

DOI: <https://doi.org/10.57125/FEL.2025.03.25.07>

**How to cite:** Said, I., Boulariah, S., & Chibi, A. (2025). The Dynamic Relationship between Tax Reform and De Facto Fiscal Space in Algeria: A Fractional Cointegration Approach. *Futurity Economics&Law*, 5(1). 118-139. <https://doi.org/10.57125/FEL.2025.03.25.07>

## **The Dynamic Relationship between Tax Reform and De Facto Fiscal Space in Algeria: A Fractional Cointegration Approach**

**Imane Said\***

Doctor, Department of Economics, LEPESE laboratory, University Centre of Maghnia, Algeria,  
<https://orcid.org/0000-0002-2699-4176>

**Smail Boulariah**

Doctor, Department of Economics, PDEP laboratory, University Akli Mohand Oulhadj Bouira, Algeria,  
<https://orcid.org/0009-0004-9679-9108>

**Abderrahim Chibi**

Doctor, Department of Economics, LEPESE laboratory, University Centre of Maghnia, Algeria,  
<https://orcid.org/0000-0001-7565-4656>

**\*Corresponding Author:** [imanesaid955@gmail.com](mailto:imanesaid955@gmail.com).

**Received:** October 23, 2024 | **Accepted:** February 20, 2025 | **Available online:** March 7, 2025

**Abstract:** This study aims to analyse the dynamic interaction between the actual fiscal space and tax reform in Algeria during the period 1990–2022, using quarterly data and applying the partial integration vector autoregressive (FCVAR) model. Despite the growing interest in studying the fiscal space in rentier economies, the current literature on the relationship between tax reforms and the evolution of the de facto fiscal space in Algeria remains limited, leaving a knowledge gap that requires further research. The study aims to fill this gap by providing an in-depth quantitative analysis that employs the FCVAR methodology, which enables the capture of characteristics associated with long

memory and fractional integration, making it suitable for studying this complex relationship. The study also highlights the extent to which tax reforms impact the stability and sustainability of the fiscal space, given the fragility of the Algerian financial system and its historical reliance on oil revenues. The results reveal the existence of a long-term equilibrium relationship between the two variables, with a long memory ( $d^{\wedge}=1.357$ ) reflecting the persistence of the impact of fiscal and tax shocks, in addition to a slow adjustment mechanism ( $\alpha^{\wedge}=-0.014$ ) that demonstrates the weak ability of the economy to return to equilibrium after any deviation. The scientific contribution of this study is to present an applied model that combines a modern methodology (FCVAR) and addresses the problem of financing the financial sector in the context of a rentier economy experiencing fluctuations in oil revenues. The study also provides actionable results that contribute to guiding decision-makers in adopting tax reforms that diversify the tax base, improve tax compliance, and enhance coordination between fiscal and tax policies to ensure financial sustainability and greater flexibility in facing economic fluctuations.

**Keywords:** Defacto, Tax reform, Fiscal Space, Fractional Cointegration, FCVAR model, Algeria.

## Introduction

Many countries rely on the tax system as a fundamental tool for achieving stability and ensuring financial stability, particularly in light of the evolution of economic systems and the growing financial challenges facing governments. According to the definition of taxes are considered "the new frontier for those interested in state building in developing countries", as they emphasise that taxes play a fundamental role in the life and development of the state, and their function is not limited to financing government goals only (Brautigam et al., 2008). About 260 years ago, the great philosopher and economist Adam Smith noted this. They confirmed that the state does not require many factors to achieve the highest levels of wealth. Still, instead, it only needs peace, easy taxation, and an acceptable administration of justice. This reasoning indicates the importance of taxes in building a prosperous society (Besley & Torsten, 2011; Christine, 2016), as they are considered more sustainable and predictable. Accordingly, mobilising tax revenues is an essential aspect of economic policy-making in many countries. In particular, in developing countries, improving tax revenue collection is critical for governments to create fiscal space to support public investment and the delivery of public services (Gaspar et al., 2016a, pp. 8-9; Gaspar et al., 2016b; Heller, 2006; Ley, 2009). Recently, there has been an expanded and renewed focus by government agencies and multilateral institutions on enhancing tax capacity, driven by the recognition that tax capacity is a cornerstone of state-building and development progress (Akitoby et al., 2020; Besley & Torsten, 2009; Gaspar et al., 2016a, p. 9; IMF, 2011).

Furthermore, domestic revenue mobilisation can be understood more broadly as the various mechanisms a government uses to finance its expenditures. The Diamond fiscal space framework suggests that countries can create fiscal space by mobilising domestic revenues through tax reforms (Bloch et al., 2019, p. 23). Fiscal space can also be expanded by generating additional income through the introduction of new taxes, expanding the existing tax base, taxing previously untapped sources of income, and enhancing tax administration to prevent tax evasion (Ter-Minassian et al., 2008). Given their importance in financing, governments should look for ways to strengthen tax collection systems by adopting a comprehensive approach to tax reform (Lora & Panizza, 2002, p. 23) that includes building citizen trust to ensure effective mobilisation of domestic resources to achieve the 2030 Agenda for Sustainable Development (Martínez-Vázquez et al., 2023).

Aizenman and Jinjark (2010) introduced an indicator called "effective fiscal space," which focuses specifically on the number of tax years required to repay public debt. Their definition of adequate fiscal space emphasises debt sustainability as a key measure of fiscal health.

Accordingly, practical fiscal space<sup>1</sup> is more broadly understood as the actual fiscal space available to a government, under current economic conditions, existing policies, and political constraints, to increase spending or reduce taxes without jeopardising its fiscal stability. This definition recognises that while debt sustainability is a critical component, other factors also significantly influence a government's true fiscal flexibility. In the context of Algeria, the results of the defacto fiscal space calculation shown below indicate that tax reforms in Algeria have contributed to improving the efficiency of the tax system and increasing tax revenues. Still, their impact on defacto fiscal space has remained limited due to the continued reliance on oil revenues as a significant source of financing the general budget. This situation highlights the pressing need for policymakers to address the challenge of ensuring the long-term sustainability of public debt as the economy recovers.

Considering the relationship between tax reforms and de facto fiscal space, Algeria is a case study. This country's economic model primarily relies on oil revenue to fill budget gaps. Algeria, therefore, becomes particularly vulnerable to global oil price shocks, which can lead to structural issues affecting the viability of its public finances. While Algeria has introduced various tax reforms since the 1990s, the role of tax revenue in supporting the public budget remains limited. This reflects the continued existence of structural imbalances within the tax system and its actual effectiveness. Moreover, as a rentier economy in the process of economic diversification, Algeria provides a valuable example for examining how tax reforms can play a crucial role in expanding fiscal space beyond oil revenues. Hence, choosing Algeria as a case study provides an opportunity to understand the dynamics of this relationship in a distinct economic context while drawing lessons applicable to other developing economies facing similar challenges.

Accordingly, this study aims to examine the dynamics between defacto fiscal space and tax reforms in Algeria to understand the nature of the interrelationship between them. The study will also provide recommendations aimed at enhancing practical fiscal space through more efficient and sustainable tax policies, thereby contributing to achieving financial stability and sustainable economic development in Algeria.

### ***Research Problem***

The research problem lies in the difficulty of maintaining public debt sustainability and adapting fiscal strategy to structural trends and challenges faced by the Algerian government. Traditional econometric methods are limited in their ability to examine the relationship between tax reform and fiscal space in sufficient detail, particularly when faced with durable fiscal variables and exogenous impacts. Thus, the study aims to fill this gap by utilising the FCVAR model, which will provide a more accurate and comprehensive understanding of the situation.

### ***Research Focus***

This study aims to analyse the dynamic link between defacto fiscal space and tax reforms in Algeria. The study aims to investigate the relationship between tax reforms and fiscal space in the medium to long term while considering the persistence of fiscal variables and their susceptibility to exogenous shocks, such as oil price volatility.

### ***Research Aim and Research Questions:***

The primary objective of this study is to investigate the relationship between tax reforms and fiscal space in Algeria, employing the Fractionally Cointegrated Vector Autoregressive (FCVAR) model to account for the fractional integration and cointegration properties of the data. The research is designed to address the following questions:

---

<sup>1</sup> De facto fiscal space, is also called in research effective fiscal space

1. What is the nature of the interrelationship between actual fiscal space and tax reforms in Algeria?
2. How do fiscal variables and tax reforms interact over the medium to long term, particularly in the context of external economic fluctuations?
3. What impact do tax reforms have on fiscal capacity, considering the persistence of fiscal shocks and the long-term dependencies of economic factors in Algeria?

## Literature Review

This research aims to review and analyse previous studies that have addressed the relationship between tax reforms and practical fiscal space, examining the theoretical and empirical frameworks employed in these studies to identify the most prominent findings they have reached. In this section of the paper, we aim to examine studies that have focused on fiscal space and tax reforms, as well as the impact of other variables on fiscal space. We will also review research that addresses the challenges of expanding fiscal space in promoting fiscal sustainability.

