

Nonlinear Analysis of the Relationship Between Domestic Savings and Investment: Evidence for Tunisia Using the NARDL Approach

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Abstract :

In view of the Feldstein–Horioka (1980) puzzle, this study examines the relationship between the investment rate and the saving rate using annual data from Tunisia for 2000 to 2020. The nonlinear version of the autoregressive distributed lag (ARDL) cointegration methodology developed by Shin (2014), based on the linear ARDL bounds cointegration testing approach of Pesaran et al. (2001), is implemented. The findings show that there is a long-term cointegration relationship between the domestic saving rate and investment rate. The cointegration analysis of the linear and nonlinear ARDL limits proves the presence of a long-term relationship between the national savings rate and the investment rate in Tunisia.

Keywords: *Saving-investment, Feldstein-Horoeka puzzle, capital mobility, and NARDL method*
JEL classification : C22, E21, E22, F21

Introduction

National savings finance various sectors of the economy, including those related to development investment. The financing of this sector is fatal for the economic development of a country, which gives major importance to savings in the process of economic development of a country. Several studies have been carried out on savings and they have identified its primordial role in the economy, we can cite the neoclassical growth model of Solow (1956), **Frankel (1962)** and **Romer (1986)**. All these authors have shown that the accumulation of capital is one of the sources of a country's economic growth. **Agion and al. (2009)** sought to prove the relationship between a country's economic growth and the savings rate.

In their empirical analyses, they found that there is a difference between rich and poor countries. For poor countries, increased savings lead to economic growth, which is not the case for rich countries. These analyzes show that a high rate of savings leads, through the accumulation of capital, to economic growth. For all countries, and especially for developing countries, it is necessary to increase their savings to increase their capital accumulation. Thus, it is interesting to study the determinants of savings in Tunisia to propose measures that facilitate economic development.

Despite the efforts made in Tunisia, sustainable economic growth requires more investment in key sectors of the national economy, namely mainly agriculture, education, and infrastructure. After the social movements of 2011, several development projects were implemented in different areas. The main constraint lies in the financing of all these priority projects. National savings are one of the main sources of financing. Faced with this observation, the objective of our work consists in analyzing its determinants. Several studies on the determinants of national savings have been carried out at the international level and they show that savings are important in the economic development of a country. *In this context, we will answer the following question: What are the implications of domestic savings on investment in Tunisia?*

The remainder of the paper is divided as follows: Section 1 briefly reviews the literature; Section 2 describes the empirical literature review; Section 3 highlights the methodology used and the model specification; Section 4 presents our results, and Section 5 concludes.

1. Theoretical literature review

Savings can be determined by current income, permanent income, the age structure of the population, demographics, and financial variables.

Starting from the fact that the effects of inflation on savings are particularly ambiguous. On the one hand, inflation changes the real value of assets, which forces households to save more to preserve the real value of their financial wealth ("*real cash flow effect*" or "*Pigou effect*"), but on the other hand, economic agents' anticipation of inflation can lead them to buy now what they will pay more for later and to reduce their savings ("*flight from money*" effect).

The need for liquidity is also an additional reason for savings for households. Financial sector anomalies often pose liquidity constraints that prevent access to borrowing (credit rationing, bank margins, pre-guarantees). Liquidity constraints could have completely opposite effects. Households that cannot borrow are forced to save. On the other hand, households that have a prior fund will prefer the savings motive.

Other factors, of an extra-economic nature, should not be overlooked, such as the profession of a household. Households that live on job security, such as salaried workers, need less to save to cover unforeseen hazards ("*precautionary savings behavior*") compared to households with risky jobs, such as the self-employed. By thus assuming that the consumer is risk averse, the equivalence to uncertainty is rejected and the agent saves more. (The difference between employees is unclear)

The development of financial activity is likely to lead to an increase in household consumer credit, particularly in several emerging countries. This situation can have a negative effect on savings because of the reduced income constraint. Households get into debt with the financial system, instead of saving. Savings are somehow diverted from the circuit of productive investment, in favor of household consumption (Aglietta, Brender and Coudert, 1990).

The study of a sample of 150 developed and developing countries from 1965 to 1994 suggests that the increase in credit to households by 1% of their income generates in the long term a reduction in the private savings rate of 0.32% (Loayza, Schmidt-Hebbel, and Serv, 2000).

Does a high-interest rate lead to an increase in the savings rate? According to neoclassical theory, savings are not a residue of consumption. It would result from voluntary behavior determined mainly by the interest rate. The effect of the interest rate on savings is ambiguous. According to the theory of financial liberalization, savings respond to the increase, following an increase in the interest rate. The elimination of financial repression would then have a positive effect on savings. In fact, this debate has been widely discussed. The question of the influence of the interest rate on savings is not yet resolved. The interest rate exerts two sets of opposite effects, a positive effect, and a negative effect, which takes into consideration the effects of substitution, income and wealth, the net impact of which is not settled by the theory. The propensity to save is an increasing function of the real interest rate, in the sense that a high-interest rate encourages the economic agent to reduce his present consumption to increase his savings: "*substitution effect*". But this relationship is counterbalanced by an "*income effect*" which proves that a rise in interest rates leads to an increase in future income, i.e. the household chooses to reduce the savings necessary to produce the desired income level. However, the reaction of savings to the interest rate is relatively difficult to determine.

Bandiera and al. (1999) examined the case of 8 developing countries that increased their interest rate as part of the process of financial liberalization. Their regressions do not detect any significant positive, and measurable effect of the interest rate on savings. The World Bank, too,

considers that positive real interest rates would encourage savers to move towards another form of savings: They would deposit real or liquid assets, for financial assets (**World Bank, 1989**). The analysis of the growth trajectories of newly industrialized countries shows that they have resorted to an increase in bank interest rates to attract savings to financial assets. In 1965, South Korea pointed out that the bank interest rate rose from 12% to 26.4%, so they became positive, in real terms. This had the effect of doubling bank deposits each year during the years 1965-1971. It is true that several developing countries had opted, within the framework of their development policies, for negative real interest rates.

In 1936, Keynes, who attributed a central role to the consumption function in determining demand, thus became interested in savings. Savings are determined by the agent's current income. According to Keynes' "**Fundamental Psychological Law**" (1), saving is defined as the unconsumed part of income, it is an increasing function of the level of income ("**income effect**", **in the short term**). For zero income, savings are negative (the agent borrows to finance autonomous consumption). Nevertheless, according to **Duesenberry (1949) and Brown (1952)**, saving does not depend only on current income, but also on income received in the past ("**ratchet effect**") (2).

Variations in the savings rate come from the lag in the adjustment of consumption, in relation to the variation in income. If income decreases, consumption is initially maintained ("**inertia effect**") (3) and the savings rate decreases. If income increases, the inertia of consumption manifests itself in an increase in the savings rate.

Taxation also influences the savings rate because it changes the distribution of income. The latter leads to an increase in consumption by increasing low incomes. This leads to a decrease in savings. The interest rate makes it possible to arbitrate between invested assets and liquid assets in the form of money. The interest rate is the price of forgoing liquidity. It determines the form of savings, but not the amount.

