ERF Working Papers Series

Dynamic Linkages between Official and Parallel Exchange Rates and Inflation in Algeria: Evidence from Wavelet and Quantile-Based Analysis

Abderazak Madouri and Hacene Tchoketch-Kebir

ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

Working Paper No. 1851
November 2026

DYNAMIC LINKAGES BETWEEN OFFICIAL AND PARALLEL EXCHANGE RATES AND INFLATION IN ALGERIA: EVIDENCE FROM WAVELET AND QUANTILE-BASED ANALYSIS

Abderazak Madouri[1] and Hacene Tchoketch-Kebir[2]

Working Paper No. 1851

November 2026

Send correspondence to:
Abderazak Madouri
Centre for Research in Applied Economics for Development
madouri1986@gmail.com

[1] Centre for Research in Applied Economics for Development (CREAD), Division of Macroeconomics and Economic Integration, Algiers, Algeria
[2] Centre for Research in Applied Economics for Development (CREAD), Division of Macroeconomics and Economic Integration, Algiers, Algeria

First published in 2026 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Copyright © The Economic Research Forum, 2026

All rights reserved. No part of this publication may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without permission in writing from the publisher.

The findings, interpretations and conclusions expressed in this publication are entirely those of the author(s) and should not be attributed to the Economic Research Forum, members of its Board of Trustees, or its donors.

Abstract

This study examines the dynamic relationships among the official exchange rate, the parallel exchange rate, and inflation in Algeria from January 1974 to October 2024, employing wavelet-based and quantile-based approaches. The Wavelet Multiple Correlation (WMC) results indicate that the parallel exchange rate maximizes the multiple correlation at short and medium scales, whereas the official exchange rate and the consumer price index emerge at longer scales; these results are statistically significant at levels 1–4 only, while those at levels 5 and 6 are indicative. The Wavelet Local Multiple Correlation (WLMC) results, which are statistically significant across all levels, confirm the dominance of the parallel exchange rate in the short run, the growing importance of the official exchange rate in the medium run, and the joint role of both exchange rates in the long run. The heat map reveals very strong long-run correlations (exceeding 0.8) and relatively strong medium-run correlations, but weaker short-run correlations, except during 2007–2015, following the global financial crisis and the oil price shock. The Quantile-on-Quantile Regression (QQR) results uncover nonlinear and state-dependent relationships, with both exchange rates exerting positive effects on the consumer price index across most quantiles, indicative of asymmetric exchange rate pass-through, alongside positive bidirectional effects between the two rates. Robustness checks based on conventional Quantile Regression (QR) and Kernel-Based Regularized Least Squares (KRLS) corroborate these findings. The study underscores the importance of greater exchange rate flexibility and enhanced dinar convertibility in easing pressures in the parallel market and narrowing the gap between the two rates, while limiting exchange rate pass-through to domestic prices to contain inflationary pressures.

Keywords: Official exchange rate; Parallel exchange rate; Wavelet analysis; Quantile-on-Quantile Regression; Inflation; Algeria
JEL Classifications: E31, F31, E42, C40

ملخص

تتناول هذه الدراسة العلاقات الديناميكية بين سعر الصرف الرسمي وسعر الصرف الموازي والتضخم في الجزائر خلال الفترة من يناير 1974 إلى أكتوبر 2024، باستخدام أساليب قائمة على التحليل الموجي والكميمي. تشير نتائج الارتباط الموجي المتعدد (WMC)إلى أن سعر الصرف الموازي يعظّم الارتباط عند المستويات القصيرة والمتوسطة، في حين يبرز سعر الصرف الرسمي ومؤشر أسعار المستهلك عند المستويات الأطول، علمًا أن النتائج معنوية إحصائيًا عند المستويات 1–4 فقط، أما المستويان 5 و6 فإرشاديان. وتؤكد نتائج الارتباط الموجي المحلي المتعدد(WLMC) ، المعنوية عبر جميع المستويات، هيمنة سعر الصرف الموازي في المدى القصير، وتزايد أهمية الرسمي في المدى المتوسط، واشتراك السعرين في المدى الطويل. وتكشف الخريطة الحرارية عن ارتباطات طويلة الأجل قوية جدًا (تتجاوز 0.8)، وقوية نسبيًا في المدى المتوسط، وأضعف في المدى القصير، باستثناء الفترة 2007–2015 عقب الأزمة المالية العالمية وصدمة أسعار النفط. وتبيّن نتائج الانحدار الكميمي إلى الكميمات (QQR) علاقات لاخطية ومعتمدة على الحالة، إذ يؤثر كلا سعري الصرف تأثيرًا إيجابيًا في مؤشر أسعار المستهلك عبر معظم الكميمات، بما يعكس انتقالًا غير متماثل لأثر سعر الصرف، إلى جانب تأثيرات إيجابية متبادلة بين السعرين. وتدعم اختبارات المتانة QR) و (KRLSهذه النتائج. وتبرز الدراسة أهمية زيادة مرونة سعر الصرف وتعزيز قابلية تحويل الدينار لتخفيف الضغوط في السوق الموازية وتضييق الفجوة بين السعرين، مع الحد من انتقال أثر سعر الصرف إلى الأسعار المحلية لاحتواء التضخم.