The concept of fiscal space, defined by Heller (2005a; 2005b) as the “room” in a government’s budget that allows it to save and allocate resources for desired purposes without compromising the sustainability of its fiscal position or the stability of the economy, has attracted the attention of economists, policymakers, and analysts in the field of macroeconomics and public finance.

In contrast to traditional fiscal approaches, Aizenman and Jinjark (2010) introduced an alternative measure of fiscal space called “effective fiscal space,” which is based on the ratio of public debt to the practical tax base. Cross-country comparative analyses revealed that adequate fiscal space before the global financial crisis was positively related to the extent of fiscal stimulus implementation during the period 2009–2010, even after controlling for other factors. Similarly, Aizenman et al. (2019) studied the dynamics of fiscal space by analysing the relationship between tax policy and government debt over the period 1960–2016. They found a strong association between fiscal policy cyclicality and declining fiscal capacity.

On the other hand, Park (2012) employed a traditional neoclassical model to explain fiscal space as the untapped potential for increasing government revenues resulting from population ageing. His study covered G7 countries, utilising the Laffer Curve to determine the optimal extent to which current tax rates generate revenue. The study identified Italy and Japan as the countries most vulnerable to population ageing, implying that there is uncollected revenue that can be considered untapped fiscal space.

To address this gap, Gnanon and Brun (2020) looked at the impact of tax reforms on fiscal space in a sample of 99 developing and least-developed countries from 1980 to 2015. Their findings revealed the most salient relationship in the least developed countries, where fiscal space is significantly enhanced by robust economic growth, good institutional quality, low inflation, and low economic dependency ratios. The study also found that trade openness has a more profound positive effect on tax reforms. Despite these findings, information on approaches to estimating fiscal space remains insufficient.

Additionally, Said and Chibi (2023) conducted a more longitudinal study on the consequences of tax changes on fiscal space in Algeria. They analysed the correlation between tax reforms and fiscal sustainability using VAR (Vector Autoregressive Analysis) and Fundamental Cointegration Analysis. The study concluded that tax reforms have a positive impact on the actual fiscal space during the first three years after their implementation. Still, this positive impact tends to decrease over time, making it necessary to rethink strategies for mobilising tax revenues to sustain the fiscal impact. The study also suggests that implementing tax reform in conjunction with structural changes is necessary to improve fiscal efficiency.

Regarding the institutional factors affecting the effectiveness of tax reforms, Ghazzi and Saghiri (2020) study examined the impact of corruption on tax revenue collection in middle-income countries. This study relied on an analysis of data from several countries over an extended period. The results showed that high levels of corruption lead to reduced tax collection efficiency, limiting governments' ability to increase revenue and achieve fiscal sustainability. The study recommended enhancing transparency and improving the efficiency of tax administration to reduce the impact of corruption on the tax system. These findings are consistent with the existing literature, which confirms that corruption undermines the effectiveness of tax reforms, particularly in countries with weak state institutions and high rates of tax evasion (Lunina et al., 2020).

Although many studies, such as Yohou (2023), have focused on the relationship between fiscal space and tax reforms, they have not given sufficient attention to the role of structural factors, such as corruption, which can be a determining factor in the effectiveness of tax reforms. Consequently, in countries with high levels of corruption, tax evasion can undermine the effectiveness of tax reforms that were intended to expand fiscal space. This is what Matselyukh (2020) highlighted in his study, emphasising the need to reevaluate tax policies to ensure their consistency with overall economic objectives.

According to the literature, tax reforms can significantly improve a state's tax collection capacity. However, their practical implementation faces numerous challenges, including opposition from groups that benefit from the existing tax system, widespread tax evasion, and fiscal constraints that may reduce their effectiveness. Some studies suggest that tax changes that overlook local economic patterns may lead to increased tax evasion or pressure on low-income groups, thereby limiting the actual gains in tax revenue (Felis et al., 2024). As a result of reduced government income, this significantly contributes to a shrinking fiscal space, underscoring the need for comprehensive structural reforms that consider the institutional and economic factors influencing the success of these reforms.

In this context, some studies have suggested that revenue-based fiscal consolidation approaches can be practical in specific contexts, even if their implementation is complex (Flanagan, 2006). Where tax reforms are effectively designed, governments can address urgent socioeconomic issues, increase fiscal resilience, and align domestic policies with international goals, such as the UN Sustainable Development Goals (Oppel et al., 2024; Roy et al., 2009). Furthermore, preserving long-term fiscal sustainability is essential because, if not handled carefully, the short-term benefits of tax cuts may lead to future fiscal instability (Lunina et al., 2020; Schick, 2009).

In this regard, Țibulcă (2021) moved the emphasis to environmental taxes as instruments for restoring budgetary room and enhancing the sustainability of the EU's debt. Employing dynamic panel data analysis, the study found that energy and transport taxes exhibit the most pronounced beneficial impacts on fiscal space, emphasising their strategic potential for attaining fiscal sustainability.

Thus, the effectiveness of tax reforms in creating adequate fiscal space depends on several factors, including the development of the tax system, the expansion of the tax base, and the improvement of tax collection mechanisms, mainly when corruption is effectively controlled (Yohou, 2023). The importance of this issue has been widely recognised in the literature, highlighting the need for effective tax systems to achieve broader development goals (Gaspar et al., 2016a; Heller, 2006; Ley, 2009).

Based on these studies, it can be argued that multiple factors, including tax reforms, fiscal policies, structural factors such as corruption, and external variables like economic shocks and fluctuations in oil prices, influence fiscal space. Therefore, analysing the relationship between these variables requires a comprehensive approach that takes into account the long-term dynamic effects of these factors on fiscal sustainability.

While the results of the fiscal space calculation shown below indicate that tax reforms in Algeria have contributed to improving the efficiency of the tax system and increasing tax revenues, their impact

on the adequate fiscal space has remained limited due to the continued reliance on oil revenues as a significant source of financing the general budget. This situation highlights the pressing need for policymakers to address the challenge of ensuring the long-term sustainability of public debt as the economy recovers. Accordingly, this study aims to examine the dynamics between adequate fiscal space and tax reforms in Algeria, to understand the nature of the interrelationship between them. The study will also provide recommendations aimed at enhancing adequate fiscal space through more efficient and sustainable tax policies, thereby contributing to achieving financial stability and sustainable economic development in Algeria.

It is essential to highlight the research gaps identified through the literature review, which justify the need for this study. The review revealed that most studies examined the relationship between tax reforms and fiscal space within the context of broad international samples, focusing on developing or least developed countries, without devoting sufficient attention to studying this relationship in Algeria in particular. These studies also relied on traditional models to analyse the relationship between tax reforms and fiscal space without taking into account the structural characteristics and financial specificity of the Algerian economy. Moreover, some studies have focused on measuring fiscal space or evaluating tax reforms separately. At the same time, research into the dynamic relationship between them has remained limited, particularly in models that account for the continuous and integrated nature of these variables. Accordingly, this study aims to fill this gap by analysing the relationship between tax reforms and the actual fiscal space in Algeria using the FCVAR model, which enables the examination of the long-run relationship between the two variables while accounting for the continuity of financial shocks and the structural characteristics of the Algerian economy.

## **Materials and Methods**

### ***Instruments and Procedures***

Aizenman and Jinjara (2010, pp. 2–4) considered the concept of “effective fiscal space” (de facto fiscal space) as a measurable indicator defined by the tax years required to repay the current public debt or to close the fiscal deficit. Accordingly, the “effective fiscal space” of a country is calculated as the ratio of the current public debt or fiscal deficit to the practical tax base as follows:

$$\text{De Facto Fiscal Space} = \text{Public Debt (\% GDP)} / \text{De Facto Tax Base (\% GDP)} \quad (1)$$

or

$$\text{De Facto Fiscal Space} = \text{Fiscal Deficit (\% GDP)} / \text{De Facto Tax Base (\% GDP)} \quad (2)$$

The de facto tax base, therefore, refers to the level of tax revenues collected, reflecting a state’s ability and willingness to finance its public expenditures and obligations through transfer payments. In other words, it indicates the availability of tax resources to support fiscal policy (Gnangnon & Brun, 2020, pp. 241–242). In practice, the de facto tax base is typically calculated as an average of tax revenues over a four- to five-year period, aiming to mitigate the impact of cyclical fluctuations in economic activity (Aizenman & Jinjara, 2010, 2011). To clarify more, the method of calculating it is as follows:

$$\text{De Facto Tax Base (GDP \%)}_t = \text{Average Tax Revenues (GDP \%)}_{t-4 \text{ to } t} \quad (3)$$

The “De Facto Fiscal Space” indicator for a given country in a given year is calculated as the ratio of total public debt (% of GDP) in year t to the average total public revenues (% of GDP) from year t-4 to year t.