In the relative income approach, **Brady and Friedman (1947)** postulate the interdependence of individual preferences ("**demonstration effect**") (4). There would be a phenomenon of social imitation, which would explain why the savings function is globally stable over a long period. Other models give income an important role in determining household consumption. According to **Friedman (1957)**, household savings do not depend on current income but on their permanent income, defined as the income that the agent can dispose of at each period of his life without increasing his wealth ("**smoothing effect**"), (permanent income hypothesis or PIH) in other words their long-term income, which is the income expected by households (**anticipated income**). Savings increase or decrease depending on whether current income is greater or less than permanent income. The difference between current income and permanent income is the transitory income that influences savings. Savings remains a residual element. If current income is greater than permanent income, the share of savings increases. If current income is less than permanent income, the share of savings falls. This allows households to maintain the same level of consumption.

Demography has a significant impact on aggregate consumption, within the framework of **the Life Cycle Hypothesis (LCH)**. This theory postulates that household savings behavior is explained by the age of savers (**Modigliani and Brumberg, 1954**). According to them, households save according to their life cycle ("**cycle effect**") (5). This theory tends to show that a typical household borrows when it is young, saves in middle age during its working life and dissaves again after retirement.

The savings rate would increase until retirement age when it decreases. The proportion of the population aged over 65 would have a negative effect on savings.

The PIH and LCH hypotheses give **Modigliani (1986)** the opportunity to formulate the implications of government policies on savings:

- In the short term, policies restricting (or stimulating) demand through a transitional tax on income (or a reduction in this tax) if it has a weak effect on the reduction in consumption, will on the other hand have consequently a decrease (or increase) in saving, because consumption depends on life-cycle income. It is not affected by a transitional tax.
- In the long term, progressive taxation on consumption is more adequate than transitional taxation because it subjects the permanent income, and it will have more influence on consumption. Moreover, as private savings are determined by the life cycle hypothesis, they are independent of government budgetary positions. So, if deficit-financed spending is borne by future generations, those that are financed by taxes are paid by the present generation. This conclusion goes against the Ricardian equivalence theory (**Barro, 1974**), according to which the budget deficit causes an increase in household savings. Households foreseeing in this case a future increase in taxes with a view to repaying the public debt would tend to increase their savings.

2. Empirical literature review

Several empirical studies have examined the determinants of savings in both developed and developing countries using different methods. Most studies have used techniques such as cointegration and error correction models when analyzing the long-term relationship of the determinants of savings. A greater number of studies that have empirically examined the determinants of the domestic savings rate have shed light on the relationship between domestic savings and its determinants in different countries around the world.

Ismael and Rashid (2013) conducted a study on the relationship between household savings and various socio-economic and demographic variables in Pakistan by applying Johansen's method of cointegration procedures. In addition, the error correction model was also estimated to determine the convergence of the model towards the steady state. The results show that there is a long-term relationship between household savings and the variables used in the study, while the result of the error correction model proved that about 45% convergence toward the balancing takes place every year.

Kudaisi (2013) studied the determinants of domestic savings in West Africa using panel data applied over the period from 1980 to 2006. The results showed that the dependency ratio and the interest are negative and insignificant on domestic savings. But GDP growth is positive and statistically insignificant. Moreover, the government budget surplus and the inflation rate are statistically significant and the development of the financial market in West Africa has a positive effect on savings. Finally, the real interest rate and the terms of trade have an insignificant impact.

Ahmad and Mahmood (2013) investigated the macroeconomic determinants of domestic savings in Pakistan using the Autoregressive Distributed Lag Model (ARDL) cointegration approach to test the robustness of long-run relationships and the error correction mechanism. They found that per capita income is inversely proportional to the domestic savings rate, both in the long term and in the short term significantly. The exchange rate and the inflation rate hurt savings. Moreover, trade openness is positively associated with national savings in Pakistan.

The objective of the study by **Ogbokor (2014)** was to empirically establish the determinants of savings in Namibia using cointegration and error correction mechanisms for the period from 1991 to 2012 on quarterly macroeconomic data. The results of the cointegration tests suggest that there is a long-term relationship between savings and the explanatory variables used in the study. Thus, inflation and income have a positive impact on savings, while the population growth rate has a negative effect on savings. Moreover, the deposit rate and financial deepening do not have a significant effect on savings.

Güngör and Olesia (2014) investigated the causal relationship between saving and economic growth in Albania on time series collected from 1992 to 2012. Johansen cointegration test and VECM were used. The results showed a positive relationship between savings and economic growth in conjunction with the corresponding role of FDI in growth. They suggested that the government pay particular attention to FDI policies that have a positive effect on the country's economic growth.

Elias and Worku (2015) analyzed the causal relationship between economic growth and savings in two East African countries, Uganda and Ethiopia, using time series (1981-2014), using Johansen's cointegration approach and the vector error correction model. The results confirmed that there is a significant relationship between domestic savings and economic growth in the case of Ethiopia and Uganda. Granger causality results showed the presence of unidirectional causality between economic growth and gross domestic savings in Ethiopia and Uganda.

Adelakun (2015) used twenty-nine-year time series data in Nigeria to examine the relationship between savings, investment and economic growth using cointegration and VECM. He found a positive relationship between savings, investment, and economic growth. The inflation rate has contributed negatively to savings, while the interest rate has a positive influence on savings.

Iragena (2015) studied the relationship between savings and its determinants in Rwanda, using VECM and Granger causality testing approaches to check the robustness of the long-term relationship and error correction model (ECM) for the short-term dynamics between 1978 and 2012. The results demonstrated that per capita income is inversely related to national savings in the short term, on the other hand, it is positively related in the long term. Capital formation has a positive effect on national savings both in the short and long term. Consumption and the interest rate have an inverse relationship with short-term and long-term savings. However, inflation has a positive influence on both long- and short-term savings in Rwanda.

Asghar and Nadeem (2016) examined the short- and long-term causal relationships between national savings and its selected determinants in Pakistan for the period 1984-2014. Using Johansen's cointegration approach and vector error correction model (VECM), they found that foreign remittances, economic stability, and population have a positive impact on savings while stability government and income inequality negatively affect savings. Using Toda Yamamoto's causality test, the study indicates that there is a two-way causality between income inequality and foreign remittances, income inequality and population size, government stability and population size, savings and income inequality.

Moussavou (2017) analyzed the determinants of domestic savings in Congo-Brazzaville. The results obtained from the VECM show that in the long term, the term of trade, the inflation rate, the real interest rate, the gross domestic product per capita and the financial deepening lagged by one period, explaining domestic savings. On the one hand, exchange rate conditions, GDP per capita and two-period lagged financial deepening affect domestic savings. On the other hand, over the long term, these results show that the terms of exchange, the inflation rate and real interest rates influence domestic savings in Congo-Brazzaville.

Hassen (2017) used the cointegration approach and Vector Error Correction Model (VECM) to examine factors affecting Gross Domestic Savings for Ethiopia with time series (specify quarterly/annually or period). The results showed that gross domestic savings in Ethiopia is affected by the age dependency ratio, real exchange rate, real interest rate, real gross domestic product, foreign capital inflows and money supply in the short and long term. The elasticity of the exchange rate regarding domestic savings is high and significant in the long run. This implied that the continued depreciation of the real exchange rate had a direct impact on encouraging domestic savings.

