

The impact of macroeconomic factors on purchasing power in Algeria
Evidence from Bootstrap ARDL Approach

تأثير العوامل الاقتصادية الكلية على القدرة الشرائية في الجزائر: دلائل باستخدام تقنية البوستراب للانحدار الذاتي
للإبطاء الموزع

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Abstract: This paper examines the effect of some macroeconomics factors on purchasing power in Algeria from 1991 to 2022. The study uses the traditional autoregressive distributed lag (ARDL) bound test and the newly-developed bootstrap autoregressive distributed lag (ARDL) testing technique as proposed by (McNown et al., 2018). Findings show that a 1% increase in minimum business wage increases purchasing power by 0.422%. In addition, It was found that a 1% increase in the explanatory variables for maximum IRG exempt wage and exchange rate decreases purchasing power by 0.236% and 0.549%, respectively. The minimum business wage will nurture the purchasing power, but the maximum IRG exempt and exchange rate will affect negatively purchasing power in the long run. The study proposes a new econometric model to examine the impact of a set of factors on purchasing power. It further employs a novel approach by utilizing the newly developed BARDL testing technique.

Keywords: purchasing power; wage policy; inflation, exchange rate; Bootstrap ARDL(BARDL).

JEL Classification Codes : E31, J31, E31, F31, C32

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1. Introduction

Purchasing power influences all facets of economics, including the health of a nation's economy, trade, as well as the purchases made by investors and consumers. Nations with high purchasing power can achieve a high living standard since they have the ability of buying more goods and services; hence, an increased economic activity. The relationship between high purchasing power and economic activities as well as what effects purchasing power has been the subject of many studies (Ayaviri-Nina et al. 2022; Frömmel 2022; Mahaputra and Saputra 2022; Steininger and Pommeranz 2020). Purchasing power is the amount of goods and services that can be purchased using a monetary unit (National Institute of Statistics and Economic, 2016), one over a certain period of time. Since the incomes of individuals are different, the guaranteed national wage can be adopted as a criterion to study the purchasing power of income for individuals of a country. Algeria as an emerging country strives to maintain solid purchasing power through adapting tax policies and rising wages. According to the World Bank report, the purchasing power parity (PPP) of Algeria was 46.6 LCU per international dollars in 2022, which is an increase from 16.2 LCU per international dollars in 2003, growing at an average annual rate of 5.87%. Purchasing power is influenced by many factors, mainly inflation and exchange rate (Seshaiah and Tripathy 2018). Therefore, this paper aims to investigate the effect macroeconomics factors on purchasing power in Algeria during the period 1991-2022 using ARDL and BARDL models. Under this fundamental question fall the following sub-questions:

- What are the factors affecting purchasing power in Algeria?
- How has Algeria's wage policy evolved to keep pace with changing purchasing Power?
- How effective are the tax measures taken in Algeria to limit the deterioration of purchasing power?

To answer the main question and the sub-questions attached to it, we provide the following initial answers represented in the hypotheses of the study:

- The variables affecting the purchasing power wage policies, exchange rate, and consumer price,
- The Algerian state makes adjustments and changes in the wage network everytime a serious decline in the purchasing power of individuals is detected.
- Tax measures taken in Algeria with regard to wages and income have strengthened purchasing power and mitigated its decline.

The importance of this research paper spans the following:

- Investigating the issues of declining purchasing power of the Algerian individual, especially in times of crises,
- Assessing the challenges faced by the Algerian state in maintaining purchasing power,
- Highlighting the efforts and mechanisms used to raise the purchasing power through the wage and tax systems.

The rest of the paper is organized as follows: Literature review in section 2 followed by data and methodology in section 3. Section 4 presents results and discussion, and finally a conclusion in section 5.

2. Literature Review

This section provides a comprehensive framework for understanding the main factors that affect purchasing power highlighted in previous studies.