1. Introduction

Recurrent debt crises and persistent external imbalances have made parallel foreign exchange markets a common feature of many developing economies, despite decades of exchange controls and stabilization efforts (Bello, 2024; Bui, 2018). Rather than alleviating foreign exchange pressures, restrictive foreign exchange and trade controls have often encouraged the expansion of parallel foreign exchange activities and the circumvention of official foreign exchange controls. In particular, restrictions on current-account transactions—including import licensing systems, administrative allocation of foreign exchange, and advance import deposit requirements—create strong incentives for smuggling, trade mis-invoicing, capital flight, and other transactions outside formal regulatory channels. Over time, these parallel markets may evolve into alternative mechanisms for preserving wealth and hedging against inflationary and exchange rate risks, exchange rate misalignment, and policy uncertainty (Agénor, 1990a, 1990b; Grosse, 1992; Henni, 1994; Diamandis & Drakos, 2005).

The persistence of parallel exchange markets is closely associated with the divergence between administratively determined exchange rates and underlying macroeconomic fundamentals. In many developing and emerging economies, less-developed financial systems, limited investment opportunities, and significant regulatory rigidities coexist with price controls, structural constraints on production, and the legacy of centralized economic management. Under such conditions, shortages of foreign exchange can generate excess demand for hard currency outside official channels, contributing to the emergence of parallel markets alongside official foreign exchange markets. This coexistence may generate substantial income and wealth flows beyond official statistical coverage, weaken macroeconomic transparency, complicate regulatory oversight, and undermine the effectiveness of monetary and exchange rate policies (Lindauer, 1989; Goldberg & Karimov, 1997). In such a dual-market structure, the official exchange rate is administratively determined or closely managed by the monetary authorities, while the parallel exchange rate is largely determined by market forces of supply and demand (Cheung & Lai, 2008).

The size and persistence of parallel market activity depend largely on the intensity of exchange restrictions and the central bank's ability to meet demand for foreign exchange at the official rate. Economies facing chronic balance-of-payments deficits and limited foreign exchange reserves often experience a rapid expansion of parallel foreign exchange markets, accompanied by a widening spread between official and parallel exchange rates. Empirical evidence consistently indicates that restrictive foreign exchange policies have rarely succeeded in preserving international reserves or ensuring exchange rate stability; instead, they have frequently accelerated the growth of black markets and reinforced macroeconomic instability in developing economies (Azam & Besley, 1989; Agénor, 1990b, 1991; Ghei & Kiguel, 1992; Agénor & Taylor, 1993; Bahmani-Oskooee & Shiva, 1998; Kanas & Kouretas, 2007).

Parallel exchange rates affect the economy through two main channels. The first operates through illicit trade, as sustained increases in the parallel market premium may divert exports

to unofficial channels while altering incentives for imports, thereby worsening the official trade balance, reducing trade tax revenues, and placing additional pressure on foreign exchange reserves. The second channel operates through domestic prices, as the parallel exchange rate can exert significant pressure on the price level, particularly under conditions of import rationing, while changes in the parallel rate may affect financial wealth and be transmitted to domestic prices (Kiguel & O'Connell, 1995).

The coexistence of exchange controls and black markets has historically been associated with fixed or closely managed exchange rate regimes, particularly across developing economies during the period 1954–1984 (Biswas & Nandi, 1986; Kamin, 1993; Morris, 1995; Onour & Cameron, 1997; Dorsainvil, 2001; Acharyya, 2001). The maintenance of such arrangements contributed to exchange rate overvaluation, thereby increasing the risk of currency (Agénor, 1990c). In this context, Krugman (1979) showed how the depletion of foreign exchange reserves could eventually trigger a speculative attack and a balance-of-payments crisis.