Byiringiro and Yu (2017) analyzed the responsiveness of national savings to monetary policy and economic growth strategies in Rwanda, via the Keynesian economic model, Johansen's

cointegration test, dynamic error correction model and vector autoregressive estimates, on data collected from 1980 to 2015. They proved that economic growth strategies increase national savings, thanks to foreign direct investment because it is significant in the short and long term while two other variables, namely the interest rate of exports and that of deposits) are significant only in the long term.

Ogren (2018) examined the determinants of savings behavior in 15 OECD countries, using panel data from 1995 to 2016. The results are that unemployment uncertainty, as a form of precaution, and the intensity of fiscal policy has had a significant effect on the level of total household income. There are other determinants, such as demographic factors, which contribute less to the explanation of unemployment but not to the inflation of the level of savings.

An overview of the above studies shows that different variables and estimation techniques have been used to study the relationship between the factors that determine savings in different economies.

3. Model specification and methodology

Starting from the accounting equation of the IS (Savings-Investment) function:

$$I_p + I_g = (Y_t - T_t - C_t) + (T_t - G_t) - (X_t - M_t) = S_t^p + S_t^g + S_t^x \quad (1)$$

Where I_p and I_g denote gross private and public investment respectively. Private saving (S_t^p) is defined as GDP (Y_t) minus taxes net of transfers and subsidies from the public sector to the private sector (T_t) minus private consumption (C_t).

Public saving (S_t^g) is equal to net taxes minus current public expenditure (G_t).

Foreign saving (S_t^x) is defined as the negative net exports of goods and services ($X_t - M_t$).

In this case, the sum of S_t^p and S_t^g is called internal or domestic savings.

Often it is useful to write equation 1 in terms of gross national product (GNP), which is the sum of GDP and net international factor payments and unrequited transfers, which we call FB_t . In this case, the appropriate expression becomes:

$$I_p + I_g = (Y_t + FB_t - T_t - C_t) + (T_t - G_t) - (X_t + FB_t - M_t) = S_t^p + S_t^g + S_t^x \quad (2)$$

Where we have assumed that net factor payments are attributed to the private sector. According to this definition, the sum of S_t^p and S_t^g corresponds to national savings, which we denote by S_t , and S_t^x (foreign savings) is the negative of the current account balance.

In this work, the determinants of savings are analyzed using the intertemporal approach of the current account. The reference model is that of **Rogoff and Obstfeld (1996)**.

The main assumptions of this model are as follows:

- ✓ A small open economy,
- ✓ An infinite horizon,
- ✓ An absence of uncertainty
- ✓ and the existence of a non-durable good.

This model was also used by **Cardenas and Escobar (1998)**.

The utility function is written as follows:

$$U_i = \sum_{i=1}^{\infty} \beta_i u(c_{t+i}) \quad 0 < \beta < 1 \quad (3)$$

Where β represents the intertemporal individual preference rate. The utility is increasing and concave: $u'(c) > 0$, $u''(c) < 0$.

The maximization of the utility function is linked to the following budget constraint:

$$D_{t+1} = (1+r)D_t + Y_t - C_t - G_t - I_t \quad (4)$$

With, D : the net foreign assets, Y : production (GDP), C : consumption, G : public expenditure, I : investment.

a) Temporal model

By rearranging equation (4), of the budget constraint, we get:

$$D_{t+1} - D_t = rD_t + Y_t - C_t - T_t + T_t - G_t - I_t \quad (5)$$

T_t represents the taxes at period t and $D_{t+1} - D_t = CC_t$ (current account at period t).

From this equation we can deduce:

1. $PNB_t = rD_t + Y_t$, gross national product is the sum of return on net foreign assets and gross domestic production ($Y = GDP$). Equation (5) shows that the current account is the difference between GNP and expenditure (C and G). If income is greater than expenditure, the current account becomes positive (surplus) and if income is lower it becomes negative (deficit).

$$2. \quad S_t = rD_t + Y_t - C_t - G_t \quad (6)$$

S_t represents national savings and equation (6) can be written:

$$S_t = rD_t + Y_t - C_t - T_t + T_t - G_t$$

National savings is made up of two parts which are private savings and public savings.

According to the previous equation, GNP is a function of national savings, consumption, and public expenditure.

Private savings:

$$S_t^{privée} = rD_t + Y_t - C_t - T_t \quad (7)$$

Private savings depend on GNP, consumption, and taxes. If consumption and taxes increase the theory predicts that private savings must decrease while the increase in GNP leads to an increase in private savings, all other things being equal.

Public savings:

$$S_t^{publique} = T - G \quad (8)$$

The only source of funding for public expenditure is taxes. If taxes increase, all other things being equal, public saving increases while the increase in public spending leads to a decrease in public saving. Substituting national savings in the current account function, we get:

$CC_t = S_t - I_t$, the current account is the difference between domestic savings and investments. If savings are less than investment, the country becomes a borrower and if savings are greater than investment, it becomes a lender. In the first case, the current account is in deficit while in the second case it is in surplus.

The analyzes carried out above clearly show the relationships that exist between these different variables: CC , PNB , PIB , I , G , T , S , $S^{privée}$ et $S^{publique}$.

b) Intertemporal model

Equation (4) can be written:

$$D_t = \frac{1}{(1+r)} [D_{t+1} - Y_t + C_t + G_t + I_t] \quad (9)$$

$D_{t+1} = \frac{1}{(1+r)} [D_t - Y_{t+1} + C_{t+1} + G_{t+1} + I_{t+1}]$, substitute the value of D_{t+1} in equation (9):

$$D_t = \frac{1}{(1+r)^2} [D_{t+2} - Y_{t+1} + C_{t+1} + G_{t+1} + I_{t+1}] + \frac{1}{1+r} [-Y_t + C_t + G_t + I_t] \quad (10)$$

In Keynesian theory, the marginal propensity to consume in period t depends on the disposable income of the same period. On the other hand, in the theory of permanent income depends on an income over time Y and we decide to have a fixed income during all periods, $\hat{Y}$.

$$Y_t + \frac{Y_{t+1}}{1+r} + \frac{Y_{t+2}}{(1+r)^2} + \frac{Y_{t+3}}{(1+r)^3} + \dots = \hat{Y} + \frac{\hat{Y}}{1+r} + \frac{\hat{Y}}{(1+r)^2} + \frac{\hat{Y}}{(1+r)^3} + \dots \quad (11)$$

$$\hat{Y} \left[1 + \frac{1}{1+r} + \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3} + \dots \right] = Y_t + \frac{Y_{t+1}}{1+r} + \frac{Y_{t+2}}{(1+r)^2} + \frac{Y_{t+3}}{(1+r)^3} + \dots \quad (12)$$

$$\hat{Y} = \frac{1}{1+r} \sum_{i=0}^{\infty} \left(\frac{1}{1+r} \right)^i Y_{t+i} \quad (13)$$