Siddharth et al. (2024) examined the relationship between the validity of Purchasing Power Parity (PPP) and the Reserve Bank of India's (RBI) interventions and across a fixed exchange rate regime (1975–1993) period and a managed floating regime (1994–2015) period. The study used an error correction model (VECM) for the empirical analysis. Results revealed that during the period of 1975–1993, the environment is conducive to PPP. However, from 1994 to 2015, selective interventions weaken the applicability of PPP. Vo and Vo (2023) explained how the purchasing power parity works and how it may be used practically using cross-country data spanning the 50 years since the Bretton Woods monetary system collapsed. They found that, in the long run, the forces of arbitrage and resource reallocation are strong enough to overcome many of these distortions, even in the face of protracted fluctuations in currency values and a plethora of trade obstacles. Hebisha (2023) highlighted the importance of comprehending the variations in price levels, the relative stability of exchange rates due to a long-run equilibrium relationship between exchange rates and prices, and the purchasing power of various currencies between different countries. Audi and Ali (2023) found that the standard of living in Asian cities is positively and significantly correlated with local purchasing power. Cakranegara et al. (2022) pointed out that pricing is positively correlated with customer purchasing interest, indicating a close relationship between price and purchasing power. Thus, meeting business goals and boosting profits are impacted by consumers' improved purchasing power at pricing established by the company. Kasem and Al-Gasaymeh (2022) investigated the accuracy of the Purchasing Power Parity between Jordan and the countries that make up its main economic partners. The findings of the cointegration tests demonstrated that, for the chosen countries, there is a cointegrating link between the exchange rate and the levels of local and foreign prices. Ardogan and Yilmaz (2021) examined the impact of minimum wages and stock market indices on purchasing power fourteen OECD countries from 2011 to 2020, while focusing on the effect of the 2008 financial crisis and the COVID-19 pandemic. The authors used minimum wages and stock market indices as proxies for disposable personal and asset prices, respectively. The study employed panel data regression analysis to examine the impact of expansionary monetary policy, as measured by changes in the M3 money supply and credits provided to the non-financial private sector, on equity prices. The study also explored the possibility of equity price booms resulting from expansionary monetary policy. The study reveals that individuals with lower income experienced a decrease in their asset purchasing power during this period. Mahendra and Parulian (2021) investigated the effect of exchange rate, economic growth, and minimum wage with the moderation impact of inflation in Indonesia from 2000-2019. The authors employed a multiple linear regression analysis to develop into the impact of the explanatory variables on unemployment. The study showed a significant impact of exchange rate, economic growth, and minimum wage on unemployment.

The literature highlights the effect of some variables on purchasing power such exchange rate and pricing, and wage and monetary policies. Therefore, This study evaluates the impact of these factors along consumer price index on purchasing power in the context of developing country, particularly, Algeria.

3. Data and Methodology

3.1. Data

The study utilised a quantitative method to examine the impact of wage policies, exchange rate, and consumer price index on purchasing power in Algeria from 1991 to 2022. The data was collected from different datasets including the World Bank Development Indicators (WDI) and the Algerian National Office of Statistics (ONS). The study applied econometrics approaches including ARDL bound test and Bootstrapping ARDL (BARDL) techniques to delve into the problematic using the following model:

$$PP = f(IRG, MBW, CPI, ER)$$

Where: PP represents purchasing power measured by guaranteed national wage; IRG holds for maximum IRG exempt wage; MBW represents the minimum base wage paid for public employment; CPI represents the consumer price index as a measure for inflation; and ER represents the exchange rate index. Table 1 represents variables used in the study.

Table 01. Variables description and sources

Variable	Acro.	Description	Source
Guaranteed national wage	PP	represents minimum total wage for individuals over a specified period.	ONS
Maximum IRG exempt wage	IRG	stands for the global income tax	ONS
Minimum Base Wage	MBW	Refers to the minimum remuneration an employer is legally required to pay wage earners for work performed during a specified period.	ONS
Consumer Price Index	CPI	reflects yearly changes in the cost to the average consumer of acquiring a basket of goods and services.	ONS
Exchange Rate	ER	Refers to the exchange rate set by national authorities or determined in a legally sanctioned exchange market.	WDI

Source: Authors' construction

All coefficients are expected to be negative except for MBW. The study incorporated the natural log of all variables to reduce the intensity of the results, and the model has built-in following empirical forms:

$$LPP_t = \beta_0 + \beta_1 LIRG_t + \beta_2 LMBW_t + \beta_3 LER_t + \beta_4 LCPI_t + \varepsilon_t$$

Where: $\beta_0 \dots 4$ represents the coefficients and ε_t denotes the residual.

