The use of seigniorage in financing budget deficits in Algeria: an ARDL Approach

Halim Zidelkhil [*1], Aissa Mouhoubi [2]

[1] Faculty of Economics and Management. Economics and Development Laboratory "LED", University of Bejaia (Algeria). halim.zidelkhil@univ-bejaia.dz
[2] Faculty of Economics and Management. Economics and Development Laboratory "LED", University of Bejaia (Algeria). aissamouhoubi@gmail.com

Reçue : 02/09/2021 Accepté :04/12/2021 Publié :12/01/2022

Abstract:

This study proposes to assess the seigniorage perceived by the Algerian's budgetary authority as well as its link with the budget deficit, for the period which spans between 1965 and 2018. The seigniorage calculation is inspired by a large review of the literature. Analysis of the composition of seigniorage illustrates that purely monetary seigniorage was used in particular before 1979. Since then, the inflation tax has been the essential component of the seigniorage calculated between 1980 and 2018. The graphical and econometric results, using the ARDL model, show at the same time, the importance of seigniorage in financing Algerian's budget deficit, notably by the inflation tax in the short and long term.

Key words: seigniorage, budget deficit, inflation tax, ARDL, government policy

Jel Classification Codes: E60, E58, C12, C22

Introduction:

The financing of fiscal deficit is done using several sources like: the use of internal and external debt, the monetization of foreign exchange reserves and finally the monetary issue in favor of the government (De Haan and Zelhorst, 1990; Fischer and Easterly, 1990; Dogru, 2013). This issue is considered as an alternative modality and pure seigniorage. Its alternative nature is due to the fact that it must be executed as a last resort and taken with great caution. It can be adopted in developed and developing countries despite their different macroeconomic configurations and fundamentals.

At the level of the latter, the financial markets are often underdeveloped, as for the public debt, this is generally chronic and represents a significant GDP share.

The Algerian economy is part of this corpus and in november 2017, following Law 17-10 of october 24 th, the government subjected the Bank of Algeria to directly buy public assets for five years. That said, once we dissect the components of the seigniorage of the algerian economy since 1970, we will discuss the other forms that have always existed and exercised by the authorities outside of known monetary financing.

The idea conveyed in this sense is that: there is not a single mode of seigniorage. The literature identifies three forms (Buiter, 1997; Berthomieu and Karimi Taranlou, 2009): a purely monetary form resulting from the variation of the real money base, a form often assimilated to the first one

* **Halim Zidelkhil**

which refers to the inflation tax and finally, a form resulting from the request for additional transactions resulting from economic growth.

The seigniorage can also refer to the gain that the central bank realizes by granting to the private sector loans and which can then be used to finance the public sector, either by the repayment of the profits to the government or in the case where it lends to this last by using these gains.

The use of this method of financing fiscal deficits represents a certain ease, especially if the monetary authority submits to the requirements of the budgetary or political authority (Leeper, 1991)[1]. This reflection is corroborated by the work of Moreira, Souza, and Almeida (2007) who argue that in a fiduciary system, the debt is always solvent since it is possible to use seigniorage as an income source.

In fact, it is intuitive to think that money creation rather than debt or tax, is more attractive in the short term because of the ease of its implementation, but the difficulty lies in the crucial choice to be made as to the distribution of national wealth: the debt defers funding to future generations, the tax makes it possible to precisely target some social groups or categories, but monetary creation and inflation have vast and uncertain effects since it is difficult to target the beneficiaries or the disadvantaged on the one hand and target inflation on the other.

This paper proposes to analyze empirically, the existing relationship between the budget deficit and the use of seigniorage income in Algeria.

To answer it, we have put forward a single hypothesis according to which monetary creation ex nihilo is an important means of financing budget deficit in Algeria between 1980 and 2018, in a context of low tax revenues, due to the low tax base.

At first, we have to discuss the different concepts related to seigniorage to better understand it. Then in the second section, we move on to its measurement. The formulation which will be advanced in this part will be the theoretical part on which our database will be produced and used in our econometric analysis.

The third section will be dedicated to a literature review about the existing links between seigniorage and the public deficit. Finally, the fourth section will verify, by an ARDL modeling, these links for the Algerian economy.

The analysis will focus on the study of possible cointegrations between seigniorage as an endogenous variable and the budgetary balance as well as the components of this seigniorage as exogenous variables. We then move on to Toda-Yamamoto (1995) causality test to determine whether variations in budget deficit do imply and cause variations in the use of seigniorage. We also analyze among the components of the Algerian seigniorage, which ones cause it the most.

1. Concept of seigniorage

The use of banknotes and coins is allowed, in particular, by the freedom to cover only part of the notes in circulation by a metallic anchor "gold", so that the issuing bank can transform this part not covered into productive investments interest and generate a profit higher than that coming from the simple creation of money. So according to the Bank of Canada (2013), seigniorage represents income from money issuance. More precisely, the difference between the interest that the Central Bank draws from a portfolio composed of public securities in which it invests the value of the notes mobilized, in circulation, subtracted from the various costs relating to the issue, distribution and replacement of these tickets. This definition excludes seigniorage drawn from coins, because it is made at the time of the sale of these coins. The definition of

[1] This configuration represents the third configuration of Leeper's configurations (1991), where the budgetary authority is considered active and does not worry about ensuring its intertemporal budgetary constraint autonomously to the detriment of a passive central bank which folds has it by deviating from its essential objective which is inflation targeting. This is what happened with article 45 bis of law 17-10 of October 24, 2017 where the bank of Algeria renounces its autonomy set out in LMC 90-10 of April 1990 and in the article 45 of the ordinance of August 26, 2003 on money and credit.

Gürbüz, Gürbüz, Miniaoui and Smida (2009), is from this point of view, similar since they consider seigniorage income as a legal financial advantage, for the benefit of money-issuing entities and public powers, so that it represents the difference between the face value in nominal terms and the price of its production and distribution. See also (Ercolani, 2000; Gürbüz and Yessim, 2009). The seigniorage can therefore, have a purely monetary origin. It is « The resources appropriated by the State following an increase in the nominal base money ... .. the marginal cost of producing fiat money is (about) zero » (Buiter, 1997, P22). In other words, the change in money created directly by the central bank and which serves as a basis or lever for monetary creation by second-tier banks.