As $CC_t = S_t - I_t$ then:

$$CC_t = rD_t + Y_t - (1 - \beta) \left[(1 + r)D_t + \left(\frac{1}{1 + r} \right) (\bar{Y} - \hat{I} - \hat{G}) \right] - G_t - I_t$$

$$CC_t = Y_t - (1 - \beta) \left(\frac{1+r}{r} \right) \bar{Y} - G_t + (1 - \beta) \left(\frac{1+r}{r} \right) \hat{G} - I_t + (1 - \beta) \left(\frac{1+r}{r} \right) \hat{I} + rD_t - (1 - \beta)(1 + r)D_t \quad (14)$$

Rearranging this equation, we get:

$$CC_t = (Y_t - \bar{Y}) - (G_t - \hat{G}) - (I_t - \hat{I}) - \theta_1(\bar{Y} - \hat{G} - \hat{I}) - \theta_2 D_t \quad (15)$$

Since foreign savings is the negative of the current account balance, then:

$$S_t^x = (G_t - \hat{G}) + (I_t - \hat{I}) - (Y_t - \bar{Y}) + \theta_1(\bar{Y} - \hat{G} - \hat{I}) + \theta_2 D_t \quad (16)$$

$$S_t = (Y_t - \bar{Y}) - (G_t - \hat{G}) + \hat{I} - \theta_1(\bar{Y} - \hat{G} - \hat{I}) - \theta_2 D_t \quad (17)$$

$$S_t^{\text{private}} = (Y_t - \bar{Y}) - (T_t - \hat{G}) + \hat{I} - \theta_1(\bar{Y} - \hat{G} - \hat{I}) - \theta_2 D_t \quad (18)$$

$$S_t^{\text{publique}} = T - G \quad (19)$$

With $\theta_1 = (1 - \beta) \left(\frac{1 + r}{r} \right) - 1$ and $\theta_2 = (1 - \beta)(1 + r) - r$

Equation (16) represents the intertemporal form of foreign saving. It shows that if production at period t (Y_t) is greater than potential production, foreign savings decrease while public spending and investment have positive effects.

Equation (17) shows that if the output at period t is higher than its potential level, national savings increase, while if government spending is higher than its potential level, national savings decrease. The increase in potential investment leads to an increase in national savings. Equation (18) shows that if the output at period t is higher than its potential level, private saving increases, whereas if taxes are higher than permanent government expenditure, private saving decreases. Equations (16), (17) and (18) of the intertemporal model will allow us to analyze the determinants, respectively, of foreign savings, national savings, and private savings in Tunisia. Equation (19) shows that public saving increases if taxes in period t increase and it decreases if current government expenditure increases.

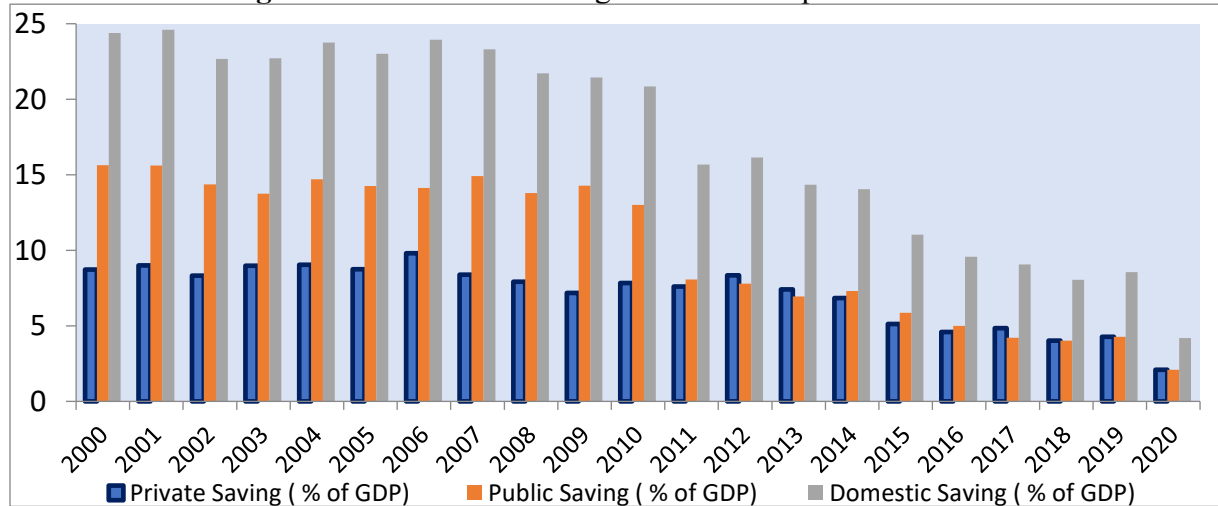
3. Empirical analysis

This section is devoted, first, to the analysis of the evolution of savings and then to the analysis of the determinants of savings in Tunisia. This analysis answers our research questions.

a) Analysis of savings in Tunisia

National savings are subdivided into two parts, namely: private savings and public savings. The figure below represents the evolution of national savings, private savings, and public savings in Tunisia during the period from 2000 to 2020.

Figure 1: Evolution of savings in Tunisia in percent of GDP



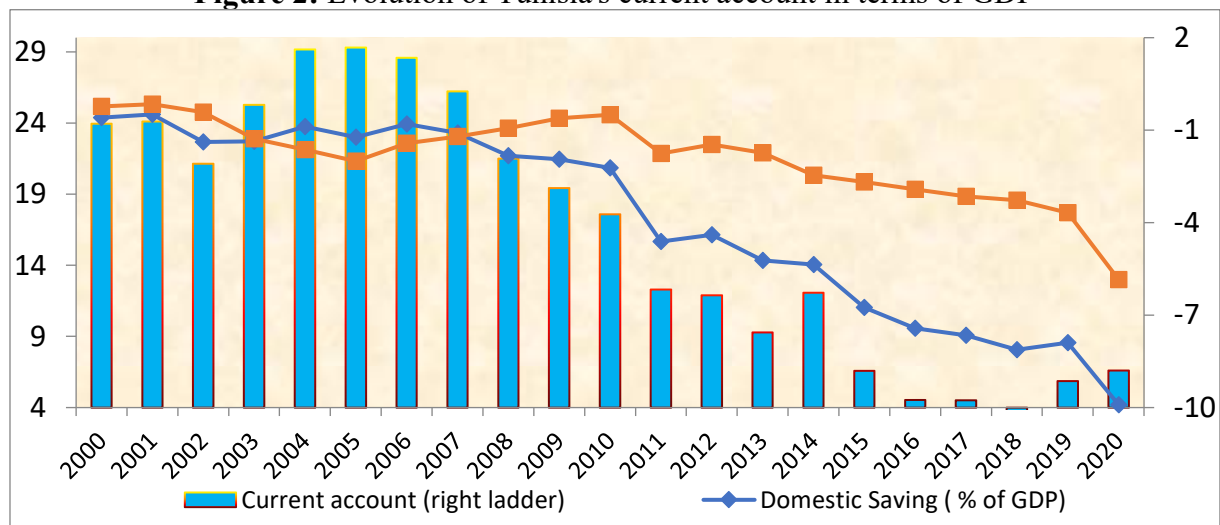
Source: National Accounts Yearbook, National Institute of Statistics, various numbers

Tunisian gross savings as a percentage of GDP fluctuated during the period 2000-2011 between 20 and 25%, and this fluctuation is considered extremely minor. However, from 2011, gross domestic savings as a percentage of GDP fell sharply. Indeed, economic instability and government policies after the revolution influenced the determinants of savings and consequently led to a sharp decline in savings rates. However, what is certain is that savings levels after the 2011 revolution in Tunisia became low compared to other countries in the MENA region, reflecting the fact that financial imbalances were worsening.