Both theoretical and empirical evidence further indicate that parallel exchange markets are particularly common in economies characterized by high inflation, persistent foreign exchange shortages, and exchange rates that are used primarily as policy instruments rather than being allowed to adjust to market-clearing levels (Fofack & Nolan, 2001). IMF assessments additionally document a geographical shift in the incidence of parallel exchange markets from Latin America during the 1980s and 1990s toward Eastern Europe and Africa in subsequent decades. More recent episodes—including the deterioration of Belarus's foreign exchange market in 2011 and the widening of parallel market premia in countries such as Burundi, Ethiopia, Lebanon, Nigeria, and Sudan—further demonstrate the continued relevance of parallel exchange markets in economies experiencing persistent external imbalances and sustained foreign exchange constraints (Huett et al., 2014; IMF, 2019; Gray, 2021).

As one of Africa's major hydrocarbon-exporting economies, Algeria remains highly reliant on hydrocarbon revenues as a key source of foreign exchange earnings. Hydrocarbons accounted for approximately 92% of total exports in 2024. This reliance is associated with greater exposure to external shocks and highlights the importance of the exchange rate as an adjustment mechanism for absorbing real shocks associated with fluctuations in international oil prices (Bank of Algeria, 2009, 2025; Madouri et al., 2026). Although Algeria adopted a managed floating exchange rate regime in 1994 and undertook measures to enhance the convertibility of the national currency, the parallel foreign exchange market continues to exist.

These challenges became more pronounced following the sharp decline in global oil prices after mid-2014. The resulting fall in hydrocarbon revenues intensified balance-of-payments pressures and accelerated the depletion of foreign exchange reserves. Following the depletion of the Revenue Regulation Fund, the authorities introduced unconventional monetary financing in 2017 to finance widening fiscal deficits. Consequently, domestic public debt increased to 28.8% and 36.6% of GDP in 2017 and 2018, respectively. Broad money also expanded significantly, reaching 82.1% of GDP in 2018 (Bank of Algeria, 2019). At the same time, the

Algerian dinar depreciated by approximately 32.5% against the U.S. dollar between 2014 and 2019 (Bank of Algeria, 2020). External and exchange rate pressures persisted during and after the COVID-19 pandemic, alongside a notable widening of the parallel exchange rate premium, which approached 50% in 2023 (Malpass, 2023).

Despite the growing policy relevance of these issues, empirical evidence on the dynamic relationships among the official exchange rate, the parallel exchange rate, and inflation in Algeria remains relatively limited. This study contributes to the existing literature in three main ways. First, it provides a comprehensive empirical investigation of the co-movements and dynamic linkages among the official exchange rate, the parallel exchange rate, and the Consumer Price Index (CPI) in Algeria over an extended historical period spanning successive exchange rate regimes and major macroeconomic adjustments. Second, unlike previous studies that have primarily employed conventional econometric approaches, such as Gamache (2020), Bouteldja et al. (2013), Bouteldja and Faïza (2023), and Bouteldja and Sifeeddine (2024), the present study examines dynamic co-movements using wavelet-based methodologies. Specifically, the study employs the wavelet multiple correlation (WMC) and wavelet local multiple correlation (WLMC) approaches developed by Fernández-Macho (2012, 2018). In addition, the quantile-on-quantile regression (QQR) framework proposed by Sim and Zhou (2015) is applied to examine nonlinear, asymmetric, and state-dependent relationships among the variables. Third, to assess the robustness of the findings, the study employs the Kernel-based Regularized Least Squares (KRLS) estimator developed by Hainmueller and Hazlett (2014) and compares the dependence patterns identified by the QQR model with those obtained from the conventional quantile regression (QR) framework.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 examines the evolution of Algeria's exchange rate system and the convertibility of the Algerian dinar. Section 4 analyzes the development of the parallel exchange rate premium over the period 1964–2024. Section 5 presents the methodological framework. Section 6 discusses the empirical findings, while Section 7 concludes with the main results and policy implications.

2. Literature review

Since the establishment of the Bretton Woods system in 1944, foreign exchange restrictions have been widely used in developing economies to preserve international reserves, mitigate capital flow volatility, and maintain overvalued official exchange rates. Although financial liberalization gained momentum during the 1970s and 1980s, these controls remained key policy instruments, often justified as short-term responses to external imbalances. However, a substantial body of literature demonstrates that such measures generally fail to address underlying structural weaknesses and instead generate significant distortions in resource allocation and macroeconomic performance (Greenwood & Kimbrough, 1987; Booth & Mustafa, 1991; Noorbakhsh & Shahrokhi, 1993).