3.2. Methodology

Series components analysis (Mann-Kendall test):

The Mann-Kendall test is employed to statistically evaluate whether there is a monotonic upward or downward trend in the study variable over time (Mann 1945). The hypotheses for the test are as follows:

H_0 : No monotonic trend

H_1 : Monotonic trend is present

Unit Root Tests:

Economic time series data often exhibit unit roots, necessitating the use of various unit root tests to identify these characteristics, thereby facilitating the selection of the most appropriate econometric estimation approach and ensuring robust results. The Augmented Dickey-Fuller (ADF) unit root test is a standard method that includes lagged values of the dependent variable alongside independent variables. The Phillips-Perron (PP) unit root test complements the ADF test by accounting for shifts in both mean and trend.

ARDL Bound Test:

Pesaran and Shin (1995) and Pesaran et al. (2001) introduced the Autoregressive Distributed Lag (ARDL) model, which allows for the simultaneous estimation of both long-run and short-run coefficients. The short-term coefficients indicate the relationship between the dependent variable's deviation from its long-run trend and are crucial for obtaining critical values in F-tests and t-tests, while they do not account for F-independent tests. However, incorporating F-independent tests alongside F-tests and t-tests is essential for achieving robust results. The ARDL model is presented as follows:

$$\begin{aligned} \Delta LPP_t = & \beta_0 + \sum_{i=1}^p \alpha_1 \Delta LPP_{t-i} + \sum_{i=1}^p \alpha_2 \Delta LIRG_{t-i} + \sum_{i=1}^p \alpha_3 \Delta LMBW_{t-i} \\ & + \sum_{i=1}^p \alpha_4 \Delta LER_{t-i} + \sum_{i=1}^p \alpha_5 \Delta LCPI_{t-i} + \zeta_1 LPP_{t-i} + \zeta_2 LIRG_{t-i} + \zeta_3 LMBW_{t-i} \\ & \zeta_4 LER_{t-i} + \zeta_5 LCPI_{t-i} + \varepsilon_t \end{aligned}$$

where the Δ is the 1st difference operator, the intercept is β_0 , the short-run coefficient are $\alpha_1, \alpha_2, \alpha_3, \alpha_4$, and α_5 , and $\zeta_1, \zeta_2, \zeta_3, \zeta_4$, and ζ_5 show the long-run coefficient relations among the selected variables. The cointegration between the variables is determinable if the valued F-statistics is greater than the upper limit, which rejects the null hypothesis without cointegration. If the valued F-statistics are lower than the lower bound, the null hypothesis for no cointegration is accepted. If F-statistics are between the lower and the upper. In this ECT, an error correction term indicates the long run speed of adjustment in the short-run after the shock. The value is estimated to be adverse and significant in this error correction term.

The ARDL-based error correction model (Banerjee et al, 1998) posits that the correction of negative and significant errors signifies the establishment of a long-term relationship between variables. The null hypothesis of the error correction model tests for no cointegration, while the alternative hypothesis asserts the presence of cointegration, thereby identifying a long-term relationship among the research variables. The model with ECM presented as follows:

$$\Delta LPP_t = \beta_0 + \sum_{i=1}^p \alpha_1 \Delta LPP_{t-i} + \sum_{i=1}^p \alpha_2 \Delta LIRG_{t-i} + \sum_{i=1}^p \alpha_3 \Delta LMBW_{t-i} \\ + \sum_{i=1}^p \alpha_4 \Delta LER_{t-i} + \sum_{i=1}^p \alpha_5 \Delta LCPI_{t-i} + \lambda ECM_{t-i} + \varepsilon_t$$

Bootstrap ARDL approach:

An enhanced version of the ARDL approach, the bootstrap ARDL method, enhances the power of t-tests and F-tests. McNown et al. (2018) noted weaknesses in the ARDL bounds test, including issues with size and power properties, as well as inconclusive inferences. Monte Carlo simulations have been conducted to address these issues, demonstrating that this new test maintains reasonable size properties. In the bootstrap ARDL approach, employing the F-independent test alongside the F-test and t-dependent tests is crucial for obtaining robust results. For variables to be deemed cointegrated using the bootstrap ARDL method, all three test statistics must exceed the critical values from the tables.