As shown in Figure 1, the savings rate fluctuated between 20 and 25% during the years 2000-2011, from 2012 to 2020 the rates continued to drop dramatically until they reached the lowest value of 4% of GDP in 2020.

The analysis of the current account, which is the difference between national savings and investment, allows us to know whether Tunisia had a financing need or a financing capacity.

Figure 2: Evolution of Tunisia's current account in terms of GDP



Source: Central Bank of Tunisia

Figure 2 shows that Tunisia's current account was still in deficit during the period from 2000 to 2010 and after 2011, it worsened to reach an average value of -8.6% between 2011-2020. In 2011, the post-revolution period, national savings fell more than investment. Indeed, when the current account of a country is in deficit, the financing of investments becomes difficult, and the country must resort to foreign loans to make up for these shortcomings. This leads us to analyze whether national savings is positively correlated with domestic investment.

b. Relationship between savings and investment in Tunisia

The analysis of the relationship between savings and investment in Tunisia shows that when there is perfect capital mobility between countries, the theory predicts that there is no significant relationship between national savings and domestic investment, and therefore the coefficient of national savings is not different from zero. In this case, domestic investment is largely financed by foreign capital. The reference model is that of **Feldstein and Horioka (1980)**. They analyzed the relationship between savings and investment in 21 developed countries. The results obtained show that national savings significantly explain domestic investment. These results contradict the theory of perfect capital mobility. The model used is the following:

$$\left(\frac{I}{Y}\right)_t = \beta + \gamma \left(\frac{S}{Y}\right)_t + \varepsilon_t \quad (20)$$

$\left(\frac{I}{Y}\right)_t$: Investment in terms of GDP at period t.

$\left(\frac{S}{Y}\right)_t$: National savings in terms of GDP at period t.

β and γ : Parameters

ε_t : The error term.

• **Linear and nonlinear ARDL model**

The linear form of the ARDL approach, for cointegration analysis, introduced by **Pesaran and al. (2001)** has been widely used in recent empirical analysis due to its statistical properties considered most relevant compared to other long-term analysis techniques (see **Abango and al., 2019; Aboagye, 2017; Nampewo and Opolot, 2016**). This cointegration technique is used to model the linear specification of equation (20) as follows:

$$\Delta\left(\frac{I}{Y}\right)_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{i=0}^p \alpha_{2i} \left(\frac{S}{Y}\right)_{t-i} + \alpha_3 \left(\frac{I}{Y}\right)_{t-1} + \alpha_4 \left(\frac{S}{Y}\right)_{t-1} + \alpha_{dum} Break_t + \varepsilon_t \quad (21)$$

Where Break is a dummy variable that captures structural breaks in the data series. **Pesaran and al. (2001)** provided upper and lower critical bounds for the evaluation of the null hypothesis of no cointegration between the H_0 : variables. This evaluation procedure consists of comparing the F-statistic calculated from equation (21) to the critical bounds, the null hypothesis is rejected when the calculated F-statistic is greater than the upper critical bound, it is accepted when 'it is lower than the lower bound and it is considered inconclusive when the calculated F-statistic remains between the lower and upper critical limits (see **Pesaran and al., 2001**). Equation (22) presents the error correction model (ECM) explaining the short-term dynamics in the linear relationship of equation (21):

$$\Delta\left(\frac{I}{Y}\right)_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{i=0}^p \alpha_{2i} \left(\frac{S}{Y}\right)_{t-i} + \alpha_{dum} Break_t + \delta_1 ECM_{t-1} + \varepsilon_t \quad (22)$$

Where ECM_{t-1} is the error correction term. The role of the model is based on the parameter, which is the coefficient of ECM_{t-1} . From an econometric point of view, this parameter (δ_1) must be negative and statistically significant to indicate that any deviation in the short term will converge towards the established equilibrium in the long term.

According to **Shin and al. (2014)**, the NARDL model can be derived by expanding the linear ARDL with the decomposition of the positive and negative partial sums of the exogenous variable, in this case national savings (S), as follows:

$$\left(\frac{S}{Y}\right)_t^+ = \sum_{j=1}^t \Delta\left(\frac{S}{Y}\right)_j^+ = \sum_{j=1}^t \max(\Delta\left(\frac{S}{Y}\right)_j, 0) \quad (23)$$

$$\left(\frac{S}{Y}\right)_t^- = \sum_{j=1}^t \Delta\left(\frac{S}{Y}\right)_j^- = \sum_{j=1}^t \min(\Delta\left(\frac{S}{Y}\right)_j, 0) \quad (24)$$

Accounting for the short-term and long-term asymmetric effects in the ARDL representation in equation (21) yields the following NARDL model:

$$\Delta\left(\frac{I}{Y}\right)_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{i=0}^p \alpha_{2i}^+ \Delta\left(\frac{S}{Y}\right)_{t-i}^+ + \sum_{i=0}^p \alpha_{2i}^- \Delta\left(\frac{S}{Y}\right)_{t-i}^- + \alpha_3 \left(\frac{I}{Y}\right)_{t-1} + \alpha_4^+ \left(\frac{S}{Y}\right)_{t-1}^+ + \alpha_4^- \left(\frac{S}{Y}\right)_{t-1}^- + \alpha_{dum} Break_t + \varepsilon_t \quad (25)$$

From equation (25), the long-run coefficients defined as measure the long-run effects of positive and negative shocks to national savings on investment, respectively. Similarly, $\sum_{i=0}^p \alpha_{2i}^+ \Delta\left(\frac{S}{Y}\right)_t^+$ and $\sum_{i=0}^p \alpha_{2i}^- \Delta\left(\frac{S}{Y}\right)_t^-$ measure the short-term effects of positive and negative shocks, respectively. The asymmetric relationship test is implemented in two steps. First, the long-term cointegrating relationship between the variables is examined. As in the linear ARDL model, the calculated F-statistic is compared to the upper and lower critical limits of **Pesaran and al. (2001)** for the evaluation of hypothesis $H_0: \alpha_3 = \alpha_4^+ = \alpha_4^- = 0$. The rejection of the H_0 hypothesis is necessary to establish a long-term relationship between the variables. Second, the long-term and short-term asymmetry in the relationship between national savings and investments is tested using the Wald test. The presence of a long-term asymmetry is confirmed by the rejection of the null hypothesis $H_0: -\frac{\alpha_4^+}{\alpha_3} = -\frac{\alpha_4^-}{\alpha_3}$. Equation (26) presents the ECM explaining the short-term dynamics in the nonlinear relationship of equation (25):

$$\Delta\left(\frac{I}{Y}\right)_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{i=0}^p \alpha_{2i}^+ \left(\frac{S}{Y}\right)_{t-i}^+ + \sum_{i=0}^p \alpha_{2i}^- \left(\frac{S}{Y}\right)_{t-i}^- + \alpha_{dum} Break_t + \delta_2 ECM_{t-1} + \varepsilon_t \quad (26)$$

When the parameter is negative and statistically significant, the coefficient of ECM_{t-1} , predicts that any short-term deviation will converge towards the long-term established equilibrium.