In addition, seigniorage can be understood as an opportunity cost of the private sector resulting from the loss of interest income resulting from an investment in the acquisition of public debt securities instead of the various possible and more remunerated financial investments (Buiter, 1997; Cukrowski, 2001).

Buiter (1997) in his contribution had considered total seigniorage as a fraction of GDP and had broken it down into three categories: a seigniorage resulting from the inflation tax, a second resulting from economic growth and a last resulting from the variation of the base money. He had emphasized the error of confusing the term seigniorage and reducing it to the sole inflation tax, I quote: « The terms seigniorage and inflation tax are often used with perfect permutation, it is a dangerous confusion since the two concepts are distinct » (Buiter, 1997, P22).

The definition of Berthomieu and karimi taranlou (2009) went further by considering seigniorage revenues as income from the issuance of central money in real terms "real money base". Strongly inspired by Buiter's work, they too, broke up seigniorage into three categories mentioned above and concluded that for the four countries studied in this case: Tunisia, Morocco, Turkey and Iran, the last two are those who have, relatively, of the two largest seigniorage sequences in terms of GDP, namely 27.83% and 37.76% respectively.

This definition requires that we define the three components of total seigniorage for a better understanding of these concepts during its calculation in section three of this study.

The first component is the inflation tax. This refers to the fall in the real value of the monetary base due to inflation called "active seigniorage". according to Cagan (1956), it is considered as a tax because it is necessary to think about seigniorage as a measure acting on real cash. As inflation rises, the nominal interest rate increases at the same time and real money holdings decrease. In this configuration, the demand for nominal money would be increased by economic agents to keep their demand for real money at its initial level. They will therefore hoard and consume less on the one hand and will see their part of their purchasing power confiscated, unlike the State which will see its real debt held by these economic agents diminish. In terms of public debt, Dogru (2013) considers it as a form of transfer of financing capacity from all creditors of the public treasury to the latter. It can also be understood as a welfare price effect by citing Cooley and Hansen (1998) and Kakar and Daniels (2018, p1) : « We are seeing significant redistribution effects because inflation acts like a regressive tax on consumption. It is unfavorable and affects low-income households and benefits those with high incomes»

The second component is the seigniorage resulting from economic growth. This represents the endogenous variation of the monetary base necessary to meet the transactional demand of economic agents, resulting in particular from economic growth.

Finally, the last component is the so-called "passive" seigniorage, calculated from the increase in the real value of the monetary base "exogenous variation of the real base money". See (Yesim, 2008 ; Insah and Ofori-boateng, 2013). Also, the definition given by Levent (2006, P 4) considers that: "The seigniorage can be defined as the value of the real resources acquired by the government thanks to its capacity to print money".

2. The measurement of seigniorage

Authors like Labossiere (2013) , Burnside (2004), Agénor and Hoffmaister (1997), Yesim (2008) and Insah Ofori-boateng (2013) evaluated the seigniorage income but only took the monetary aspect, in this case, the inflation tax and the change in the real base money as follows:
With:

M_t = The stock of nominal base money

p_t = The price level taken by these authors as the deflator of GDP

We designate the seigniorage by S_t

$$S_t = \Delta M_t/p_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.1)$$

We have the following equation:

$$\Delta M_t/p_t = \frac{M_t}{p_t} - \left(\frac{p_{t-1}}{p_t}\right)\left(\frac{M_{t-1}}{p_{t-1}}\right) = \Delta\left(\frac{M}{p_t}\right) + \left(1 - \frac{p_{t-1}}{p_t}\right)\left(\frac{M_{t-1}}{p_{t-1}}\right) \quad \ldots\ldots\ldots\ldots\ldots \quad (1.2)$$

Equation *(2.2)* can be rewritten as follow:

$$\Delta M_t/p_t = \Delta\left(\frac{M_t}{p_t}\right) + \left(\frac{p_t - p_{t-1}}{p_{t-1}}\right)\left(\frac{M_{t-1}}{p_t}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.3)$$

With:

$m_t = M_t/P_t$: As the real base money

And,

$\pi_t = \left(\frac{p_t - p_{t-1}}{p_t}\right)$: As the inflation rate

We will have:

$$\Delta M_t/p_t = \Delta m_t + \pi\left(\frac{p_{-1}}{p_t}\right) m_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.4)$$

Where:

$$S_t = \Delta m_t + \left(\frac{\pi}{1+\pi}\right) m_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.5)$$

With:

Δm_t = The share of seigniorage resulting from the change in the real base money.

And:

$\left(\frac{\pi_t}{1+\pi_t}\right) m_{t-1}$ = The share of seigniorage resulting from the inflation tax also called « active » seigniorage.

In this paper, we have chosen to use the approach of Buiter (1997), Berthomieu and Karimi Taranlou (2009) as well as Zidelkhil and Mouhoubi (2020), which measure seigniorage in terms of GDP and not, exclusively, as monetary seigniorage as follows :

$$S_t = \frac{\Delta M_t}{y_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.1)$$

With:

y_t = The nominal GDP

ΔM_t = The change of nominal money base = $M_t - M_{t-1}$

$M_t = (1 + \pi_t)(1 + x_t)\ m_{t-1}$

In the following, we treat the base money as not bearing interest and posing the problem in terms of real GDP, equation (1.1) can be written as follows:

$$S_t = \frac{\Delta M_t}{y'_t\ def_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.2)$$

$$S_t = \frac{[(1+\pi_t)(1+x_t)-1]}{(1+\pi_t)(1+x_t)}\ m_{t-1} + \Delta m_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.3)$$

$$S_t = \frac{\pi_t}{(1+\pi_t)(1+x_t)} m_{t-1} + \frac{x_t}{(1+x_t)} m_{t-1} + \Delta m_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2.4)$$

$$= Sinf_t + Sx_t + Sm_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.5)$$

Where:

x_t : The growth rate of real GDP
$Sinf_t$: The inflation Tax
Sx_t : The share of seigniorage "income" relative to economic growth
Sm_t : The change of base money

We have summarized some works which measured seigniorage. Incomes as a% of GDP are summarized in table 1 below:

Table 1. Decomposition of seigniorage revenues from 1965 to 2017 as a percentage of GDP in some countries

	Authors	*Data*	*S inft /GDP*	*S ΔM0t /GDP*	*S xt /GDP*	*St /GDP*
(Berthomieu and Takanlou, 2009) Study for 4 MENA countries, Annual data	*IRAN*	*Min V*	*4,69*	*-32,21*	*0,52*	*-26,99*
	(1971-2004)	*Max V*	*3,11*	*36,09*	*-2,43*	*36,76*
		Average value	-	-	-	-
	TURKEY	*V Min*	*4,556*	*-3,73*	*0,98*	*1,81*
	(1971-2004)	*V Max*	*17,65*	*13,67*	*-3,48*	*27,84*
		Average value	-	-	-	-
	MOROCCO	*Min V*	*1,07*	*0,81*	*1,67*	*3,45*
	(1971-2004)	*Max V*	*1,53*	*4,58*	*4,68*	*10,76*
		Average value				
	TUNISIA	*Min V*	*1,56*	*1,27*	*-0,661*	*2,17*
	(1971-2004)	*V Max*	*3,96*	*1,79*	*2,13*	*7,89*
		Average value	-	-	-	-
(Buiter, 1997) 12 Eastern European countries Annual data	*BULGARIE*	*Min V*	-	-	-	*-1,03*
	(1991-1994)	*Max V*	-	-	-	*7,81*
		Average value	-	-	-	*3,71*
	F.R.RUSSIA	*Min V*	-	-	-	*6,11*
	(1992-1994)	*Max V*	-	-	-	*20,88*
		Average value	-	-	-	*12,73*
	UKRAINE	*Min V*	-	-	-	*11,03*
	(1992-1994)	*Max V*	-	-	-	*17,13*
		Average value	-	-	-	*14,05*
(Gurbuz, 2008) Quarterly data	*TURKEY*	*Min V*	-	-	-	*1,1*
	Q3 1987-Q4 2004	*Max V*	-	-	-	*10,3*
		Average value	-	-	-	*4,32*
and Mouhoubi,2020) Algeria,	*ALGERIA*	*Min V*	*5,94*	*-6,13*	*-0,3*	*-0,49*
	(1965-2017)	*Max V*	*22,51*	*2,88*	*0,48*	*25,87*

Average value	*7,85*	*0,94*	*0,65*	*9,44*

Source: Summarized and calculated by authors

The seigniorage revenues calculated for Algeria as well as its components are summarized for the period between 1965 and 2017 in Table 2 below. We note that, the average of seigniorage after the oil shock increased by 20.42% from 21.48% to 25.87% between 2014 and 2017. This could be explained by unconventional financing, following law 17-10 of October 24, 2017, started in November 2017, as well as the opening of the bank refinancing window of April 2016, facilitating the rediscounting of the assets of public economic enterprises in difficulty since the oil shock of 2014.

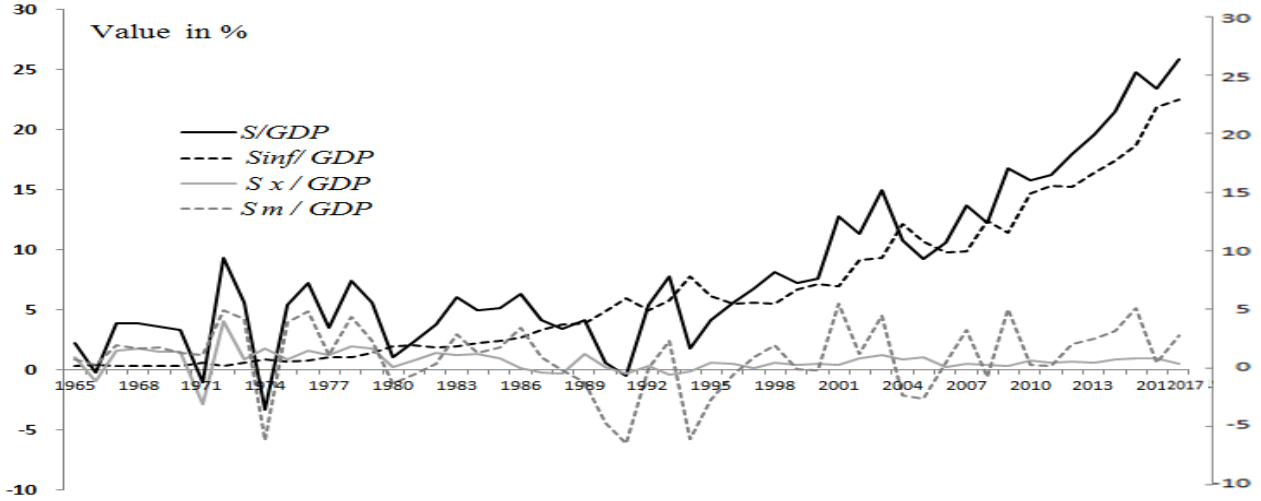
Table 2. Decomposition of seigniorage revenues from 1965 to 2017 as a percentage of GDP in Algeria

	St /GDP	S Sinft /GDP	ΔM0t /GDP	Sxt /GDP
1965-1969	*2,6495*	*0,3162*	*1,3641*	*0,9692*
1970-1979	*4,2786*	*0,7522*	*2,2616*	*1,2648*
1980-1989	*4,1022*	*2,585*	*0,8516*	*0,6657*
1990-1999	*4,6811*	*5,8655*	*-1,3689*	*0,1845*
2000-2009	*11.9967*	*9.8800*	*1.4899*	*0.6268*
2010-2014	*18.2133*	*15.8074*	*1.7057*	*0.7001*
2 015	*24,7651*	*18,72*	*5,097*	*0,9481*
2 016	*23,3826*	*21,8363*	*0,5803*	*0,966*
2 017	*25,8764*	*22,514*	*2,8847*	*0,4777*
2 018	*23,0716*	*25,0133*	*-2,0226*	*0,3207*

Source: Calculated by the authors from IMF and Bank of Algeria data

Figure 1 gives us a visual illustration of the most influential component in the constitution of seigniorage income. As a result, the inflation tax is the most important up to 22.51% of GDP in 2017 against 25.87% of GDP for total seigniorage. As for seigniorage resulting from economic growth, this fluctuated between -2.8962% in 1971 and 1.7819% of GDP in 1968 as the minimum and maximum value for the period analyzed. Revenue from the change in the real base money, as a% of GDP, range from -5.9311% in 1974 to 5.097% in 2015. This indicates the constant use of the inflation tax which could be explained by the recourse of the budgetary authorities to this mode of financing which allows it to tax on the same equal footing the formal sector as informal especially as the latter is important in the national economy. In addition, this comes down to the evolutionary inflation rates during the study period without excluding the financing of fiscal deficits by decreasing the value of loans obtained from the Bank of Algeria and of public securities held by the private sector.