4. Results and Discussion

The descriptive statistics and correlation coefficients are summarised in Table 2, which shows its minimum, maximum, mean, median, standard deviation, and correlation matrix. These basic statistics show that LPP and LIRG have the greatest mean of 9.143 and 9.466, respectively. Moreover, the correlation results indicate positive correlation variables. All variables have strong positive linear correlation with guaranteed minimum wage with LCPI and LMBW have the greatest values, 0.962 and 0.950 respectively. These reflect the importance effect on inflation and minimum base wage in explaining purchasing power for employers in Algeria.

Table 02. Descriptive statistics and the correlation matrix

Variables	Mean	Median	Standard Deviation	Max	Min
LPP	9.143	9.301	0.704	9.903	7.495
LCPI	4.738	4.754	0.536	5.542	3.282
LER	4.244	4.301	0.494	4.955	2.916
LIRG	9.466	9.472	0.546	10.308	7.495
LMBW	8.623	8.405	0.540	9.590	7.408
Correlation matrix					
	LCPI	LER	LIRG	LMBW	LPP
LCPI	1				
LER	0.971	1			
LIRG	0.873	0.888	1		
LMBW	0.931	0.843	0.755	1	
LPP	0.962	0.903	0.784	0.950	1

Source: Authors' construction

To check the existence of trend series, the Mann-Kendall test results are described in Table 03. Results show that all series have a monotonic trend.

Table 03. Mann-Kendall test results

Variables	tau	Test statistic Z	p-value
LPP	0.952501	7.365606	0.000000***
LER	0.809284	6.487434	0.000000***
LIRG	0.821829	5.857246	0.000000***
LMBW	0.875288	6.480763	0.000000***
LCPI	0.875288	6.480763	0.000000***

***, ** and * indicate the 1%, 5%, and 10% significance levels

Source: Authors' construction

Table 4 represents the results of the augmented Dickey-Fuller (ADF) and Philips Perron (PP). Results show that LPP, LMBW, and LER are stationary at the the first order, while LIRG and LCPI are stationary at level. ARDL cointegration technique is preferable when dealing with variables that are integrated of different order, I(0), I(1) or combination of the both (Nkoroand Uko, 2016).

Table 04. Unit root test results

Variable	Standard unit root (ADF)		Standard unit root (PP)	
	Level	First order	Level	First order
LPP	0.4688	0.0082***	0.3574	0.000***
LIRG	0.0042***	0.0000***	0.0029**	0.0001***
IMBW	0.1226	0.0005***	0.1226	0.0076**
LER	0.1375	0.0231**	0.1652	0.0228**
LCPI	0.0000***	0.0402	0.0003***	0.2951

***, ** and * indicate the 1%, 5%, and 10% significance levels

Source: Authors' construction

Table 5 presents the results of the ARDL bound test. The results indicated a cointegration relationship between variables at the 5% significance level for model.

Table 05. Bound test ARDL results

Model	F value	Sig	Critical Bound Value		Conclusion
			LowerI(0)	UpperI(1)	
ARDL(3,4,4)	15.0710*	10%	2.75	3.99	Cointegration
	*	5%	3.35	4.77	
k(4)		1%	4.76	6.67	

***, ** and * indicate the 1%, 5%, and 10% significance levels

Source: Authors' construction

Several diagnostic measures, such as tests for serial correlation, normality, and heteroscedasticity, were conducted. Additionally, long-term and short-term stability evaluations were performed using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMsq) tests, as recommended by Brown et al. (1975) and Pesaran et al. (1999). The