Furthermore, adjustment asymmetry is investigated to extract the asymmetric cumulative dynamic multiplier on investment for unit changes of $(\frac{S}{Y})_j^+$ and $(\frac{S}{Y})_j^-$ by implementing:

$$Z_{\theta}^+ = \sum_{j=0}^h \frac{\mu(\frac{I}{Y})_{t+j}}{\mu(\frac{S}{Y})_t^+} \text{ and } Z_{\theta}^- = \sum_{j=0}^h \frac{\mu(\frac{I}{Y})_{t+j}}{\mu(\frac{S}{Y})_t^-} \quad (27)$$

It is expected that as θ tends to infinity, then Z_{θ}^+ and Z_{θ}^- the long-term skewed coefficients $\frac{\alpha_4^+}{\alpha_3}$ and $\frac{\alpha_4^-}{\alpha_3}$, respectively.

- **Test of unit roots**

Several tests help to verify the stationarity or not of a series (existence of a unit root) such as: the standard unit root test (Augmented Dickey-Fuller test (ADF), modified Dickey-Fuller test (DF-GLS) and Phillippe-Perron (PP) test), the breaking unit root test and the seasonal unit root test. Standard tests are easy to apply and commonly used. In fact, the ADF test is effective in case of error autocorrelation, the DF-GLS test is used when the data incorporates deterministic trends. The PP test is suitable in the presence of heteroscedasticity. The break test is used for a series that shows a structural break or regime change identified exogenously and/or endogenously and the seasonal test is used for a series with a seasonal effect. In this study, we used two-unit root tests to identify the stationarity properties of the series. The first Augmented Dickey-Fuller (ADF) test investigates the stationarity properties of the series without considering the structural changes of the series. Thus, the second Zivot-Andrew's test considers a structural change. The Dickey-Fuller test results indicate that all variables are stationary only to the first difference (see Table 1). The results of the unit root test which considers possible structural changes in the series are presented in Table 2. The results suggest that the two series are stationary in level. Interestingly, structural breaks are identified in both series. This means that Tunisia has observed significant economic, financial, political, and social shocks following the global financial crisis in 2008 (at the level of investment) and the Tunisian revolution in 2011 (at the level of resource accumulation). The summary of the unit root analysis shows that none of the model variables are stationary at the second difference, therefore, the ARDL and NARDL models can be used to model the empirical log-linear specification in the equation (20).

Table 1: stationarity tests: Augmented Dickey-Fuller

Specification	In Level			In first difference		
		<i>I</i>	<i>S</i>		<i>d(I)</i>	<i>d(S)</i>
With constant and trend	<i>t-Statistic</i>	-1.7551	-2.0227	t-Statistic	-5.4542	-5.0300
	<i>Prob.</i>	0.6914	0.5576	<i>Prob.</i>	0.0013	0.0032
	<i>Décision</i>	Non	Non	<i>Décision</i>	Oui	Oui

Table 2: Stationarity tests of series with structural breaks: Zivot-Andrews

Spécification	In level		
		<i>I</i>	<i>S</i>
With constant and trend	<i>t-Statistic</i>	-3.481017	-4.400400
	<i>Prob.</i>	0.015384	0.005707
	<i>Breakup date</i>	2008	2011
	<i>Decision</i>	Yes	Yes

Source: author (our estimates on Eviews 10)

Decision: stationary at 5%

- **Symmetrical and asymmetric limit tests for the presence of cointegration**

Tables 3 and 4 present the F-statistics for both linear and nonlinear ARDL model specifications. In both specifications, national saving is decomposed into positive and negative partial sums to examine the non-linear relationship between national saving and investment. The results of all the linear and nonlinear specifications reject the null hypothesis of no cointegration and they indicate that there is a long-term causal relationship between these two variables in Tunisia.

Table 3: ARDL cointegration test results (linear specifications)

Specification	Break	F-statistic	
$\Delta(\frac{I}{Y})_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta(\frac{I}{Y})_{t-i} + \sum_{i=0}^p \alpha_{2i} (\frac{S}{Y})_{t-i} + \alpha_3 (\frac{I}{Y})_{t-1} + \alpha_4 (\frac{S}{Y})_{t-1} + \alpha_{dum} Break_t + \varepsilon_t$	2008,2011	5.679	
Critical value bounds	1%	5%	10%
I₀ Bound	4.13	3.1	2.63
I₁ Bound	5	3.87	3.35

Table 4: NARDL cointegration test results (nonlinear specifications)

Specification	Break		F-statistic
$\Delta\left(\frac{I}{Y}\right)_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{i=0}^p \alpha_{2i}^+ \Delta\left(\frac{S}{Y}\right)_{t-i}^+ + \sum_{i=0}^p \alpha_{2i}^- \Delta\left(\frac{S}{Y}\right)_{t-i}^- + \alpha_3 \left(\frac{I}{Y}\right)_{t-1} + \alpha_4^+ \left(\frac{S}{Y}\right)_{t-1}^+ + \alpha_4^- \left(\frac{S}{Y}\right)_{t-1}^- + \alpha_{dum} Break_t + \varepsilon_t$	2008,2011		11.183
Critical value bounds	1%	5%	10%
I₀ Bound	4.13	3.1	2.63
I₁ Bound	5	3.87	3.35

Source: author (our estimates on Eviews 10)

The cumulative sum of the recursive residuals (CUSUM) and the cumulative sum of the squares of the recursive residuals (CUSUMSQ) were applied to check the stability of the parameters of the linear and nonlinear models studied. These stability tests are shown in the figures below and they show that the linear and non-linear model estimates are stable and can support economic policy analysis and formulation.