Fig.1.Decomposition of seigniorage income as a percentage of GDP in Algeria from 1965 to 2018



Source: Authors. Using ONS and Bank of Algeria's data

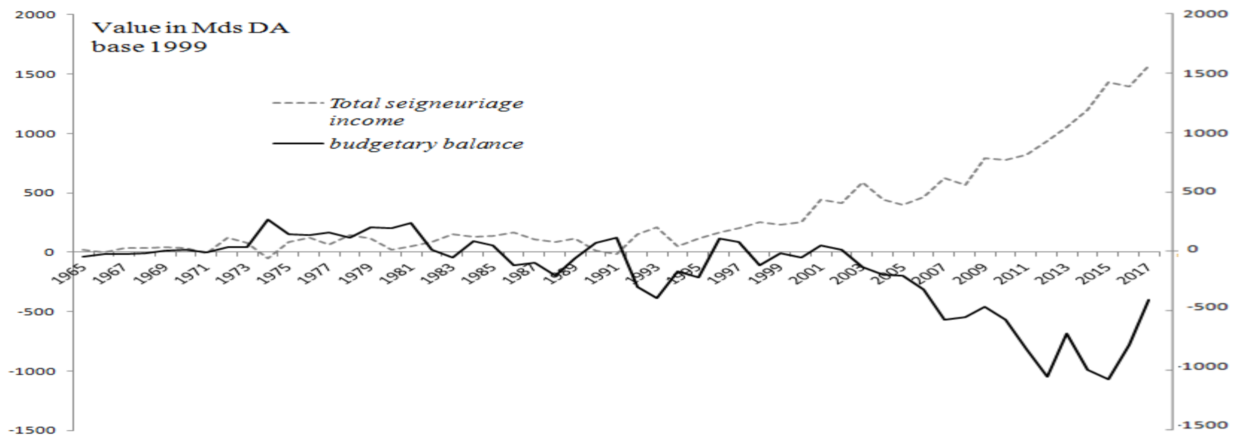
We can proceed to the verification of the negative correlation which could exist between the level of the budgetary balance and the seigniorage drawn by a visual examination in figure 1, which will be either affirmed or denied by the econometric tool in section 4.

3. The théorical link between seigniorage and budget deficit

The literature dedicated to the use of seigniorage income to alleviate the financial difficulties of governments is very vast. It teaches us a major fact. It is the fact that each government can have recourse to one or more specific components of seigniorage. Generally it is the inflation tax and the purely monetary seigniorage which are used. King and Plosser (1985) investigate the deficit – seigniorage relationship in terms of neoclassical macroeconomic models. They find little connection between fiscal deficits and seigniorage in the 1953–1982 period in the United States. The work of Cukrowski (2001) found that in certain central european countries, in a period of transition to a market economy, seigniorage income is indeed a source for financing public deficits, notably through the inflation tax due reduction of the public debt portfolio and not through the use of increased monetary creation. Gürbüz et al, (2009), for their part, and for the case of Turkey, have shown that monetary seigniorage has a greater weight, in total seigniorage, until the end of 2001 when the Central Turkish Bank has gained its autonomy. This mode of financing was the second source of financing for the Turkish government after the domestic debt.

This link is also consolidated in the Klein's and Neumann's (1990) study, which has shown that even if the use of monetary creation is a means of financing deficits, it remains less true than both theoretically and empirically what method of financing depends essentially on the legal, institutional and operational details of the creation of the monetary base on the one hand and the degrees of operational independence of the central bank. Samely, Aghevli (1977) had shown that, in developing countries, economic recovery and development programs can be financed by the inflation tax because of the inability of the tax system to effectively drain all direct debits. For the Algerian economy, the use of seigniorage income seems to be an important lever for the financing of budget deficits. Indeed, the widening of budget deficits coincides with the seigniorage peaks. We can explain it by the recourse of the government to this kind of financing "or to a very specific component of seigniorage" for each financial difficulty encountered.

Fig.2. Evolution of the budgetary balance and seigniorage income in Algeria from 1965 to 2018



Source: Authors. Using ONS and Bank of Algeria's data

We will proceed, in the following section, to an econometric study for more precision as for the component of seigniorage most correlated with the budgetary deficits.

4. The model

4.1 Estimation and methodology

The series used are annual going from 1980 to 2018 "39 observations". Some come from the Algerian National Office of Statistics as well as from the Bank of Algeria. However, they are all calculated and transformed into constant values base 1999.

This study used the ARDL model to test the relationship between the inflation tax, the change in the base money, the budget deficit and hydrocarbon exports as an indicator of external shock with the use of seigniorage. The cointegration test of the ARDL model provides two critical value bounds, one for I (0) and the second for I (1), where I (0) refers to integrated at level zero, and the I (1) refers to integrated at level one. The ARDL model can be used when the variables are integrated of order I (0) or I (1) or a mixture of both. it has advantages compared to traditional cointegration tests since it can be applied even with the problem of endogeneity of the independent variables. In addition, it explores short-term dynamics and long-term relationships. Finally, it is appropriate when the series have a relatively small number of observations.