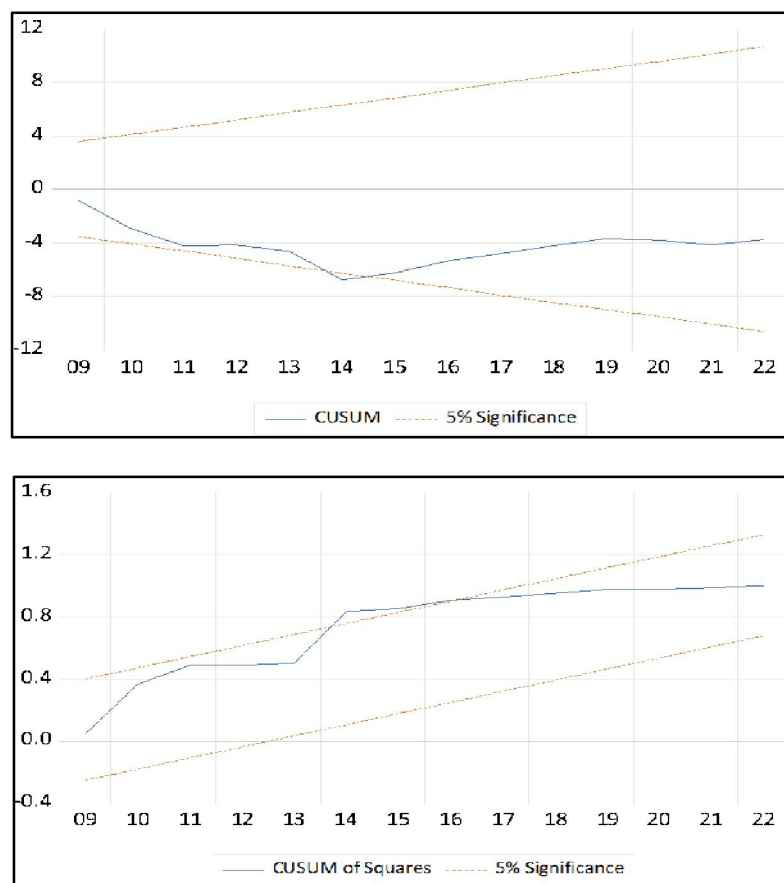
diagnostic tests confirmed the absence of serial correlation, heteroscedasticity, non-normality, and specification problems in the residual terms. Furthermore, the CUSUM and CUSUMsq tests indicated that the coefficients obtained from the model were stable. Results are presented in Table 6 and Figure 1.

Table 06. Diagnostic test results

Test	Serial correlation	ARCH	Ramsey reset test	JarqueBera
P-value	0.1755	0.6409	0.5381	0.5973
Conclusion	No serial correlation	Absence of heteroscedasticity	Absence of specification errors	Normality of residuals

Source: Authors' construction

Figure 01. CUSUM and CUSUMsq tests results



Source: Authors' construction using Eviews 12

The results of the short run and long run ARDL method for these coefficients are presented in Table 7. In the short run, maximum IRG exempt wage and exchange rate negatively affected purchasing power at the 5% significance level, while consumer price index was found to nurture purchasing power of Algerian employers. However, minimum base wage had no effect on guaranteed national wage in Algeria. In the long run, a 1% increase in the explanatory variables for maximum IRG exempt wage and exchange rate decreases purchasing power by 0.236% and 0.549%, respectively.

Table 07. Diagnostic test results

Variables	Coef	std	T value
Short run coefficients			
D_LMBW	0.0355	0.0274	1.2940
D_LIRG	-0.1753	0.0250	-6.9979**
D_LER	-1.1705	0.0632	-18.5012***
D_LCPI	1.3895	0.2478	5.6057**
ECT(-1)	-1.2742	0.0668	-19.0693***
Long run coefficients			
Intercept	-0.1265	0.6077	-0.2082
LIRG	-0.2367	0.0625	3.7841**
LMBW	0.0936	0.1175	0.7967
LCPI	0.3278	0.2852	1.1493
LER	-0.5492	0.1766	-3.0729**

***, ** and * indicate the 1%, 5%, and 10% significance levels

Source: Authors' construction

Table 8 presents the results of the ARDL bound test. The results indicated a cointegration relationship between variables at the 5% significance level for model.