Against this backdrop, a growing strand of research has examined the emergence and persistence of parallel foreign exchange markets. Early theoretical contributions generally developed around three complementary analytical frameworks: the real trade approach (Bhagwati & Hansen, 1975; Pitt, 1984), the monetary approach (Blejer, 1978; Nowak, 1984), and the portfolio balance/currency substitution approach (Dornbusch et al., 1983). The real trade approach explains parallel market activity through exchange restrictions, trade controls, and smuggling incentives arising from excess demand for foreign currency, while also emphasizing the role of illicit trade and informal market networks in sustaining black-market exchange rate dynamics. The monetary approach links black-market dynamics to excess money supply, inflationary pressures, and expected exchange rate depreciation. By contrast, the portfolio balance approach emphasizes the role of foreign currency as a store of value and portfolio asset under conditions of macroeconomic instability and low confidence in the domestic currency. Collectively, these frameworks highlight how trade restrictions, monetary disequilibria, and asset substitution contribute to the development and persistence of parallel market activity (Siddiki, 2000; Nkurunziza, 2002; Ebaidalla, 2017). In this context, earlier studies further emphasized that exchange and trade controls, institutional rigidities, and sanctions may create strong incentives for illicit foreign exchange transactions (Culbertson, 1975; Sheikh, 1976; Gupta, 1980).

Subsequent research further extended these frameworks by incorporating additional structural features, including currency inconvertibility, trade taxation, and informal market mechanisms (De Macedo, 1987). During the 1990s, the implementation of structural adjustment programs and exchange rate liberalization renewed scholarly interest in parallel foreign exchange markets. In particular, Frenkel (1990) emphasized the challenges faced by economies transitioning from controlled exchange rate regimes toward greater flexibility, highlighting the persistence of parallel market dynamics even under partially liberalized systems.

Empirical studies indicate that black-market exchange rates influence money demand behavior and shape broader monetary dynamics in developing economies characterized by exchange restrictions (Bahmani-Oskooee & Tanku, 2006a; Rehman & Afzal, 2003; Bahmani-Oskooee, 1996; Hassan et al., 1995a). Related research has also shown that attempts to unify official and parallel exchange rates—particularly through sharp nominal devaluations—often generate inflationary pressures, exchange rate volatility, and broader macroeconomic instability (Pinto, 1988, 1991). Moreover, empirical evidence suggests that black-market exchange rates frequently anticipate movements in official exchange rates, reflecting their informational efficiency and forward-looking nature (Akgiray et al., 1989; Noorbakhsh & Shahrokhi, 1993). Meanwhile, persistent and substantial parallel market premia tend to undermine price stability, weaken export competitiveness, and erode fiscal revenues (Agénor & Flood, 1992; Elbadawi, 1992; Aron & Elbadawi, 1992).

Further empirical studies examined the determinants and macroeconomic effects of parallel market premia across countries. Existing evidence identifies real income, inflation expectations, interest rates, and holdings of foreign-currency-denominated assets as key determinants of both

money demand and black-market exchange rate premia (Hassan et al., 1995b; Shachmurove, 1999). Furthermore, macroeconomic constraints—particularly declining foreign exchange reserves and restrictive trade policies—have been shown to intensify pressures in parallel foreign exchange markets. Conversely, greater exchange rate flexibility and economic liberalization tend to reduce parallel market premia and restore long-run relationships between official and unofficial exchange rates (Siddiki, 2000; Kouretas & Zarangas, 2001). Consistent with these findings, Dorsainvil (2000), based on the Haitian experience, demonstrated that tolerating a parallel market under an overvalued fixed exchange rate regime intensified foreign exchange rationing and increased the probability of regime collapse. Evidence from Ethiopia, Pakistan, Venezuela, and Sudan indicates that persistent parallel market premia adversely affect exports, economic growth, and price stability (Degefa, 2001; Rehman & Afzal, 2003; Cerra, 2016; Ebaidalla, 2017).