The unrestricted error correction representation of ARDL general model, using our variable specification, is presented as follows:

$$\Delta s_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, s_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta def_{t-i} + \sum_{i=0}^{q} \alpha_{3i}\, \Delta sm_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta sinf_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta exh_{t-i} + \beta_1\, s_{t-1} + \beta_2\, def_{t-1}\beta_3\, sm_{t-1} + \beta_4\, sinf_{t-1} + \beta_5\, exh_{t-1} + \mu_t \quad (3.1)$$

Where:

S_t = Total seigniorage revenue in real terms base 1999 as a percentage of GDP. "Dependent variable"

(Data calculated from Bank of Algeria reports)

def_t = Domestic Budget Balance in real value base 1999 as a percentage of GDP. "The target independent variable"

(Data calculated from the Algerian National Office of Statistics)

$Sinf_t$ = Real inflation tax base 1999 as a percentage of GDP.

(Data calculated from Bank of Algeria reports)

Sm_t = Seigniorage income from the change in the base money in real terms base 1999 as a percentage of GDP.

(Calculated from World Bank data)

exh_t = hydrocarbon export in real terms base 1999.

*(Data calculated from the Algerian National Office of Statistics) "*Control variable"

NB: The GDP used in this model is taken as a real GDP base 1999, taken from The World Bank data and all the variables are divided on the World Bank GDP deflator base 1999.

The observations in the S_t, $Sinf_t$ and Sm_t series, represent, respectively, the series of residuals *Res_* S_t, *res_*$Sinf_t$ and *Res_* Sm_t calculated after removing the trend from the original series.

4.2 Results and Discussion

4.2.1 Unit root test

We use Augmented Dickey-Fuller Test (ADF) in order to examine the stationarity of all series in this research. As the result, the null hypothesis of existing unit root is accepted in some series « def_t, S_t and exh_t » and rejected in just tow series which are « $Sinf_t$ » and « Sm_t ».

The ADF test will be applied at first to the model three which encompasses the possibility of the existence of a trend and a constant. It turns out that apart from the S_t, $Sinf_t$ and Sm_t series which has a trend, the rest of the variables have neither.

Thus, with regard to the S_t, $Sinf_t$ and Sm_t series, the tests are carried out on the series of residues, after removing the trend. The results of the stationarity tests are summarized in table 3 below:

Table 3. Results of unit root test

			Model 3		*Model 2*		*Model 1*		
	Variables	*Lag*	*T-trend*	*tc*	*T-cons*	*tc*	*ADF*	*Tc*	
	s	*2*	*2,102*	*2.79*	*0.284*	*2.54*	*-5.795*	*-1.950*	*I(1)*
- Optimal ARDL	*def*	*2*	*-1,693*	*2.79*	*-1,530*	*2.54*	*-6,156*	*-1,950*	*I(1)*
(1.0.0.0.0)	*exh*	*2*	*1.428*	*2.79*	*1.321*	*2.54*	*-6.127*	*-1.950*	*I(1)*
- Optimal Lag VAR= 1	*sinf*	*2*	*2.660*	*2.79*	*-0.094*	*2.54*	*-3.317*	*-1.950*	*I(0)*
	sm	*1*	*2.047*	*2.79*	*0.163*	*2.54*	*-2.699*	*-1.949*	*I(0)**

Source: Authors. From ONS and Bank of Algeria's data, Eviews 10

The statistics calculated at 5% are superior to the statistics of Augmented Dickey-Fuller "T_{ADF}" for the series « Sm_t *and* $Sinf_t$ » in level stationary at level, and at fist difference for the rest of series. This attests to a stationarity in terms of all of these variables.

4.2.2 ARDL model output

Table 4. Estimates of Regression

dependent variable: S				
Regressor	*Coefficient*		*t-Statistic*	*Prob*
s(-1)	*0,0184*		*0.520449*	*0.6063*
def	*-0.0284*		*1.934584*	*0.0619*
sinf	*1.0791*		*21.50666*	*0.0000*
sm	*1.0309*		*29.93533*	*0.0000*
exh	*8.52E-05*		*1.821481*	*0.0779*
c	*-0.00069*		*-0.57133*	*0.5718*
R-Squared	*0.985097*	*F-stat*		*423.0338*
Adjusted R-Squared	*0.982768*		*Prob (F-statistic)*	*0,000000*

Source: Authors. Based on the estimation results on Eviews10.

The estimation results in Table 4 show that the statistics associated with the coefficients of the variables *Sinf* and *Sm* are greater than the critical value of the Student table (1.96) at the 5% threshold, with a probability of 0.0000 <0.05. Moreover, their respective signs are positive, however, these two variables are statistically significant and positively correlated with total seigniorage *S*. the variables *def* and *exh* have significant probabilities at the threshold of 10% respectively 0.0619 and 0.0779 both less than 0.05. As for the correlation sign, the budgetary balance is negatively correlated with the use of seigniorage.

The AIC information criterion indicates the ARDL model (1.0.0.0.0)) as the most optimal among the 20 suggested models where the latter corresponds to the minimum value of the AIC criterion.

Also, the model has an adjusted R-squared of 98.50%, which means that 98.50% the variance in "*S"* can be jointly explained by *def*, *sinf*, *Sm* and *exh*.

4.2.3 Bounds test

The results of the ADRL bound test are shown in Table 5. The null of no cointegration may not be accepted at a 1% level of significance, as F-statistics (197.3497) lies outside the upper bound 4.37. Therefore, the long-run relationship is confirmed.

Table 5. Pesaran et al cointegration test results. (2001)

Test statistic	Value	Critical Value	significance	
			I(0)	I(1)
F-statistic	197.3497	10%	2,2	3,09
K	4	5%	2,56	3,49
		2,50%	2,88	3,87
		1%	3,29	4,37

Source: Authors. Based on the estimation results on Eviews10.

With table 5, we have verified the existence of a cointegration relation. Now we will check the different validation and stability tests of the model.