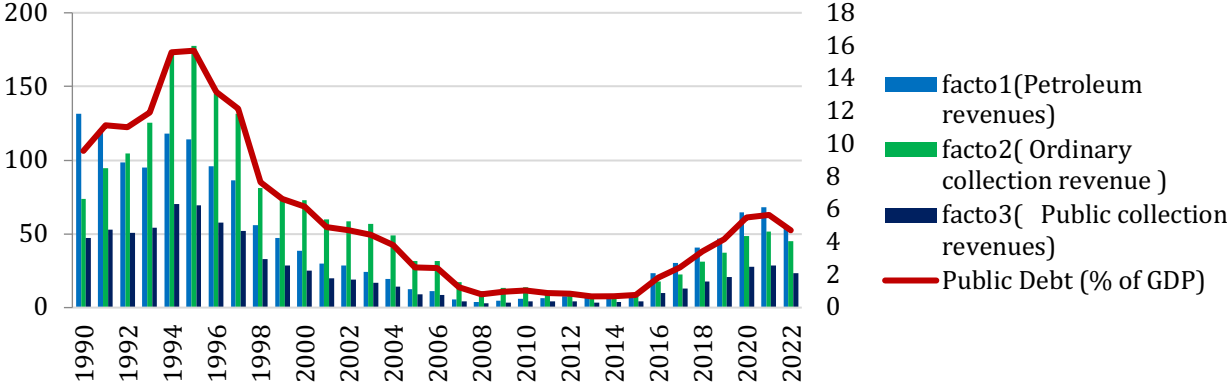
### ***Calculating the De Facto Fiscal Space in Algeria***

As previously discussed, the De Facto Fiscal Space (DFFS) index serves as an indicator of the number of years required, based on average tax revenues, to repay public debt in the current year. Low values on this index signify a broader fiscal space, reflecting the government’s ability to manage its debt obligations with relative ease (i.e., fewer years). On the other hand, high index values indicate a

narrower fiscal space, suggesting that it will take a more extended period to resolve the debt burden using average tax revenues (Gnangnon, 2019, pp. 7–8). The DFFS is a valuable tool for evaluating a country's fiscal health and its ability to efficiently service its public debt (see Figure 1, where the fiscal space for Algeria was calculated).

**Figure 1**

*The facto fiscal space in Algeria (1990–2022)*



Source: Calculations by the researchers, based on data available at the following links:  
[https://www.ons.dz/IMG/pdf/CH12\\_Finance\\_Public1962\\_2020Ar.pdf](https://www.ons.dz/IMG/pdf/CH12_Finance_Public1962_2020Ar.pdf)  
[http://www.majliselouma.dz/images/pdf/nossousse/Textes\\_nov22/rplf\\_2023\\_fr.pdf](http://www.majliselouma.dz/images/pdf/nossousse/Textes_nov22/rplf_2023_fr.pdf)

The examination of adequate fiscal space in Algeria, as depicted in Figure 1 reveals differing repayment durations contingent upon the origin of revenue and its mobilisation potential. It is observed that an increase in the effective fiscal space index corresponds to more extended repayment periods for public debt, whereas a lower index indicates shorter repayment periods. This finding aligns with the conclusions drawn by Aizenman and Jinjark (2010). The considerable disparity in repayment durations among these revenue origins underscores the crucial role of oil revenue collection in promptly meeting debt obligations. Simultaneously, it underscores the challenge posed by the limited efficacy of regular revenue collection in addressing substantial debt burdens within a reasonable timeframe.

**Theoretical Model**

This study is based on quarterly data covering the period from 1990 to 2022, including data on the actual fiscal space and tax reforms in Algeria, which were collected from official sources such as the Algerian Ministry of Finance and the Central Bank of Algeria, in addition to international databases such as the International Monetary Fund and the World Bank. This period was chosen for scientific and methodological considerations, as it represents a critical stage during which Algeria witnessed the implementation of broad tax and structural reforms following the economic transformations of the 1990s, which provides an appropriate time frame to study the dynamic relationship between tax reform and actual fiscal space. The sample comprises 132 quarterly observation points, and the study measures the actual fiscal space using a methodology that calculates the ratio of public debt to the practical tax base. In contrast, tax reform is measured by the rate of tax revenue collection as a percentage of GDP, taking into account the major tax reforms implemented by the financial system in Algeria during the period studied (Aizenman & Jinjark, 2010).

**The Fractional Cointegration VAR Model**

Fractional integration or differentiation is a technique in time series analysis that permits a fractional degree of differencing in the data. For a given time series,  $x_t, t = 1, 2, \dots$ , it is considered integrated of order  $d$ , represented as  $I(d)$ , if differencing it  $d$  times results in a covariance-stationary series of order 0, i.e.,  $I(0)$ . A process is  $I(0)$ , or second-order stationary, and is referred to as having

short memory if the total sum of its auto-covariances is finite. This definition arises from the time-domain perspective of the data.

This model accommodates fractional integration with non-integer orders when a time series is not integrated at the zero-order (Gil-Alana & Carcel, 2020). It enables researchers to identify instances where transience is a plausible explanation rather than assuming that shocks are permanent and take a prolonged period to dissipate. Consequently, we will employ the fractional integration framework to analyse tax reform and de facto fiscal space in Algeria.

The study employs the recently developed Fractional Cointegration Vector Auto-regression (FCVAR) model introduced by Johansen and Nielsen (2012). This approach integrates fractional integration, which enables the simultaneous estimation of the differencing parameter  $d$  for both Tax reform and de facto fiscal space in Algeria. By confirming that these variables exhibit fractional integration, the next step involves assessing the evidence of fractional cointegration between them. In simpler terms, the goal is to determine if there is a typical long-term fractional relationship between Tax reform and De facto fiscal space in Algeria. Unlike traditional cointegration methods where the differencing parameter  $d$  is an integer, fractional cointegration techniques accommodate continuous differencing, enabling more flexible modelling of the integration properties of economic time series (Engle & Granger, 1987; Robinson, 2008).

In this model, the random variable  $\varepsilon_t$  is assumed to be independent across dimensions  $p$  and follows a symmetric distribution (i.i.d.), with a mean of zero and a variance-covariance matrix  $\Omega$ . As for the parameters, they have the standard interpretations familiar from the CVAR model. Specifically,  $\alpha$  and  $\beta$  are matrices of dimensions  $p \times r$ , where  $r \leq p$ . The columns of the matrix  $\beta$  indicate the cointegrating relationships, which reflect the long-run equilibria in the system. In contrast, the parameters  $\Gamma_i$  are concerned with describing the short-run dynamics, as they express the speed of adjustment coefficients that measure the response of the variables to deviations from the long-run equilibrium. Thus, the FCVAR model provides a flexible framework that allows for an integrated analysis of both long-run equilibria, the mechanisms of correction towards these equilibria, and the short-run interactions between variables in the system (Gil-Alana & Awe, 2017; Gil-Alana & Carcel, 2020).

Assuming that the individual time series are non-stationary and belong to class  $I(1)$ , the possible values of the fractional parameter  $b$  lie in the range  $(0, 0.5)$ . In this case, the equilibrium errors are integrated to a degree higher than 0.5, indicating that they converge towards the mean, albeit with a non-stationary pattern. Conversely, when  $b$  belongs to the range  $(0.5, 1)$ , the equilibrium errors become integrated to a degree lower than 0.5, reflecting a stationary behaviour. Finally, in the special case where  $d = b = 1$ , the FCVAR model reduces to the classical CVAR model (Malmierca-Ordoqui et al., 2024).

To derive implications for De facto fiscal space in Algeria from the fractional cointegration between Tax reform and De facto fiscal space, which will be interesting to Political authorities in Algeria, the vector of endogenous variables was normalised on the unemployment rate in this study, such that we have:

$$\text{De facto fiscal space}_t = \alpha + \beta \text{Tax reform}_{t-k} + x_t, (1 - L)^d x_t = u_t, t = 1, 2, \dots \quad (4)$$

Where the parameter  $d$  indicates the degree of persistence,  $\beta$  is now an indicator of the effect of the Tax Reform on De facto fiscal space in Algeria—the differencing parameter,  $d$ , in the cointegrating equation, eq. (1) relies on equality between the fractional integration of de facto fiscal space and Tax reform ( $d_{\text{De facto fiscal space}} = d_{\text{Tax reform}}$ ).