Table 08. Bootstrap ARDL approach results

Model	statistic	Value	Bootstrap based table critical values		
			5%	2.5%	1%
ARDL(2,2,2,2,2)	F-statistic	7.699	4.380	5.240	7.070***
	t-dependent	-2.924	-2.410	-2.870	-3.560***
	F-dependent	4.533	3.690***	4.780	5.720

***, ** and * indicate the 1%, 5%, and 10% significance levels

Source: Authors' construction

The results of the short run and long run BARDL method for these coefficients are presented in Table 9. In the short run, minimum business wage and exchange rate negatively affected purchasing power the 5% significance level, while maximum IRG exempt wage had a positive impact on purchasing power of Algerian employers.

Table 09. Short and Long run BARDL coefficients

Variables	Coef	std	T value
Long run effect			
Intercept	1.0936	0.4307	2.539**
LIRG	-0.1052	0.0931	-1.130
LMBW	0.4226	0.1721	2.455**
LCPI	-0.0257	0.3689	-0.070
LER	-0.1432	0.2375	-0.603
Short run effect			
D_LIRG	0.2255	0.0927	2.431**
D_LMBW	-0.4412	0.1522	-2.889**
D_LCPI	-0.1729	0.6649	-0.260
D_LER	-0.5326	0.2410	-2.210**
Diagnostic tests			
Serial correlation	ARCH	Ramsey reset test	JarqueBera
12.676 (0.6273)	1.8651 (0.172)	1.6701 (0.2326)	2.7427 (0.2538)

Source: Authors' construction

However, consumer price index had no effect on guaranteed national wage in Algeria. In the long run, a 1% increase in the minimum business wage increased purchasing power by 0.422%. The diagnostic tests confirmed the absence of serial correlation, heteroscedasticity, non-normality, and specification problems in the residual terms.

The negative impact of minimum business wage and exchange rate in the short run is due to the the instability in wages through the continuous change in the wage index network during the period 1990-2001, and this is primarily due to the state's work on the continuous increase in wages, to reduce the effects of the economic reform measures adopted during the nineties, which resulted in a continuous decline in the exchange rate of the dinar against foreign currencies, which in turn led to the loss of the real value of wages, so hardly a year passes without a change in the inferential network. Despite the Algerian authorities attempts to unify and define the guaranteed national minimum wage between the various sectors and to establish an evidential network for wages and salaries in the public service, they have not been able to address the contradictions and disparities in wages and salaries. Starting in 2001, the country's economic situation witnessed stability, with improved incomes, and stability in the exchange rate, which is reflected in the stability of wages from 2001 to 2008 and from 2008 to 2022, the change in the wage network for the year 2008 was due to the recovery of state incomes, while the last two changes 2022 and 2023 were inevitable, like the changes of the nineties, illustrates the state's effort to support purchasing power after the 2014 oil crisis and the Covid crisis 2019 and the

subsequent inflation that caused the erosion of capacity. The increase in wages, despite its importance and positive repercussions in supporting purchasing power, which explains the positive impact of the minimum business wage in the long the long period. The instability in purchasing power for Algerian employees is because that the development of the wage and salary system in Algeria is mainly based on decisions for political purposes and social considerations rather than relying on an integrated strategy and rational economic and logical controls in a rentier consumer economy rather than a productive economy.

5. Conclusion

This study investigated the impact of wage policies, exchange rate, and consumer price index purchasing power Algeria by applying traditional ARDL model and a novel bootstrap ARDL approach over the period of 1991 to 2022. In the ARDL model a cointegration relationship only existed among consumer price index, exchange rate, maximum IRG exempt wages, and guaranteed national wages. While, in the novel BARDL, a cointegration relationship only existed among minimum business wage, exchange rate, maximum IRG exempt wages, and guaranteed national wages. This research indicated the following findings:

- The minimum business wage will nurture the purchasing power, but the maximum IRG exempt and exchange rate will behave negatively with purchasing power in the long run. A 1% increase in minimum business wage increases purchasing power by 0.422%.
- In addition, It was found that a 1% increase in the explanatory variables for maximum IRG exempt wage and exchange rate decreases purchasing power by 0.236% and 0.549%, respectively.

Since purchasing power is affected mainly by wage policies that are linked to political instability, we recommend that future research should consider the impact of political instability on purchasing power in the context of Algeria.

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