Table 6. Diagnostic tests for ARDL

Test statistics	tests	F- Version	P-value
Autocorrelation	Breusch-Godfrey	0,626371	0,5414 > 0,05

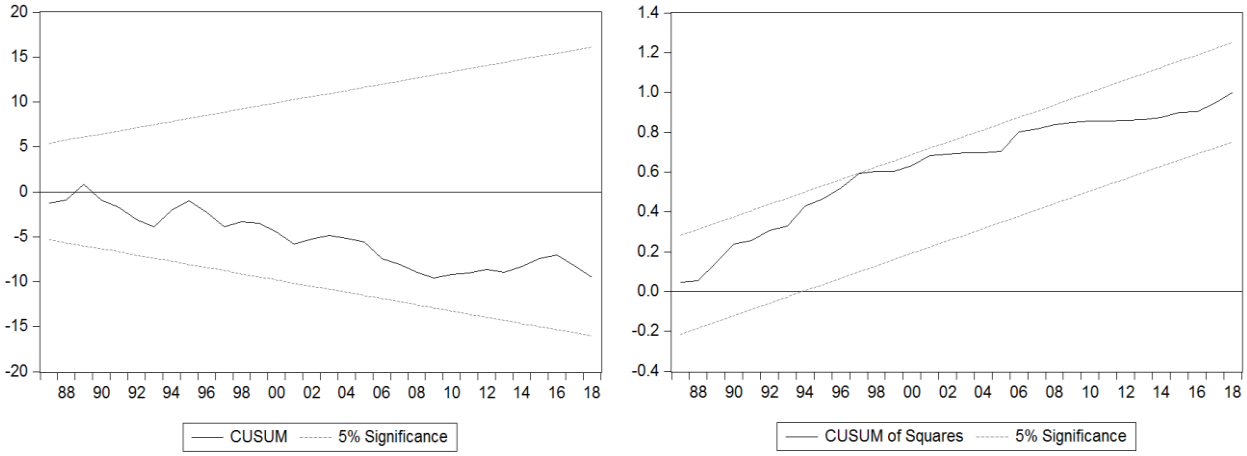
Hétéroskedasticity	Breusch-Pagan-Godfrey	2.022854	0.1041 > 0,05
Normality	Jarque-Bera	0.833932	0.6590 > 0,05
Specification « stability »	Ramsey(Fisher)	1.259522	0.2704 > 0,05

Source: Authors. Based on the estimation results on Eviews10.

Note that for all these tests, resumed in table 6, the null hypothesis is accepted. Statistically, our optimal ARDL model (1.0.0.0.0) estimated is generally good and the variables explain 98% of the dynamics of the use of seigniorage income in Algeria for the period from 1980 to 2018.

The results displayed in Table 6 indicate that the probability associated with each test is much higher than the 5% threshold, which leads us to accept the null hypothesis: absence of autocorrelation of errors and homoscedasticity including the respective probabilities are [Breusch-Godfrey (0.05414> 0.05)] and [Breusch-Pagan-Godfrey (0.1041> 0.05)]. The hypothesis of the non-normality of long-term residuals [Jarque-Bera (0.6590> 0.05)] and the critical probability associated with the Ramsey specification test is equal to 0.2704 is greater than the critical threshold of 5%, which allows us to say that the model is well specified.

Fig.3. Stability test of recursive estimation on Cusum and Cusum of squares



Source: Authors. Based on the estimation results on Eviews10.

Figure 3 above, represents the CUSUM and CUSUM of Squares tests. It indicates that the curve of the sum of the residues remains between the critical lines at 5%, which means the stability of the coefficients of the model of the use of seigniorage income in Algeria during the period from 1970 to 2018 is stable.

4.2.4 Short term coefficients and long term dynamics

a. Model short-run coefficients

The estimates of the error correction model based on the associated short-run estimates are shown in table 7. There are no significant short-term variables because any of them, are statistically significant at five percent confidence level.

Table 7. ARDL Long-run Coefficients

Dependent variable: S			
Regressor	*coefficients*	*t-statistic*	*Prob.*
CointEq(-1)	*-0,981514*	*-37.00154*	*0,0000 < 0.05*

Source: Authors. Based on the estimation results on Eviews10.

The ECM coefficient of -0.981514, representing the short-run adjustments, suggests that there is low speed of convergence to the equilibrium level when the economy is shocked.
Thus, the results in table 7 show that recourse to seigniorage income, in the short term, is not affected by budget deficits, and the situation of hydrocarbon revenues which, through oil taxation, constitutes an important budgetary revenue. As for the short-term neutrality of the inflation tax, this could be explained by the long-term adjustment of inflation rates which is an important component in the calculation of this tax. Concerning the income derived from the change in the base money, these do not seem to affect the use of total seigniorage since neither the advances to the treasury nor the ex-nihilo issues were made significantly during the period of the study.

b. Long term relationship analysis

Table 8. Error Correction representation for the selected ARDL

Dependent variable: S			
Regressor	*coefficients*	*t-statistic*	*Prob.*
def	*-0.028945*	*1.964176*	*0.0582 < 0.10*
sinf	*1.099447*	*29.53896*	*0.0000 < 0.05*
sm	*1.050344*	*39.16432*	*0.0000 < 0.05*
exh	*8.68E-05*	*1.822323*	*0.0778 < 0.10*
c	*-0.000703*	*-0.570400*	*0.5724*

Source: Authors. Based on the estimation results on Eviews10.

According to the long-term analysis, based on table 8, the results show that all the explanatory variables are related to the use of seigniorage income "St".

- The budget deficit is negatively correlated with the use of seigniorage and plays an important role in determining the level of seigniorage applied in Algeria because this variable is statistically significant at 10% "Prob=0.0582< 0.10". This can be explained by the use of the components of seigniorage to either end up with an issue of a new currency or by the increase in the inflation tax which has the merit of taxing all sectors even in the informal sector. This is done by reducing the value of the public debt held by the banking sector and even that held by the private sector in the form of "ENCE" [2] bonds.
- The inflation tax is statistically significant at 5% "0.0000 < 0.05" and positively correlated with total seigniorage. This is explained by the fact that the inflation tax is an essential component of total seigniorage. Its increase is mainly due to the increase in inflation rates since the calculation of this tax is mainly carried out using inflation rates. This means that the government derives significant income from inflation and reduces the real value of its commitments, which reduces the real value of its deficits
- Same for Sm_t, this variable is statistically significant and positively correlated with total seigniorage. Thus we can deduce that the seigniorage resulting from the variation of the base money is a means used by the government to finance its deficits by monetary impression or advances to the treasury. It should be noted that between 1992 and 1995 the bank of Algeria had approved as advances of treasury advances in current account, respectively, the following sums: 58, 911, 1666.609, 154.259, 140.662, and 73.611 billion dinars in 1995.
  As for the nonconventional financing operated in 2017, the government had amended the 2003 law by law n ° 17-10 of October 24, 2017 supplementing ordinance n° 03-11, with the addition of article 45 bis which stipulates: "The Bank of Algeria proceeds upon the entry into force of this provision, to exceptional title and for a period of five (5) years, with the

[2] The ENCE was established by decree N ° 21 of March 28, 2016. Applied on April 17, 2016, made it possible to collect 557, 828 MDS of dinar the same year to start reimbursements from 2017.

purchase directly from the Treasury, of securities issued by it " (Zidelkhil and Mouhoubi, 2020).