The fractional cointegration between Tax reform and De facto fiscal space in Algeria describes how Tax reform can affect the De facto fiscal space of Algeria in four cases depending on the values of the cointegration difference coefficient  $d$ :

**Table 1**

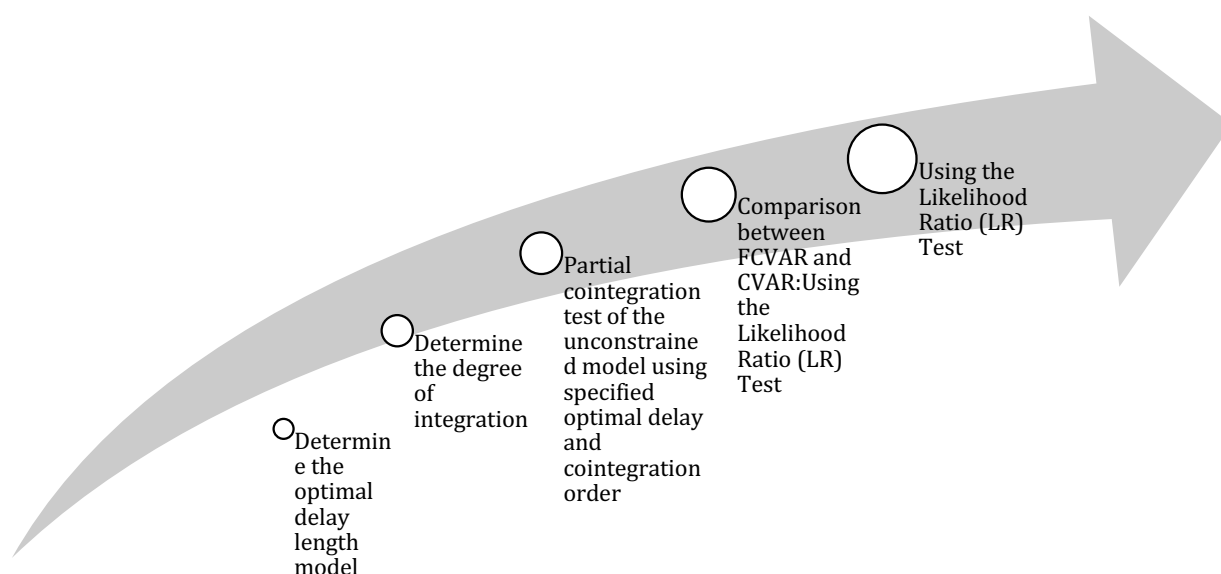
*Classification of the Impact of Tax Reform on the Actual Fiscal Space According to the Degree of Cointegration (d)<sup>2</sup>*

Condition	d range	Properties of cointegration	Impact memory	Continuity of influence	The nature of the impact on the factio fiscal space
The first case	$d = 0$	Fixed, short-term memory	Very short	Not continuous	The effect is immediate and lasts only briefly.
The second case	$0 < d < 0.5$	Fixed, limited long-term memory Short	Short	Limited persistence	The effect lasts only briefly and then dissipates.
The third case	$0.5 < d < 1$	Persistent, highly long-lasting memory	Long-lasting	Highly persistent	The effect lasts a long time before gradually fading.
The fourth case	$d \geq 1$	Unstable	Permanent	Sustainable	The impact results in a permanent change to the actual fiscal space.

The capacity of the Fractional Co-Integration Vector Autoregressive (FCVAR) model to account for long-memory effects in the fiscal data and represent the long-term link between the real fiscal space and the tax reform led to its selection. In contrast to conventional models like VAR, VECM, or ARDL, FCVAR is better suited for researching economic shocks that have long-lasting impacts but do not result in unstable processes because it can handle situations where the two variables are partially integrated ( $0 < d < 1$ ) as opposed to assuming full integration or no integration. Furthermore, this model facilitates an understanding of the mechanism by which slow variable adjustment occurs following aftershocks, which in turn aids in evaluating the effectiveness of tax policies in modifying fiscal space over time. Figure 2 shows the steps for estimating the FCVAR model.

**Figure 2**

*Steps to Estimate the FCVAR Model*



*Source:* Author's development.

<sup>2</sup> The R code for its calculation is available in Morin et al. (2021).

## Data Analysis

This study employs the Fractionally Cointegrated Vector Autoregressive (FCVAR) model to analyse the dynamic relationship between tax reforms and fiscal space in Algeria (see Table 2 and Figure 3). The FCVAR model is particularly suited for capturing fractional integration and cointegration properties, which are essential for understanding the long-term dependencies and persistence of fiscal variables.

**Table 2**

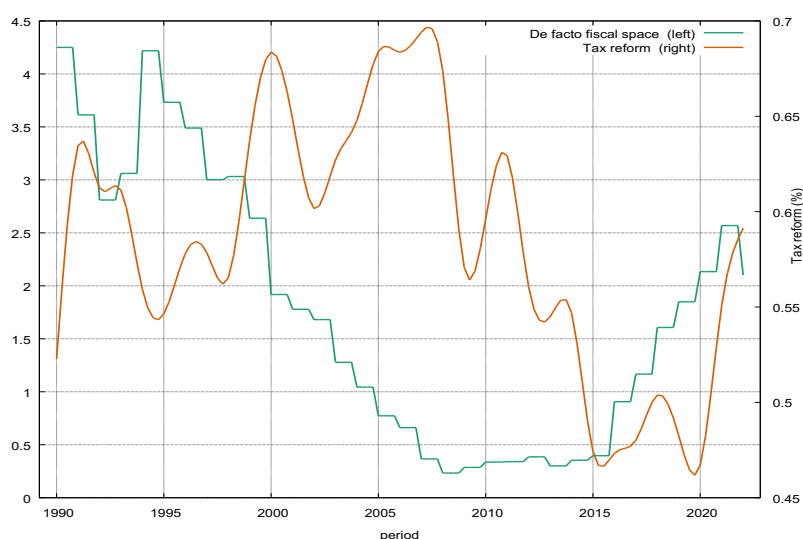
### Data Source

Variables	Descriptions	Measurement	Sources
<i>Independent variables</i>			
TAX REFORMS	The extent of tax reform indicator	The extent of tax reform index was calculated through: <b>1</b> <u>country's tax revenues as a percent of GDP</u> <b>0.268</b>	The data available at the <a href="http://www.ons.dz">www.ons.dz</a> <a href="http://www.dgpp-mf.gov.dz">www.dgpp-mf.gov.dz</a>
<i>Dependent variable</i>			
FSPACE	The facto fiscal space	The ratio of public debt in year t to the actual tax base over an average period of 4 years	The data available at the International Monetary

Source: Authors' development.

**Figure 3**

### Trends in De facto fiscal space and Tax reform for Algeria



Source: Authors' development.

Table 3 presents the descriptive statistics for de facto fiscal space and Tax reform in Algeria, spanning the period from 1990 to 2022.

**Table 3**

### Descriptive Statistics

Series	Obs	Mean	Max	Min	Median	Skew	S. Dev	Kurt	J-B	Prob
De facto fiscal space	129	1.76	4.25	0.23	1.68	0.42	1.28	-1.11	10.43	0.00
Tax reform	129	0.59	0.70	0.46	0.58	-0.15	0.07	-0.89	4.79	0.09

Source: Authors' development.

## Results

### Stationarity of Data

The first step in our analysis is to determine whether our various series contain a unit root. To this end, we propose applying the Dickey-Fuller, Phillips-Perron, and Kwiatkowski-Phillips-Schmidt-Shin tests (Breitung & Franses, 1998; Dickey & Fuller, 1981; Kagalwala, 2022). The results are presented in Table 4.

**Table 4**

*Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Test Results*

Variables	Test	Dickey-Fuller	Phillips-Perron	KPSS
De facto fiscal space	With Const	-1,955 (0,306) no	-1,944 (0,311) no	0,847 ***
	With Const & Tred	-0,649 (0,974) no	-0,643 (0,974) no	0,206 ***
	Without Const & Tred	-1,921 (0,052) *	-1,861 (0,059) *	=====
Tax reform	With Const	-1,777 (0,389) no	-2,011 (0,281) no	0,550 **
	With Const & Tred	-2,052 (0,566) no	-2,503 (0,326) no	0,239 ***
	Without Const & Tred	0,134 (0,723) no	0,042 (0,694) no	=====

*Note.* \*, \*\*, \*\*\*significant at the 10%, 5%, and 1% respectively; no – Not Significant; \*MacKinnon one-sided p-values.

*Source:* Computed by the authors.

By applying the Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests, the results presented in Table 4 indicate that the null hypothesis of a unit root cannot be rejected for both De facto fiscal space and Tax reform in Algeria. This conclusion is based on the fact that the t-statistics exceed the critical values at all conventional significance levels (1% and 5%). Additionally, the probability values confirm that the unit root hypothesis is not rejected in the PP and ADF tests. In contrast, the opposite holds for the KPSS test, which suggests stationarity under its null hypothesis.

Since standard unit root tests (ADF, PP, and KPSS) are known to be insensitive to fractional unit roots, there is a need for a more robust unit root test that can accurately determine the order of integration in the time series. Identifying fractional unit roots is crucial for enhancing modelling accuracy, improving forecasting reliability, and informing policy analysis. The presence of non-stationarity in the time series also justifies further investigation into cointegration relationships, allowing for a deeper understanding of the long-term dynamics between De facto fiscal space and Tax.

### Fractional Integrated Model Estimation

Table 4 presents the results of the fractional integration on the time series, using both the local Whittle estimator and log-periodogram (GPH) approaches. The results are computed for three periodogram points:  $m = T^{0.6}$ ,  $m = T^{0.7}$  and  $m = T^{0.8}$ . Fractional integration estimates are computed for values less than 1 or greater than 1 in all cases across the three period-gram points for both time series (de facto fiscal space and Tax reform).

