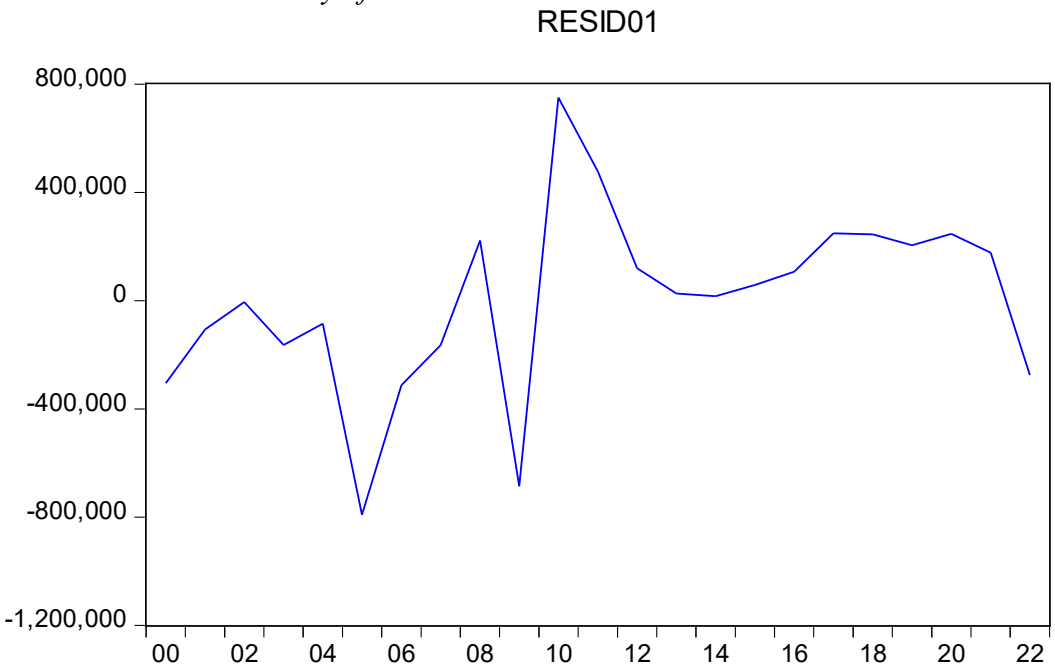
,Figure (3) and Table (4) show that the preferred model according to the criteria (AIC*HQ BIC) is the ARDL(1, 0, 0) model.

After evaluating the above model, the residual series can be constructed and its stationarity tested at the level.

Table 5 shows the results of the unit root test for the residual series: It is observed from Table that the value of the PP test statistic for the variable is (3.94), which is greater than the (5) critical value at the 5% significance level (3.01). Therefore, we reject the null hypothesis and accept the alternative hypothesis that the residual series is stationary at The level.

Figure 4

Illustrates the stationarity of the residual series



Source: prepared by the researcher based on the results of the E-views 10 analysis.

It is observed from Table (5) and Figure (4) that the residual sequence is complete and of order I(0), i.e., stationary at the level. Therefore, the ECM(Estimate of compound) model can be estimated.

Estimation Command:

ARDL S Y INF

Estimation Equation:

S = C(1)*S(-1) + C(2)*Y + C(3)*INF + C(4)

Substituted Coefficients:

S = 0.042124376797*S(-1) + 0.125165312341*Y + 3319.94490751*INF - 186383.133243

Cointegrating Equation:

D(S) = -186383.133243314950 -0.957875623203*S(-1) + 0.125165312341*(S - (0.13066969*Y(-1) + 3465.94571058*INF(-1) -194579.68104469) + 3319.944907507077*INF**)

Table 5

Illustrates the error correction model(ARDL ECM) :

ARDL Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	**Prob**
CointEq(-1)*	-0.957876	0.105073	-9.116288	**0.0000**
R-squared	0.797735	Mean dependent var	**38709.55**	
Adjusted R-squared	0.797735	S.D. dependent var	**759270.7**	
S.E. of regres-sion	341473.8	Akaike info criterion	**28.36432**	
Sum squared resid	2.45E+12	Schwarz criterion	**28.41391**	
Log likelihood	-311.0075	Hannan-Quinn criter.	**28.37600**	
LM Test: Obs*R-squared1.931483	Prob. Chi-Square(2) 0.3807	Durbin-Watson stat	**1.8695**	
-	-	Test: ARCH - squared=1.82	**Prob. Chi- Squar (2) =0.178**	

Source: prepared by the researcher based on the results of the E-views 10 analysis.