According to the (Bank of Algeria, 2019), since mid-November 2017 and at the end of January 2019, an amount of 6,556.2 billion DA, has been mobilized by the Treasury, from the Bank of Algeria, under of the implementation of this funding

4.2.4 Causality test of Toda-Yamamoto (1995)

The choice of the Toda-Yamamoto test is not accidental. In fact it represents significant statistical advantages compared to that of granger. The latter only applies to stationary or stationary series, which makes preliminary stationary tests essential before verifying a possible causality between them. In addition, unit root tests are less effective when the sample size is small. Also, by proceeding with the transformation of the series by the first difference, for the sake of stationarization or cointegration, we obtain good statistical properties but we lose information on the level of the series, which information in level should not be deleted. Since it is enriching to explain the dynamics of the studied model

These two authors propose to estimate a level VAR to serve as a basis for the causality test, on the assumption of a potential probable cointegration between the series. The Granger causality test procedure proposed by Toda and Yamamoto (1995) therefore begins by finding the order of maximum integration of the series using stationarity tests and then determining the optimal lag or offset of the VAR in level using information criteria (AIC, SIC and HQ) and finally, estimate the optimal VAR. The results of the Akaike and Schwartz criteria are summarized in Table 9 below:

Table 9. Optimal VAR Lag

	P=1	*P=2*	*P=3*	*P=4*
Akaike AIC	*-7.834287*	*-7.787379*	*-7.673491*	*-7.672211*
Schwarz SC	*-7.573057*	*-7.303526*	*-6.962475*	*-6.729459*
Result	*VAR 1*			
R-squared	*0.982501*		*F-Statistic*	*348.1024*
Adj. R-squared	*0.979678*			

Source: Authors. Based on the estimation results on Eviews10.

The optimal VAR model is a VAR 1. Thus, we proceed from this output to the causality test of Toda-Yamamoto (1995).

Table 10. Causality test of Toda-Yamamoto (1995)

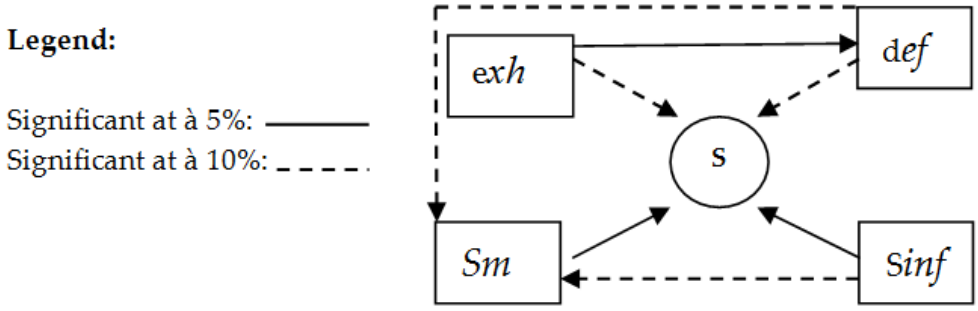
	causal variables				
Dependent variables	*s*	*def*	*exh*	*sinf*	*sm*
s	-	*0.0871*	*0.0680*	*0.0000*	*0.0000*
def	*0.1281*	-	*0.0275*	*0.1895*	*0.1230*
exh	*0.3497*	*0.3140*	-	*0.2881*	*0.0018*
sinf	*0.1306*	*0.6247*	*0.0991*	-	*0.7969*
sm	0.1478	0.0922	0.6238	0.0005	-

Source: Authors. Based on the estimation results on Eviews10.

According to Table 10, the results of Toda Yamamoto's causality test indicate one-way causal relationships ranging from the independent variables to the dependent variable *"S"*. The probabilities for the variables *def* and exh_t are less than 10% and those for "*Sinf"* and "*Sm"* are less than 5%. Thus, we deduce that the budget deficit, the hydrocarbons export, the inflation tax

as well as the variation of the base money would explain seigniorage revenues in Algeria during the period studied. These causality results corroborate the significance results in Table 8.
The directions of causation are summarized in Figure 4 below:

Fig.4. Simplified diagram of the results of Toda Yamamoto's causality test



Source: Authors. Based on test of Toda-Yamamoto results. Eviews 10

Conclusion

The purpose of this article is to calculate the seigniorage income of the Algerian economy, from 1980 to 2018 on the one hand and to verify empirically whether the Algerian government uses the seigniorage income in a situation of budget deficit even if these are met by external financing, domestic bank loans and budgetary savings which have become “FRR” since 2000.

The composition of seigniorage in Algeria reveals that the main component between 1965 and 1979 was purely "monetary seigniorage, resulting from the variation of the money base ". However, since 1980 the inflationary tax has become the main source. This can be explained by the large proportion of inflation rates between 1980 and 2018. Indeed, as these rates enter into the calculation of seigniorage income and that the latter are important in the period before structural adjustment program (1994- 1998) and the stabilization period between 1988 and 1993, the composition of the inflation tax in calculated income is the most dominant.

This inflationary tax is appropriate compared to other direct and indirect taxes since it taxes the formal sector in the same way as the informal sector known to be important in Algeria. However, if the deficit is also filled by the revenue regulation fund, the inflationary tax essentially contributes to the reduction of the real value of the government's commitments towards the banking sector in particular. That said, the inflation tax does play an opportunity-winning role relative to the subtracted value of repayments that should be due.

As for seigniorage resulting from economic growth, the exogenous nature of nearly 50% of the added value constituting the GDP coming from the export of hydrocarbons is exogenous, which excludes internal economic operators from the overall economic dynamic and, by consequently, the demand for transactional currency of the latter. This is why, even statistically, the seigniorage resulting from economic growth is not significant for the case of Algeria and does not appear as a predominant variable in the used model.