**Table 5**

*Fractional Integration Estimates Based on the Local Whittle Estimator and GPH Test*

Variables	M	Local Whittle estimator	GPH test	p-val
De facto fiscal space	$T^{0.6}$	1.13302 (0.117851)	0.994093 (0.203753)	0.000 ***
	$T^{0.7}$	1.00712 (0.0912871)	0.894325 (0.129977)	0.000 ***
	$T^{0.8}$	0.933682 (0.0714286)	0.881976 (0.0975234)	0.000 ***

Tax reform	T <sup>0.6</sup>	1.02032 (0.117851)	1.09698 (0.12663)	0.000 ***
	T <sup>0.7</sup>	1.44008 (0.0912871)	1.37549 (0.0979915)	0.000 ***
	T <sup>0.8</sup>	1.44128 (0.0714286)	1.40832 (0.0592297)	0.000 ***

*Note.* The total sample size is 129, and the three period-gram points, T0.6, T0.7, and T0.8, are 18, 30, and 49, respectively. Asterisks (\*\*\*) indicate a 1% level of significance. Figures in square brackets represent the standard errors.

*Source:* Computed by the authors.

To summarise the univariate framework, it can be stated that the De facto fiscal space series exhibits a high degree of persistence, indicating that any shocks experienced will have lasting effects. This characteristic suggests that the trajectory of nearly all De facto fiscal space series is significantly influenced by exogenous factors that impact the variable in question. Consequently, any changes in the behaviour of the Tax reform time series could potentially have a substantial effect on the direction of the De facto fiscal space for Algeria. This observation provides a strong rationale for conducting a bivariate analysis that encompasses both variables. Furthermore, when considering the Tax reform time series, the analysis implies that the effects of shocks will also be prolonged in the context of Algeria. Therefore, it appears that the course taken by Tax reform is heavily reliant on economic fluctuations as well as other external factors that are beyond the control of the policymakers. This interdependence underscores the importance of understanding the relationship between these two series to grasp the broader economic implications for the country.

Moving now to the multivariate framework, a necessary condition for cointegration is that the individual series must display the same degree of integration. Table 5 summarises the results for the individual series using the local Whittle estimator and GPH test. We see in these tables that the orders of integration of the two variables are similar in all cases. We say they are similar in the sense that the confidence intervals for the differencing parameters overlap. So, the fact that the integration factor for the De facto fiscal space and the Tax reform in Algeria concerned with the study differs from zero and from the one, which indicates that the De facto fiscal space and the Tax reform in Algeria are fractionally integrated and this is what drives us to more tests to estimate the FCVAR model.

### Fractional Cointegration Model Estimation

Assuming that:  $d = b$ , which can be followed to ensure the stability of the short memory in the cointegration relationship, i.e. assuming that the equilibrium relationship is  $I(0)$  and there is cointegration, and through the results of Table 5, we note that the fractional cointegration coefficient  $d$  for the unconstrained model is estimated at 1.357 which is greater than 1, i.e. ( $d > 1$ ) and the adjustment speed coefficient is estimated at  $\hat{\alpha} = [-0.000, -0.014]$ , which indicates that the variance is not fixed, as Tax reform causes permanent de facto fiscal space to persist in Algeria.

**Table 6**

*Estimation of the Unrestricted FCVAR Model*

k	r	$\hat{d} = \hat{b}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\mu}$
3	1	1.357 (0.088)	$[-0.014]$ $[-0.000]$	$[1.000]$ $[37.575]$	$[4.598]$ $[0.504]$

*Note.* Figures in square brackets represent the standard errors.

*Source:* Computed by the authors.

This estimation demonstrates the suitability of the FCVAR model for capturing the dynamics between these variables, which analyses the relationship between De facto fiscal space and Tax reform in Algeria. The model employs three lags to capture the dynamics between the variables, ensuring sufficient flexibility to accommodate the persistence and fractional integration properties of the series, which are crucial for modelling long-term relationships. The cointegration rank indicates the presence

of one cointegrating relationship, confirming the existence of a stable, long-term equilibrium despite short-term fluctuations. The estimated fractional differencing parameter ( $d^{\wedge} = 1.357$ ) suggests strong persistence with slow mean reversion in the cointegrating relationship, reflecting the fractional nature of the variables, where shocks have long-lasting effects without complete decay in the short run. The low adjustment coefficient ( $\alpha^{\wedge} = -0.014$ ) indicates that deviations from the equilibrium relationship correct slowly, emphasising the need for careful planning and gradual policy adjustments. The cointegration vector estimates underscore the interdependence between Tax reform and De facto fiscal space, suggesting that changes in one variable have a significant and lasting impact on the other. The findings underscore the importance of sustained policy measures in addressing fiscal challenges and the necessity of long-term planning to maintain economic stability.

**Testing the Model Residuals for Serial Correlation**

The results of the white noise tests are presented below. For each residual, the Q-test and LM-test statistics, along with their respective p-values, are reported. Additionally, Table 6 includes the multivariate Q-test and its corresponding p-value. Based on the results shown in Table 7, there is no evidence of serial correlation in the residuals.

**Table 7**

*White Noise Test Results*

Variable	Multivar	De facto fiscal space	Tax reform
Q (P-val)	34.122 (0.935)	4.016 (0.983)	13.114 (0.361)
LM (P-val)	----	20.404 (0.060)	66.159 (0.000)

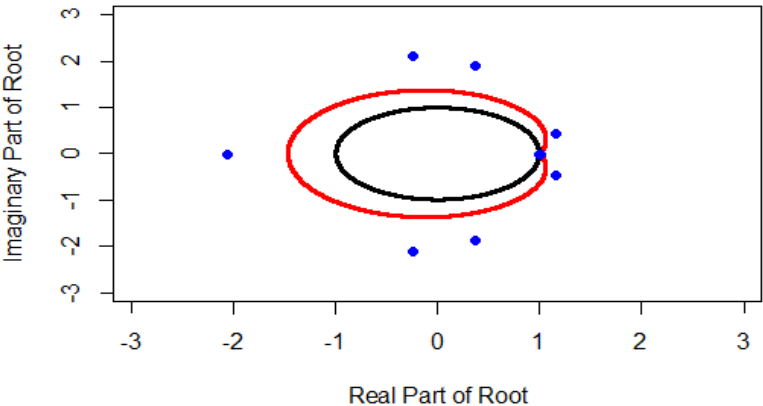
*Note.* The LM p-values in the last column are missing.

*Source:* Computed by the authors.

The roots of the characteristic polynomial are also plotted, along with the unit circle and the transformed unit circle, Cb (see Figure 4), to check the stability of the parameters.

**Figure 4**

*Roots of the Characteristic Polynomial (Parameter Stability Test)*



*Source:* Computed by the authors.

Figure 4 clearly shows that most characteristic polynomials lie within the unit circle, indicating the model's dynamic stability. The majority of roots within the unit circle indicate a robust system capable of maintaining stability over time, except for a few points where instability occurs. This stability of parameters reinforces the validity of the results and confirms that the FCVAR model is correctly specified.

### Comparison of the FCVAR and VAR Model Using the LR likelihood Ratio

Here, we test the CVAR model (null hypothesis:  $d = b = 1$  against the FCVAR model (alternative hypothesis:  $d = b \neq 1$ , which restricts  $b = d = 1$ , where we reject the null hypothesis if the probability ratio (LR) is statistically significant, where we prefer the FCVAR model, otherwise the opposite, we prefer the CVAR model.

**Table 8**

*LR Likelihood Ratio Test Results Between the CVAR and FCVAR Models*

Unrestricted log-likelihood	Restricted log-likelihood	LR statistic	P-value	Decision
632.857	630.290	5.134	0.023 **	FCVAR

Note. \*\* indicate the 5% level of significance.

Source: Computed by the authors.

Examining the test results shown in Table 8, which presents the log-likelihood values for models, degrees of freedom, the LR test statistic, and p-values, indicates the level of significance in Algeria, which is significant at traditional confidence levels (2.3%). Therefore, the test does not accept the null hypothesis that the preferred model is CVAR. Consequently, we reject the null hypothesis and accept the alternative hypothesis, indicating that the FCVAR model is the better choice in all cases.

### Hypothesis Testing and Estimation of the Restricted FCVAR Model

The following strategies are employed to test various hypotheses for this model, and the results are presented in Table 9.

**Table 9**

*Hypothesis Test Results*

Tests	$\mathcal{H}_\beta^1$	$\mathcal{H}_\alpha^1$	$\mathcal{H}_\alpha^2$
Unrestricted log-likelihood	632.857	632.857	632.857
Restricted log-likelihood	630.008	630.905	631.436
LR statistic	5.697	3.904	2.843
P-value	0.017**	0.048 *	* 0.092
Result	Accept the null hypothesis $\beta_2 \neq 0$	Accept the null hypothesis $\alpha_1 \neq 0$	Reject the null hypothesis $\alpha_2 \neq 0$

Note. \*, \*\* significant at the 10% and 5% respectively.

Source: Computed by the authors.

In testing the hypotheses in the first column of Table 9, the null hypothesis ( $\beta_1 \neq 0$ ) was rejected. This suggests a long-term relationship between De facto fiscal space and Tax reform in Algeria. Consequently, we conclude that both variables are in long-term equilibrium.

In testing the hypotheses in the first column of Table 9, the null hypothesis ( $\alpha_2 \neq 0$ ) was rejected. According to this, the de facto fiscal space in Algeria is internal in the long run, i.e., it is determined within the economic model being analysed over time.