Figure 3: Stability test (CUSUM and CUSUMSQ statistics) of the ARDL model

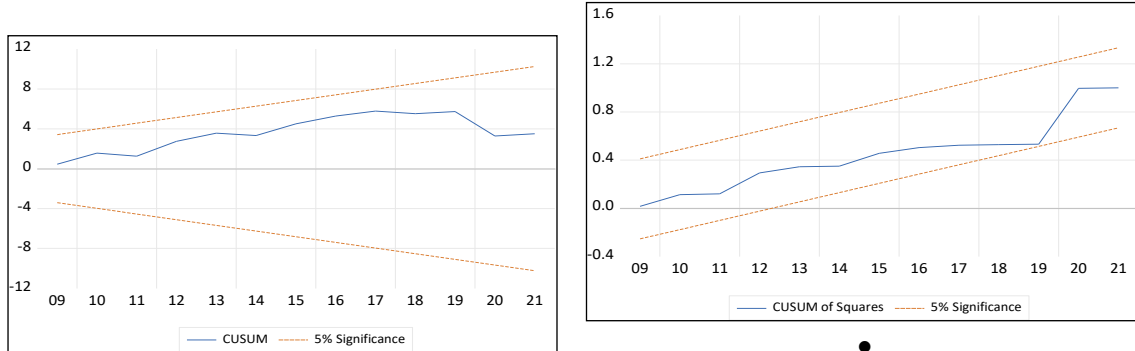
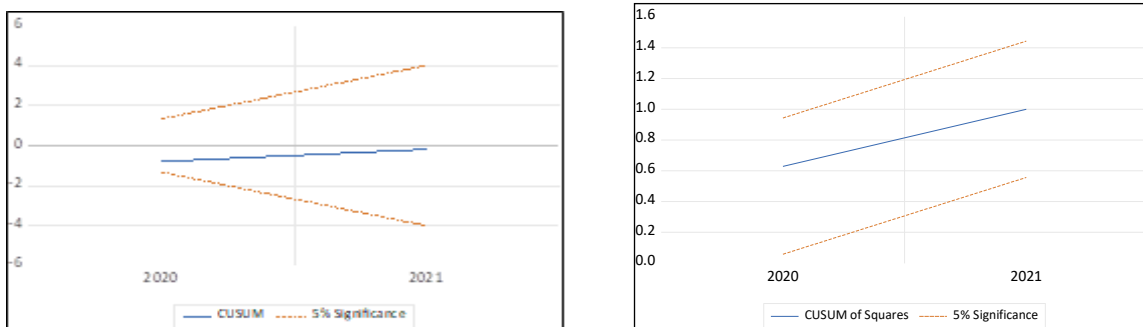


Figure 4: Stability test (CUSUM and CUSUMSQ statistics) of the NARDL model



Source: author (our estimates on Eviews 10)

- **Analysis of the linear ARDL model**

The short-term and long-term estimates of the linear ARDL model are shown in Table 5.

Table 5: Linear relationship between investment and national savings in Tunisia

Variable	Coefficient	t-Statistic	Prob.
Part A : Short term estimates			
D(I(-1))	0.268572	1.817622	0.1190
D(S)	0.789059***	11.17870	0.0000
D(S(-1))	-0.156819	-1.450095	0.1972
D(S(-2))	-0.075964	-0.958762	0.3747
D(S(-3))	0.285526***	3.779354	0.0092
D(BREAK08_11)	-0.170114	-0.410521	0.6957
D(BREAK08_11(-1))	-3.064977***	-4.178753	0.0058
D(BREAK08_11(-2))	-1.734277**	-2.708140	0.0352
D(BREAK08_11(-3))	-1.658653**	-2.997456	0.0241
ECM(-1)*	-0.666772***	-5.837452	0.0011
Part B: Long-term estimates			
S	1.179280	4.000776	0.0071
BREAK08_11	4.827900*	2.373420	0.0553
C	-2.995865	-0.457136	0.6637

ECM: Error Correction Model

Note: *, **, and *** denote significance at the 10% level, 5% level, and 1% level, respectively

Source: author (our estimates on Eviews 10)

In panel A, the short-term coefficient of national saving is positive and statistically significant at the 1% level. This result suggests that national savings contribute significantly to the improvement of investment in Tunisia in the short term. The coefficient of the lagged error correction term ECM(-1) is negative and statistically significant at the 1% level. The negative value is theoretically expected and suggests the restoration of long-term equilibrium after an exogenous shock.

The long-term estimates of the linear ARDL model presented in panel B of Table 6 show a positive and statistically significant coefficient for national savings.

Overall, the linear analysis suggests an increasing impact of national savings on investment in Tunisia.

- **Analysis of the nonlinear ARDL model**

The short-run and long-run estimates from the non-linear ARDL analysis are shown in Table 6. The short-run estimates in Part A and the long-run estimates in Part B confirm that optimal resource mobilization (savings national) encourages the financing of profitable projects and productive investments in Tunisia.

The lagged error correction term ECM(-1) has a statistically significant negative coefficient at the 1% level, confirming the existence of a long-term relationship between the variables.

Table 6: Non-linear relationship between investment and national savings in Tunisia

Variable	Coefficient	t-Statistic	Prob.
Part A : Short term estimates			
D(I(-1))	-0.052123	-0.814383	0.5010
D(I(-2))	-0.565616**	-5.407420	0.0325
D(I(-3))	-0.126557	-1.595249	0.2517
D(S POS)	-0.012160	-0.086077	0.9392
D(S POS(-1))	-3.361609***	-10.14242	0.0096
D(S POS(-2))	-2.831187**	-7.037098	0.0196
D(S POS(-3))	-1.346779**	-4.679363	0.0428
D(S NEG)	1.111168***	12.41875	0.0064
D(S NEG(-1))	0.445692**	5.718040	0.0292
D(S NEG(-2))	0.496826**	6.367143	0.0238
D(S NEG(-3))	0.629309**	9.162089	0.0117
BREAK08_11	-0.270303	-1.283235	0.3280
ECM(-1)*	-0.548444***	-10.57513	0.0088
Part B: Long-term estimates			
S_POS	5.436380	1.260634	0.3346
S_NEG	1.216988	1.831329	0.2085
C	27.69703***	12.24677	0.0066

ECM: Error Correction Model

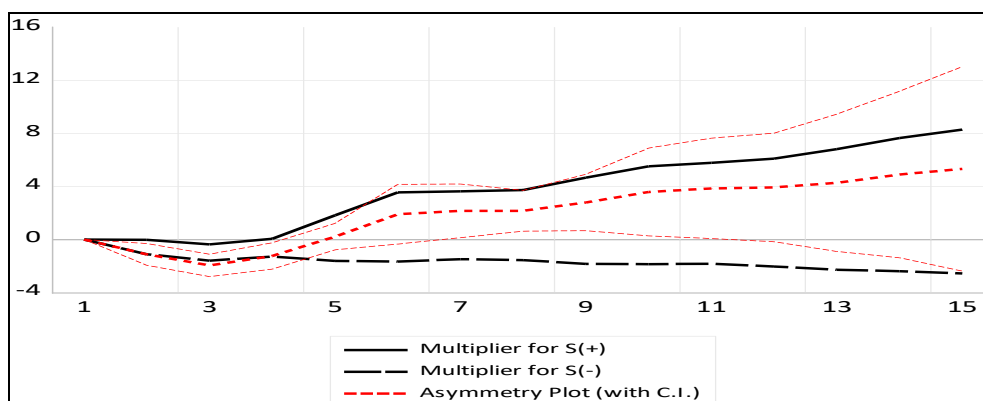
Note: *, **, and *** denote significance at the 10% level, 5% level, and 1% level, respectively

Source: author (our estimates on Eviews 10)

The sign and size of the national savings coefficient in Table 5 show the effect of positive and negative changes in the behavior of national savings on investments in Tunisia. Considering the sign of the coefficients, the short and long run estimates show that positive innovations in national savings have negative and significant coefficients at the 1% and 5% level, while negative innovations in national savings have positive and significant coefficients at the 1% and 5% level.

The long-term coefficients of positive and negative changes in national savings are 5.436 and 1.216, respectively. Indeed, the impact of positive shocks on the behavior of savers on investments in Tunisia is identified as being stronger than the reducing effect of a unitary negative shock on national savings.