The parameters analysis as well as Toda-Yamamoto causality (1995) reveals that budget deficit is positively correlated with the use of seigniorage income. However, the downside of this result, and that if the inflation tax is the main component of seigniorage, and this is mainly due to the inflation rate, the latter could encourage the monetary authority "Central Bank" to increase its rates of interest which could generate significant crowding out effects of private investment. However, this situation could transfer financial difficulties from the state to private companies. Thus, the macroeconomic effects of such measure can be canceled out. As a research perspective, in our next paper, we want to discuss the macroeconomic effects of seigniorage, particularly in a small, almost closed economy, and one that is developing, with imperfect capital mobility, “fixed exchange rate” to neutralize the link between interest rates and

the change in the exchange rate. This will allow us to focus only on macroeconomic effects of seigniorage without external influences.

Bibliography List:

Works and Theses:

Bank of Algeria. (2006). Bulletin Statistique de La Banque d 'Algérie, series rétrospectives, statistiques monétaires 1964 – 2005 :

Bank of Canada. (2013). Le seigneuriage, document d'information

Labossiere, E. N. (2013). Crédibilité et efficacité de la politique monétaire emphase sur Haïti. Thèse de Doctorat en sciences économique, Université des Antilles et de La Guyane, pp 1–240 ;

Trésory, G. D. (2011). Chapitre - Xii - Finances Publiques Chapter - Xii - Public Finances. Finances Publiques, Rétrospective Statistique 1962-2011.

Yesim, Z. (2008). Crédibilité et efficacité de la politique de ciblage d'inflation en Turquie sur la période 2002-2006 Zehra Yesim Gürbüz Besek To cite this version: Thèse de doctorat en sciences économiques, Université Rennes 2 Ecole Doctorale – Humanités et Sciences de l'Homme LESSOR, HAL Id: Tel-00298438, 1–223. Retrieved from https://tel.archives-ouvertes.fr/tel-00298438.

Articles:

Agénor, P.-R., & Hoffmaister, A. W. (1997). Money, Wages and Inflation in middle-Income Developing Countries (No. WP/97/174);

Aghevli, B. B. (1977). Inflationary Finance and Growth. Journal of Political Economy, 85(6), 1295–1307. https://doi.org/10.1086/260638;

Berthomieu, C., & Karimi Taranlou, Z. (2009). La mesure du seigneuriage comme mode de financement du déficit budgétaire dans quatre Pays de la Région MENA (l'Iran, la Turquie, le Maroc et la Tunisie). Economie Appliquée, LXII(1), pp 169–190;

Buiter, W. H. (1997). Aspects of Fiscal Performance in some Transition Economies Under Fund-Supported Programs;

Burnside, C. (2004). Assessing New Approaches to Fiscal Sustainability Analysis. World Bank, Mimeo, (September), pp 1–53;

Cagan. (1956). The Monetary dynamics of hyperin. Fried- Man, M. (Ed.), Studies in the Quantity Theory of Money. University of Chicago Press, Chicago, 25–43;

Cooley, T., & Hansen, G. (1998). The Inflation Tax in a Real Business Cycle Model. Real Business Cycles, 79(4), 200–215. https://doi.org/10.4324/9780203070710.ch11;

Cukrowski, J. (2001). Financing Budget Deficit by Central Bank Seigniorage in Selected Transitional Economies: A Comparative Study (37);

De Haan, J., & Zelhorst, D. (1990). The impact of government deficits on money growth in developing countries. Journal of International Money and Finance, 9(4), 455–469. https://doi.org/10.1016/0261-5606(90)90022-R;

Dogru, B. (2013). Seigniorage Revenue and Inflation Tax: Testing Optimal Seigniorage Theory for Turkish Economy. International Journal of Economics and Finance, 5(6). https://doi.org/10.5539/ijef.v5n6p122;

Ercolani, M. G. (2000). Inflation Tax and the Hidden Economy .

Fischer, S., & Easterly, W. (1990). The economic of the government budget consraint. The World Bunk Research Observer, 5(2 July), 127–142. https://doi.org/10.1177/109114217800600309;

Gürbüz, B., Gürbüz, Z. Y., Miniaoui, H., & Smida, M. (2009). Seigniorage and Public Deficit : A Test of Comparison between Turkey and Tunisia. International Journal of Business and Management, Vol. 4,No9, 55–71;

Insah, B., & Ofori-boateng, K. (2013). A model of price determination and fiscal policy in

Ghana, 2(4), pp 2414–2428;
Kakar, V., & Daniels, G. E. (2018). Role of cash and costs of inflation for different income groups in the U.S. Economic Modelling, 80(November), 303–319. https://doi.org/10.1016/j.econmod.2018.11.016:
Klein, M., & Neumann, M. J. M. (1990). Seigniorage: What is it and who gets it? Archiv, 126(2), 205–221. https://doi.org/10.1007/BF02706356:
Leeper, E. M. (1991). Equilibria under ‘ active ’ and ‘ passive ’ monetary and fiscal policies, 27, 129–147:
Levent, K. (2006). Seigniorage Revenue and Turkish Economy. Munich Personal RePEc Archive Seigniorage “Mpra,";
Moreira, T. B. S., Souza, G. da S. e, & Almeida, C. L. (2007). The Fiscal Theory of the Price Level and the Interaction of Monetary and Fiscal Policies : The Brazilian Case *. Brazilian Review of Econometrics, 27, n° 1(May), pp 85–106.
Zidelkhil, H., & Mouhoubi, A. (2020). Analyse du financement non conventionnel en Algérie, Al-riyada for Business Economics Journal/ Vol 06 – N° 01 / January 2020. Al-Riyada for Business Economics Journal, 06(01/ January), pp 348–363.
Zidelkhil, H., & Mouhoubi, A. (2020). Le financement des deficits budgétaires en Algérie, mécanismes et interactions inflationnistes. Revue d’Economie et de Statistique Appliquée/ Vol 17, spécial Issue : Alegria, economic prospect, June 2020. pp 204–218.