As shown in Table 9 in the third column, the only hypothesis that we failed to reject is hypothesis  $\mathcal{H}_\alpha^2$ , i.e.  $\alpha_2 \neq 0$ , according to which the De facto fiscal space in Algeria is exogenous in the long run, i.e. it is determined in the long run outside the economic model being analysed, as the De facto fiscal space is affected by other factors.

After estimating all the constrained models of interest, we present the full estimation output of the model, imposing the constraint on  $\mathcal{H}\alpha_2$  and noting that  $\alpha_2 = 0$ , as required by the constraint.

**Table 10***Estimation of the Restricted FCVAR Model*

<b>k</b>	<b>R</b>	<b><math>\hat{d} = \hat{b}</math></b>	<b><math>\hat{\alpha}</math></b>	<b><math>\hat{\beta}</math></b>	<b><math>\hat{\mu}</math></b>
4	1	1.303 (0.105)	$\begin{bmatrix} -0.019 \\ 0.000 \end{bmatrix}$	$\begin{bmatrix} 1.000 \\ 33.4187 \end{bmatrix}$	$\begin{bmatrix} 4.591 \\ 0.504 \end{bmatrix}$
FCVAR	$\Delta^{1.303} \left( \begin{bmatrix} \text{De facto fiscal space} \\ \text{Tax reform} \end{bmatrix} - \begin{bmatrix} 4.591 \\ 0.504 \end{bmatrix} \right) = \hat{\alpha} \hat{\beta}' L_{1.303} \left( \begin{bmatrix} \text{De facto fiscal space} \\ \text{Tax reform} \end{bmatrix} - \begin{bmatrix} 4.591 \\ 0.504 \end{bmatrix} \right) + \sum_{i=1}^k \hat{\Gamma}_i \Delta^{1.303} L_{1.303} \left( \begin{bmatrix} \text{De facto fiscal space} \\ \text{Tax reform} \end{bmatrix} - \begin{bmatrix} 4.591 \\ 0.504 \end{bmatrix} \right) + \varepsilon_t,$				

*Note.* Figures in square brackets represent the standard errors—Source: Computed by the authors.

*Source:* Computed by the authors.

The ability to model a VECM structure within a fractional framework, as opposed to the traditional I(0)/I(1) context, highlights the significance of considering the long-memory aspect of time series, such as Algeria's de facto fiscal space and tax reform. Acknowledging this phenomenon will help policymakers make informed decisions about cointegration and forecasting using the recently introduced FCVAR model.

The equilibrium relationship is estimated as follows:

$$\text{De facto fiscal space}_t = 0.629 - 0.983 \text{Tax reform}_{t+k} + x_t,$$

$$(1 - L)^{1.303} x_t = u_t, t = 1, 2, \dots,$$

In Table 10, we estimate the restricted FCVAR model where  $\alpha_2 = 0$ , and we note that the fractional cointegration order  $\hat{b}$  is more significant than 1/2, indicating that the integrated process of the de facto fiscal space and the Tax reform is stationary.

The estimation of the restricted Fractional Cointegration Vector Autoregressive (FCVAR) model in Table 9 offers key insights into the long-term dynamics between De facto fiscal space and Tax reform in Algeria, characterised by persistent slow adjustment and significant interdependence. The fractional differencing parameter ( $\hat{d} = 1.303$ ) indicates prolonged but mean-reverting effects of shocks, while the adjustment coefficient ( $\hat{\alpha} = -0.019$ ) reveals a gradual pace of correction towards equilibrium, emphasising the persistence of deviations. Furthermore, the cointegration vector ( $\hat{\beta} = 1.000$ ) and its coefficient (33.4187) confirm a strong long-term relationship, illustrating the substantial influence of tax reforms on fiscal capacity trajectories. The deterministic term ( $\hat{\mu} = 4.591$ ) further highlights the underlying trends shaping the relationship, reflecting a steady baseline shift over time. These findings underscore the critical need for policymakers to implement comprehensive tax reform strategies, such as modernising tax administration, broadening the tax base, and adopting adaptive fiscal frameworks. Such measures are crucial for enhancing fiscal resilience, improving revenue efficiency, and promoting sustainable economic growth in Algeria, particularly given the prolonged impact of fiscal shocks.

### **Wavelet Analysis**

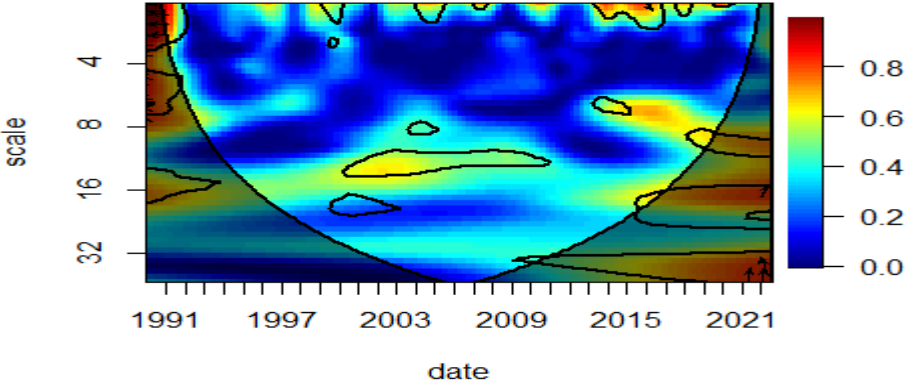
Wavelet methodology analyses time series in the time-frequency domain. This paper employs two tools—wavelet coherence and wavelet phase difference—following the work of Aguiar-Conraria and Soares (2011, 2014), Jammazi et al. (2017), Tiwari et al. (2016), and Vacha and Barunik (2012), who have applied the continuous wavelet transform (CWT) in finance and economics research. To measure synchronism between time series, we use the Morlet wavelet, a complex sinusoidal wave within a Gaussian envelope (Aguiar-Conraria & Soares, 2014).

Figure 5 represents the coherence of the waves that represent the mutual relationships between the De facto fiscal space in Algeria regarding Tax reform when it is more substantial or not, and at what frequencies these points occur, where the frequencies appear on the vertical axis from scale 1 (one quartile) to scale 32 (about 08 years). In contrast, time is plotted on the horizontal axis, ranging from

the beginning to the end of the sample period. The colours represent the levels of correlation between the De facto fiscal space and tax reform, with blue colours indicating low correlation and red colours indicating high correlation.

**Figure 5**

*Wavelet Coherency between De Facto Fiscal Space and Tax Reform in Algeria*



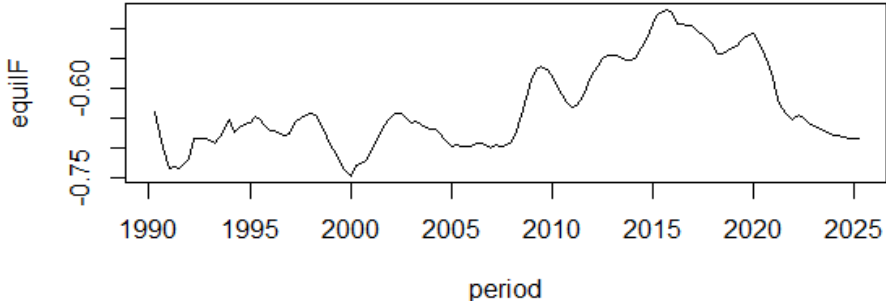
Source: Computed by the authors.

Figure 5 presents the wavelet coherency analysis between De facto fiscal space and Tax reform in Algeria, spanning the period from 1991 to 2021. The horizontal axis represents time, while the vertical axis corresponds to scale (frequency), with the colour spectrum indicating the strength of coherence between the two variables—ranging from blue (low coherence) to red (high coherence). Significant areas of high coherence, observed mainly in the early 2000s and post-2015, reflect periods where de facto fiscal space and tax reform exhibited assertive and synchronised behaviour across specific frequency bands. These areas suggest that tax reforms had a significant impact on fiscal space during these times, likely due to policy interventions or external economic conditions. In contrast, blue regions indicate weaker co-movement, highlighting periods where the relationship between the two variables was less pronounced or diverged.

Overall, the wavelet coherency analysis reveals a dynamic, time- and frequency-dependent relationship, emphasising the need for adaptive fiscal policies to align tax reforms with long-term fiscal stability in Algeria.

**Figure 6**

*Equilibrium Relation, Including Forecasts*



Source: Computed by the authors.

Figure 6 shows the changes in the equilibrium relationship over the study period, including future predictions, which can help in understanding the patterns and factors that affect this relationship. The equilibrium values (equilF) range from -0.75 to -0.45, as shown by the fluctuations in the graph over time, with a general trend of decrease. This trend is also evident in the predictive periods, indicating a relative change in the direction of the relationship.

In general, we can see from the chart that there is a pattern of equilibrium between the de facto fiscal space and tax reform in Algeria, as the rise in Tax reform is often attributed to de facto fiscal space or significant economic events that affect economic stability. It is worth noting that this pattern continues even during the forecast period, indicating that any significant changes in Tax reform are likely to affect the De facto fiscal space in Algeria in a similar way to previous events.