Figure 5: Effect of the dynamic multiplier of negative and positive variations in national savings



Source: author (our estimates on Eviews 10)

Figure 5 presents the effect of the dynamic multiplier of negative and positive changes in national saving. The solid black line reflects positive changes, which means that it gives information about the asymmetric adjustment of investment to the positive shock of national savings at a given time horizon. The dotted black line captures the negative changes, which means that it gives information on the asymmetric adjustment of investment to the negative shock of national savings at a given time horizon. The red dotted line represents the difference between positive and negative shocks. Figure 3 shows that in the short run, positive shocks are unstable relative to negative shocks. However, these shocks do not last long, and they become relatively stable throughout the period (in the long run). The results in Figure 3 indicate that an increase in national savings appears to have a greater impact on long-term investment than a negative shock to national savings in Tunisia. In other words, the impact of positive shocks on national savings exceeds the impact of negative shocks on the variable in the case of Tunisia.

• Empirical results of the intertemporal approach

This section presents and analyzes the empirical results of the intertemporal model. This model is formulated by equations (16), (17) and (18). These equations concern, respectively, the functions of foreign saving, national saving, and private saving in an intertemporal model. The elements of potential savings, investment and output are obtained using the Hodrick-Prescott filter. Suppose $\beta = 1/1+r$, this means that the rate of consumer preference is the same over time and it is equal to the market return. As $\beta = 1/1+r$, we have $\theta_1 = \theta_2 = 0$. The estimation of these equations gives the following results:

Table 7. Determinants of savings in Tunisia

Dependent variable	Equation 16: Foreign savings	Equation 17: National savings	Equation 18: Private savings
Constante	3.799*** (0.001)	7.565*** (0.0001)	0.888** (0.038)
$Y_t - \hat{Y}$	0.253 (0.802)	0.389* (0.0915)	-0.022 (0.5869)
$G_t - \hat{G}$	0.126 (0.897)	-0.529 (0.2393)	
$\hat{I}$		0.134 (0.2527)	0.530*** (0.000)
$I_t - \hat{I}$	-0.181 (0.920)		
$T - \hat{G}$			0.505*** (0.000)
R^2	2.9%	21.8%	82.9%
Number of observations	21	21	21
Estimation method	MCO	MCO	MCO

(): Standard deviation

*** significant at 1%; **significant at 5% and * significant at 10%

Source: author (our estimates on Eviews 10)

From the table above:

- **In equation 16:** The explanatory power is very low at around 2.9%. Not all variables are significant. If the difference between actual investment and potential investment increases, foreign savings decrease and vice versa. The difference between actual investment and potential investment increases if there is an increase in actual investments relative to potential investments or if there is a decrease in potential investments relative to actual investments. To increase foreign savings, potential investments must be greater than actual investments.

- **In equation 17:** the explanatory power is 21.8%. Among the explanatory variables used, only the difference between actual production and potential production has a positive and significant sign. The potential investment variable positively influences national savings, but it is not significant, which means if a country makes a potential investment its production must increase in the future. If production increases, the country must have the possibility of building up national savings.

- **In equation 18:** the explanatory power is 82.9%. The difference between actual production and potential production is not significant and explains in a negative way. The increase in current output relative to potential output leads to a decrease in private savings. Potential investment explains private savings positively and significantly. The difference between taxes and potential public expenditure has a positive and significant effect. The positive sign of $(T_t - G)$ implies that if taxes are higher than potential public expenditure, private saving decreases. The increase in taxes negatively influences private savings.

Conclusion

This study examines the determinants of national savings in Tunisia through an in-depth econometric analysis over the period 1999-2021. The empirical analysis explores two fundamental models: the first model is based on the linear ARDL technique, and the second model is based on the nonlinear ARDL optics. The ARDL linear model is considered a benchmark analysis that explores the symmetric effects of national savings on investment in Tunisia. The nonlinear ARDL model decomposed national savings into positive and negative partial sums to explore possible asymmetric effects of national savings on investment in Tunisia. The development of tests relating to the asymmetric effects of national savings aims to determine the negative impact (a fall in the national savings rate) and the positive one (an increase in the national savings rate) on investment in the economy. The cointegration analysis of the linear and nonlinear ARDL limits proves the presence of a long-term relationship between the national savings rate and the investment rate in Tunisia.

Empirical results from intertemporal models show that the relationship between permanent investment and national savings is positive and significant. If a country increases its permanent investment, its production will increase in the future, which will lead to an increase in national savings. The other explanatory variables remained have the expected signs, but they are now not significant. Private saving in Tunisia is positively and significantly explained by the difference between temporal output and permanent output and permanent investment. The difference between taxes and permanent public expenditure has the expected sign but does not have significant effects. Foreign savings are significantly explained by the difference between time investment and potential investment.

Nevertheless, the econometric analysis shows that the two variables used (investment and savings) have undergone a change and have a downward trend on two occasions. Indeed, the first date is that of 2008 which corresponds to the spread of the international financial crisis. This financial crisis has had a massive impact on the behavior of foreign and national investors in Tunisia. However, the second date is 2011, which corresponds to the Arab Spring revolution in Tunisia. These events have perverse effects on the behavior of Tunisian savers. Thus, domestic savings levels are moderately low. Access to external savings is restricted.

By way of conclusion, the promotion of investment in Tunisia is mainly based on the mobilization of domestic savings and on the optimal allocation of financial resources towards public and private investments with high rates of return. In other words, the potentially low savings do not contribute to the optimal allocation of resources and cause the lack of productive investments.

Footnotes

(1) “The basic psychological law on which we can safely rely, both a priori on account of our knowledge of human nature and posteriori on account of the detailed information of experience, is that on average and most of the time, men tend to increase their consumption as income increases, but not by as much as the increase in income”, general theory, chapter 8, p.117.

(2) In the medium term, Duesenberry had highlighted the ratchet effect, according to which the level of consumption of a period depends on the highest level of consumption of previous periods.

(3) According to Brown (1952), consumption depends on income, but it is necessary to introduce a delay effect which accounts for a certain inertia in consumption behavior. Consumption therefore depends on the income and consumption of the previous period.

In the short term, we therefore have: $C_t = C_0 + cY_t + aC_{t-1}$ with $0 < c < 1$ and $0 \leq a < 1$

In the long term, the consumption function is: $C_t = C_0 + c.Y_t + a.C_t$ and therefore

$$C_t = c.Y_t / (1-a) + C_0 / (1-a)$$

(4) According to Duesenberry, the demonstration effect is a corrective to Keynesian consumption function theory, which postulated that a family's consumption expenditure was related only to the level of its income.

(5) This theory holds that individuals attempt to maintain a stable standard of living as their income experiences three very different phases: early in life, resources are low; they then increase during working life, only to fall again after retirement. This leads young people to go into deep debt; then, during the second phase of life, households save to repay their youth loans and to prepare for their retirement; during the 3rd phase, they draw on their past savings to preserve their consumption.

Data availability Data will be made available on reasonable request

Declarations

Ethical approval All authors have read, understood, and have complied as applicable with the statement on “Ethical responsibilities of Authors” as found in the Instructions for Authors.

Competing of interest The authors have no relevant financial or non-financial interests to disclose.

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