ARDL Error Correction Regression

Dependent Variable: D(S)

Case 2: Restricted Constant and No Trend

Date: 09/26/26 Time: 09:17

Sample: 2000 2022

Included observations: 22

It is noted from Table (6) that the error correction parameter is negative and significant at a significance level of 5%, estimated at (-0.96), which confirms the existence of a long-term equilibrium relationship and proves that the behavior of the factors affecting savings may take more than a year, approximately nine months and six days, to reach the equilibrium position in the long term, i.e., less than a year, when any shock occurs. This result reflects that the dependent variable's response to changes in the independent variables is subject to a very rapid self-correction mechanism, moving directly towards long-term equilibrium in 96% of cases during each time period. This occurs without the need for complex, slowing dynamics in the ,short term. Therefore, the initial differences in the independent variables do not appear; rather their direct and overall effect is transferred and manifested through the long-term equilibrium relationship embedded in the cointegration term. Consequently, there is no need to evaluate the model according to the three criteria. Instead, it Should be noted that the model is free of measurement problems.

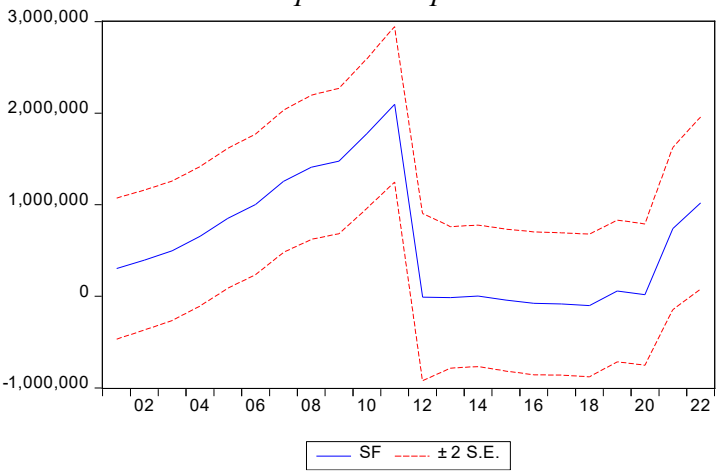
-Below Table 6 are some standard tests, detailed as follows: - Durbin

- Watson test (DW) test:

.Used to detect autocorrelation problems for residuals or model errors. Its value is (1.87) Referring to the tabulated value, which ranges from (1.5 to 2.5), it is observed that it is close .to the standard value, meaning that the model does not suffer from an autocorrelation problem .Arch test: Used to detect the variance problem, which is rarely found in time series data - From the test value, we find that the probability value of the test is OPs*R-squared = (0.187) is greater than 5%, which leads to the rejection of the alternative hypothesis and acceptance of the null hypothesis, which states that there is no variance problem. We also find that the Breusch-Godfrey Serial Correlation LM Test value is 0.38, which is greater than 0.05 indicating the absence of an autocorrelation problem for errors.

Figure 5

Illustrates the model's predictive power:



Forecast: SF	
Actual: S	
Forecast sample: 2000 2022	
Adjusted sample: 2001 2022	
Included observations: 22	
Root Mean Squared Error	334661.4
Mean Absolute Error	243458.0
Mean Abs. Percent Error	590.9221
Theil Inequality Coefficient	0.181328
Bias Proportion	0.000003
Variance Proportion	0.053220
Covariance Proportion	0.946778
Theil U2 Coefficient	4.751932
Symmetric MAPE	95.22975

It is observed from the figure that the value of Theil's coefficient is (0.18), which is close to zero. This indicates that the model has strong Predictive power.

Conclusion

The results of the stationarity tests showed that all study variables, namely savings, national income, and inflation, were non-stationary at their initial levels but became stationary after taking the first difference. This indicates that the variables are integrated of order one, I(1), confirming the suitability of the Autoregressive Distributed Lag (ARDL) methodology for analysing their relationships.

The cointegration test revealed the existence of a long-term equilibrium relationship between savings and their main determinants, namely national income and inflation. The error correction model also showed a high speed of adjustment towards long-term equilibrium, with approximately 96% of short-term imbalances corrected within about nine months and six days. This indicates that savings adjust relatively quickly towards their equilibrium path following economic shocks.

The estimation results revealed a positive relationship between national income and savings, indicating that an increase in national income leads to higher savings. This finding is consistent with the economic view that higher income increases disposable resources and, consequently, the capacity to save after meeting consumption needs.

The study also found a positive relationship between inflation and savings, which differs from the traditional expectations of some economic theories. However, this result may be explained by the precautionary savings hypothesis, according to which economic uncertainty and rising prices may encourage individuals to increase their savings to meet future obligations and higher living costs.

The ARDL (1,0,0) model was identified as the most suitable model for explaining the relationship between savings and their determinants. Furthermore, the coefficient of determination (R^2

= 0.80) indicated that national income and inflation explain approximately 80% of the variations in savings, while the remaining 20% may be attributed to other factors not included in the model, such as real interest rates, consumption levels, unemployment, fiscal and monetary policies, and economic and political conditions.

A comparison of the current study with previous research reveals general agreement on the importance of savings in economic activity and their relationship with national income. However, differences emerge regarding the direction of the relationship between savings and inflation. These differences may be attributed to variations in economic environments, study periods, and the characteristics of the economies examined.

The current study highlights the nature of saving behaviour in the Sudanese economy, where high inflation does not necessarily lead to a decline in savings. Instead, it may encourage individuals to increase their precautionary savings in response to economic risks and instability in the general price level.

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