## **Discussion**

The results of the FCVAR cointegration analysis revealed a consistent link between tax reforms and fiscal space in Algeria, demonstrating the persistent impact of tax policies on fiscal sustainability. These results are consistent with the study by Said and Chibi (2023), which found that fiscal reforms had a positive impact on real fiscal space during the first three years of the study period. However, this effect begins to diminish towards the end of the year, reinforcing the need to review fiscal revenue mobilisation strategies to ensure their sustainability. However, all modifications to the model suggest a weak response of fiscal space to these reforms, underscoring the progressive nature of fiscal reforms and the limited immediate impact on fiscal sustainability.

Yet, the model's adjustment rate suggests that the fiscal space addressed by this reform is relatively stagnant, reflecting the gradual pace of tax reforms and the slow pace of change in fiscal sustainability. Structural tests revealed that external factors, such as oil price fluctuations and trade shocks, integrate with this relationship. This echoes the findings of Gnanon and Brune (2020), who found that fiscal space is conditioned by macroeconomic factors rather than tax policy alone, suggesting that the effectiveness of tax reforms in oil-dependent economies may be limited.

In addition, the challenges to tax reform focus not only on economic factors but also on the institutional context where the level of openness and corruption are essential determinants for the success of these reforms. In this context, Ghazzi and Saghiri (2020) demonstrated that corruption hurts the effectiveness of tax collection in middle-income countries, thereby highlighting the need for enhanced tax administrative efficiency, accompanied by political and economic reforms, to broaden the tax base.

Likewise, Yohou (2023) affirms that low-corruption countries sustain better fiscal results from tax reforms, demonstrating the necessity of good governance for the successful implementation of fiscal policies. These findings underscore the connection between fiscal space and tax reforms; however, other factors not included in the analysis, such as monetary policy or fluctuations in the exchange rate, that affect the feasibility of public finances may also influence this relationship.

On the other hand, the delay associated with tax reforms may be related to the shift in economic activity of specific institutions and individuals, which necessitates further investigation into how these subgroups behave as participants and how deeply their participation extends to investment and consumption activities. Nevertheless, this study has a limited scope. It is constrained by several methodological limitations, primarily due to the use of historical data that does not capture all the recent structural changes in the Algerian economy.

## ***Limitations of the Study***

While the study provides a comprehensive overview of the relationship between tax reform and practical fiscal space, it is subject to several methodological limitations. Notably, one of these limitations is its reliance on historical data, which may not accurately reflect recent structural shifts in the Algerian economy. Furthermore, while the FCVAR model is capable of analysing long-run dynamic relationships, it may not be able to capture all the complex economic interactions that occur in the short run. Accordingly, future research could be expanded by incorporating more complex economic models that take into account the impact of other institutional and financial factors on tax reforms.

## **Conclusions and Implications**

Using the FCVAR model, this study examines the relationship between tax reform and adequate fiscal space in Algeria from 1990 to 2022 every quarter. The findings suggest that tax reform and fiscal space are both interrelated in the long run. Results revealed that the interactions have a high level of persistence ( $d = 1.357$ ) and slow responsiveness to equilibrium-restoring forces ( $\alpha = -0.014$ ), which indicates that fiscal shocks will have a long-lasting impact on the country's fiscal position. Economics typically discusses the presence of long memory in the political economy of fiscal variables, in the sense that changes result from significant political or external economic shocks, which necessitate fiscal intervention to mitigate the adverse impacts of these shocks. Slow responsiveness to changes in the tax level emphasises the need for careful long-term planning and consistency in the execution of fiscal policies. The study further showed that tax reform extends beyond improving revenue collection to play a critical role in enhancing financial stability by reducing dependence on external oil revenues, which remain dominant in Algeria.

This study makes a new contribution to the literature by applying the Fractional Cointegration (FCVAR) model for the first time to study the relationship between tax reform and the actual fiscal space in Algeria, allowing for the analysis of the sustainable effects of fiscal and tax shocks. Unlike previous studies that focused on short-term effects or employed traditional models, such as ordinary cointegration, this approach reveals the continuity of the fiscal-tax relationship over time and the impact of external factors on fiscal space. The study also shows that the success of tax reforms depends largely on supportive policies, including diversifying revenue sources, improving the efficiency of public spending, and enhancing trade openness.

## ***Suggestions for Future Research***

This research aims to investigate the interdependent dynamics of tax reforms and fiscal space in Algeria, utilising the partial integral vector autoregression (PIVAR) model. This model permits the integration and long-term relations between tax and fiscal variables. This model estimates the simultaneous feedback relations between tax reforms and the actual capacity of the state to finance its expenditures, taking into account the persistence of fiscal shocks and relevant exogenous factors.

According to the findings, the study suggests that the tax system needs to be improved by broadening the tax base, reducing dependency on volatile revenue sources, and utilising innovative technological methods to enhance compliance and reduce tax evasion. The study also emphasises the importance of enhancing integration between tax and fiscal policies to ensure that collected resources are directed towards productive investments that support long-term economic growth rather than being spent on short-term current obligations.

In addition, the study emphasises the importance of establishing a mechanism for periodic evaluation of tax reforms to adjust their course in response to emerging economic developments, with a focus on enhancing transparency and improving tax governance by involving various economic actors in the design and implementation of tax policies. To ensure long-term financial sustainability, the study recommends diversifying tax revenue sources by introducing gradual environmental taxes in line with the requirements of sustainable development. Adopting an integrated and balanced reform approach would enhance Algeria's ability to achieve even better financial stability and increase its flexibility in the face of future economic fluctuations.

## **Acknowledgements**

None.

## **Conflict of Interest**

None.

## Funding

The authors received no funding for this research.

## References

- Aguiar-Conraria, L., & Soares, M. J. (2011). Oil and the Macroeconomy: Using Wavelets to Analyze Old Issues. *Empirical Economics*, 40(3), 645–655. <https://doi.org/10.1007/s00181-010-0371-x>
- Aguiar-Conraria, L., & Soares, M. J. (2014). The continuous wavelet transform: Moving beyond uni- and bivariate analysis. *Journal of Economic Surveys*, 28(2), 344–375. <https://doi.org/10.1111/joes.12012>
- Aizenman, J., & Jinjarak, Y. (2010). *De facto fiscal space and fiscal stimulus: Definition and assessment* [Working paper No. 16539]. National Bureau of Economic Research. <https://doi.org/10.3386/w16539>
- Aizenman, J., & Jinjarak, Y. (2012). The fiscal stimulus of 2009–2010: Trade openness, fiscal space and exchange rate adjustment. *NBER International Seminar on Macroeconomics*, 8(1), 301–342. <https://doi.org/10.1086/663626>
- Aizenman, J., Jinjarak, Y., Nguyen, H. T. K., & Park, D. (2019). Fiscal space and government-spending and tax-rate cyclicity patterns: A cross-country comparison, 1960–2016. *Journal of Macroeconomics*, 60, 229–252. <https://doi.org/10.1016/j.jmacro.2019.02.006>
- Akitoby, B., Baum, A., Hackney, C., Harrison, O., Primus, K., & Salins, V. (2020). Tax revenue mobilization episodes in developing countries. *Policy Design and Practice*, 3(1), 1–29. <https://doi.org/10.1080/25741292.2019.1685729>
- Besley, T., & Persson, T. (2009). The Origins of State Capacity: Property Rights, Taxation, and Politics. *American Economic Review*, 99(4), 1218–1244. <https://doi.org/10.1257/aer.99.4.1218>
- Besley, T., & Persson, T. (2011). *Pillars of prosperity: The political economics of development clusters*. Princeton University Press.
- Bloch, C., Bilo, C., Helmy, I., Osorio, R. G., & Soares, F. V. (2019). *Fiscal space for child-sensitive social protection in the MENA region* [Research report No. 36]. International Policy Centre for Inclusive Growth (IPC-IG). <https://www.econstor.eu/handle/10419/224105>
- Brautigam, D., Fjeldstad, O. H., & Moore, M. (Eds.). (2008). *Taxation and state-building in developing countries: Capacity and consent*. Cambridge University Press. <https://www.cmi.no/publications/file/2598-taxation-and-state-building-in-developing.pdf>
- Breitung, J., & Franses, P. H. (1998). On Phillips–Perron-type tests for seasonal unit roots. *Econometric Theory*, 14(2), 200–221. <https://doi.org/10.1017/S0266466698142032>
- Christine, L. (2016, February 22). *Revenue mobilization and international taxation: Key ingredients of 21st-century economies by IMF managing director Christine Lagarde*. International Monetary Fund. <https://www.imf.org/en/News/Articles/2015/09/28/04/53/sp022216>
- Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 49(4), 1057–1072. <https://doi.org/10.2307/1912517>
- Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica*, 55(2), 251–276. <https://doi.org/10.2307/1913236>
- Felis, P., Bernardelli, M., Jamrózy, M., Malinowska-Misiąg, E., Sarnowski, J., & Otczyk, G. (2024). Impact of tax reforms on the local government revenues in Central and Eastern European countries in the context of their effect on socioeconomic development in the region. In M. Strojny (Ed.), *Report of*

the SGH Warsaw School of Economics and the Economic Forum 2024 (pp. 73–102). SGH Publishing House. [https://doi.org/10.33119/978-83-8030-677-6\\_73-102](https://doi.org/10.33119/978-83-8030-677-6_73-102)

- Flanagan, M. (2006). Creating fiscal space: Medium-term directions for tax reform. In C. Purfield & J. A. Schiff (Eds.), *India Goes Global* (pp. 128–145). International Monetary Fund. <https://www.elibrary.imf.org/downloadpdf/book/9781589065680/9781589065680.pdf#page=137>
- Gaspar, V., Jaramillo, L., & Wingender, P. (2016a). Political institutions, state building, and tax capacity: Crossing the tipping point. *IMF Working Papers*, 16(233), 1. <https://doi.org/10.5089/9781475558142.001>
- Gaspar, V., Jaramillo, L., & Wingender, P. (2016b). Tax capacity and growth: Is there a tipping point?. *IMF Working Paper*, 16(234), 1. <https://www.imf.org/external/pubs/ft/wp/2016/wp16234.pdf>
- Ghazzi, I., & Saghiri, S. A. (2020). The impact of corruption on tax revenues in middle-income countries during the period (2000–2017). *Journal of North African Economics*, 16(3), 47–58. <https://asjp.cerist.dz/en/article/136429>
- Gil-Alana, L. A., & Awe, O. O. (2017). Time Series Analysis of Co-Movements in the Prices of Gold and Oil: A Fractional Cointegration Approach. *Resources Policy*, 53, 117–124. <https://doi.org/10.1016/j.resourpol.2017.06.006>
- Gil-Alana, L. A., & Carcel, H. (2020). A fractional cointegration var analysis of exchange rate dynamics. *The North American Journal of Economics and Finance*, 51, Article 100848. <https://doi.org/10.1016/j.najef.2018.09.006>
- Gnangnon, S. K. (2019). De Facto Fiscal Space in Donor Countries and Their Aid Supply: To What Extent Is Trade-Related Aid Supply Affected? *South Asian Journal of Macroeconomics and Public Finance*, 8(1), 1–25. <https://doi.org/10.1177/2277978719835615>
- Gnangnon, S. K., & Brun, J.-F. (2020). Tax reform and fiscal space in developing countries. *Eurasian Economic Review*, 10(2), 237–265. <https://doi.org/10.1007/s40822-019-00135-z>
- Heller, P. (2005a). Understanding fiscal space. *IMF Policy Discussion Paper*, 05(4), 1. <https://www.imf.org/external/pubs/ft/pdp/2005/pdp04.pdf>
- Heller, P. S. (2005b). Back to basics — Fiscal space: What it is and how to get it. *Finance and Development*, 42(2). <https://www.imf.org/external/pubs/ft/fandd/2005/06/basics.htm>
- Heller, P. S. (2006). The prospects of creating ‘fiscal space’ for the health sector. *Health Policy and Planning*, 21(2), 75–79. <https://doi.org/10.1093/heapol/czj013>
- IMF. (2011). United Republic of Tanzania: 2011 Article IV consultation and second review under the policy support instrument. *IMF Country Report*, (11/105). <https://www.imf.org/external/pubs/ft/scr/2011/cr11105.pdf>
- Jammazi, R., Ferrer, R., Jareño, F., & Shahzad, S. J. (2017). Time-varying causality between crude oil and stock markets: What can we learn from a multiscale perspective?. *International Review of Economics & Finance*, 49, 453–483. <https://doi.org/10.1016/j.iref.2017.03.007>
- Johansen, S., & Nielsen, M. Ø. (2012). Likelihood inference for a fractionally cointegrated vector autoregressive model. *Econometrica*, 80(6), 2667–2732. <https://doi.org/10.3982/ECTA9299>
- Kagalwala, A. (2022). kpsstest: A command that implements the Kwiatkowski, Phillips, Schmidt, and Shin test with sample-specific critical values and reports p-values. *The Stata Journal: Promoting Communications on Statistics and Stata*, 22(2), 269–292. <https://doi.org/10.1177/1536867X221106371>

- Martínez-Vázquez, J., Sanz-Arcega, E., & Tránchez Martín, J. M. (2023). Tax revenue management and reform in the digital era in developing and developed countries. In K. Dzigbede & W. B. Hildreth (Eds.), *Research Handbook on Public Financial Management* (pp. 202–225). Edward Elgar Publishing. <https://doi.org/10.4337/9781800379718.00023>
- Ley, E. (2009). *Fiscal policy for growth*. The World Bank. Retrieved from <https://documents1.worldbank.org/curated/en/543691468341073798/pdf/483760BRI0prem10Box338903B01PUBLIC1.pdf>
- Lora, E., & Panizza, U. (2002). *Structural Reforms in Latin America Under Scrutiny*. Inter-American Development Bank. <https://doi.org/10.18235/0012220>
- Lunina, I., Bilousova, O., & Frolova, N. (2020). Tax reforms for the development of fiscal space. *Baltic Journal of Economic Studies*, 6(3), 48–58. <https://cyberleninka.ru/article/n/tax-reforms-for-the-development-of-fiscal-space>
- Malmierca-Ordoqui, M., Gil-Alana, L. A., & Monge, M. (2024). Fractional cointegration between energy imports to the EURO area and exchange rates to the US dollar. *Empirical Economics*, 66(2), 859–882. <https://doi.org/10.1007/s00181-023-02468-w>
- Matselyukh, N. (2020). Tax reform as a way to transform the paradigm of the state's tax activity. *Economic Bulletin*, 4, 115–126. <https://doi.org/10.33244/2617-5932.4.2020.115-126>
- Morin, L., Nielsen, M. Ø., & Popiel, M. K. (2021). *FCVAR: An R package for the fractionally cointegrated vector autoregressive model*. Institut for Økonomi, Aarhus Universitet. <https://drive.google.com/file/d/1i0IYxYsPAJGj9IQjvtvgIqxbIKu2-IP1/view>
- Oppel, A., McNabb, K., Gupta, S., Brown, H., Plant, M., & Camps Adroque, B. (2024). *Confronting debt, climate change and poverty: Global financial architecture reform and the fiscal space of developing countries*. European Union. <https://www.cgdev.org/sites/default/files/confronting-debt-climate-change-and-poverty-global-financial-architecture-reform.pdf>
- Park, S. G. (2012). *Quantifying Impact of Aging Population on Fiscal Space*. International Monetary Fund. <https://doi.org/10.5089/9781475505122.001>
- Robinson, P. M. (2008). Multiple local whittle estimation in stationary systems. *The Annals of Statistics*, 36(5), 2508–2530. <https://doi.org/10.1214/07-AOS545>
- Roy, R., Heuty, A., & Letouzé, E. (2007). Fiscal space for what? Analytical issues from a human development perspective. In A. Heuty & R. Roy (Eds.), *Fiscal space: Policy options for financing human development* (pp. 53–88). Routledge. <https://doi.org/10.4324/9781849771344>
- Said, I., & Chibi, A. (2023). Tax reforms in order to develop the de facto fiscal space in Algeria—A standard study with the VAR model 1991–2020. *Aggregates of Knowledge Magazine*, 9(1), 225–246. Retrieved from <https://asjp.cerist.dz/en/article/218505?utm>
- Schick, A. (2009). Budgeting for fiscal space. *OECD Journal on Budgeting*, 9(2), 7–24. [https://www.oecd.org/content/dam/oecd/en/publications/reports/2009/12/oecd-journal-on-budgeting-volume-2009-issue-2\\_g1gh9b48/budget-v9-2-en.pdf](https://www.oecd.org/content/dam/oecd/en/publications/reports/2009/12/oecd-journal-on-budgeting-volume-2009-issue-2_g1gh9b48/budget-v9-2-en.pdf)
- Ter-Minassian, T., Hughes, R., & Hajdenberg, A. (2008). Creating sustainable fiscal space for infrastructure: The case of Tanzania. *IMF Working Paper*, (08/256). [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1316724](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1316724)
- Țibulcă, I.-L. (2021). Debt sustainability: Can EU member states use environmental taxes to regain fiscal space? *Sustainability*, 13(11), Article 5952. <https://doi.org/10.3390/su13115952>

- Tiwari, A. K., Mutascu, M. I., & Albuлесcu, C. T. (2016). Continuous wavelet transform and rolling correlation of European stock markets. *International Review of Economics & Finance*, *42*, 237–256. <https://doi.org/10.1016/j.iref.2015.12.002>
- Vacha, L., & Barunik, J. (2012). Co-movement of energy commodities revisited: Evidence from wavelet coherence analysis. *Energy Economics*, *34*(1), 241–247. <https://doi.org/10.1016/j.eneco.2011.10.007>
- Yohou, H. D. (2023). Corruption, tax reform and fiscal space in emerging and developing economies. *The World Economy*, *46*(4), 1082–1118. <https://doi.org/10.1111/twec.13385>