A related strand of the literature has focused on the dynamic relationship between official and parallel exchange rates. Several empirical studies have documented cointegration and long-run convergence between the two rates, with the parallel market often playing a leading role in the adjustment process. For instance, Bahmani-Oskooee and Tanku (2006b), using a bounds testing approach for a panel of developing countries, found that the black-market rate Granger-caused the official rate across all sampled economies. Similarly, Baliamoune-Lutz and Lutz (2008) reported that, in Tunisia, the black-market exchange rate led the long-run adjustment process and Granger-caused the official rate in the short run prior to current-account convertibility. Further evidence was provided by Baliamoune-Lutz (2010), who found that causality ran from the parallel market to the official exchange rate in Morocco, supporting the informational efficiency hypothesis. By contrast, Bui (2018), using a VECM framework, confirmed the existence of a long-run equilibrium relationship between official and parallel exchange rates in Vietnam and identified unidirectional causality running from the official rate to the black-market rate.

Although scholarly interest in parallel exchange rate premia declined after the early 2000s, largely due to the widespread assumption that economic liberalization had contained informal currency market activity, renewed balance-of-payments pressures and recent global shocks—particularly the COVID-19 pandemic—have restored the relevance of this line of inquiry (Ogun, 2015; Ezema, 2018; Gray, 2021).

Recent empirical evidence highlights the macroeconomic relevance of parallel exchange rate premia in developing and emerging economies. Adejoh (2025) identified threshold effects in the relationship between parallel exchange rate premia and inflation in Nigeria, showing that higher premia intensify inflationary pressures. Gurhy et al. (2025) highlighted several structural factors sustaining parallel market premia across African economies, including residual current-account restrictions, limited financial openness, and underdeveloped financial systems. Bello (2024) found that parallel market premia significantly affected both output and the trade balance in Nigeria, while their long-run impact on inflation remained negligible. From a methodological perspective, Elsafoury (2025) argued that neglecting parallel foreign exchange markets has

contributed to a systematic underestimation of exchange rate pass-through effects in conventional empirical analyses. In a related context, Sirag (2021) showed that exchange rate pass-through to inflation in Sudan was asymmetric across inflationary regimes, with parallel exchange rate fluctuations exerting stronger inflationary effects during periods of high inflation.

Overall, the literature suggests that parallel exchange rate premia are closely associated with macroeconomic imbalances, exchange restrictions, and inflationary dynamics.

In the Algerian context, the literature has examined various real and monetary dimensions of the informal economy, including the parallel foreign exchange market. Nevertheless, the dynamic interactions among the parallel exchange rate, inflation, and the official exchange rate remain relatively underexplored, particularly regarding their evolving interdependencies across different time horizons and market conditions.

Bouteldja et al. (2013), using an ARDL framework over the period 1974–2005, found that black-market exchange rates played a more prominent role than official rates in explaining money demand in Algeria. Gamache (2020) identified long-run cointegration relationships among key macroeconomic variables and showed that nominal depreciation reduced the parallel market premium in the short run.

Bouazizi (2020) linked the expansion of black-market foreign exchange markets in Maghreb economies since the 1990s to managed exchange rate regimes and widening gaps between official and parallel exchange rates. Using PMG estimation and Granger causality tests, the study identified the official exchange rate as the main determinant of black-market exchange rate dynamics.

Bouteldja and Faïza (2023), in Algeria, identified excessive foreign exchange market regulation as a major driver of the persistent divergence between official and parallel exchange rates, with adverse implications for inflation, foreign direct investment, and economic growth. Bouteldja and Sifeeddine (2024), using quarterly data for Algeria over the period 1990–2021, found that the parallel exchange rate provides a more relevant benchmark for monetary policy formulation than the official rate. Finally, Bouteldja et al. (2024), in Algeria, showed that prolonged exchange controls and repeated currency devaluations reinforced currency substitution and weakened the effectiveness of macroeconomic stabilization policies.

3. Evolution of Algeria's exchange system and dinar convertibility

Between 1963 and 1986, Algeria's monetary and financial system operated within a highly centralized and state-controlled institutional framework. Foreign exchange earnings generated from hydrocarbon exports were largely managed by the state, while access to foreign currency was subject to administrative authorization through a centralized allocation system overseen by economic planning authorities. Allocation decisions were guided by sectoral priorities defined

under the central plan, leaving the Central Bank and commercial banks with primarily administrative roles in the distribution of foreign exchange quotas (Henni, 1987; Henni, 2009).

The promulgation of Law No. 86-12 on the banking and credit system on August 19, 1986, marked an initial effort to partially restore the Central Bank's authority over foreign exchange management and external trade, as stipulated in Articles 08 and 09 of the law, while simultaneously redefining its institutional relationship with the Treasury.

The evolution of the Algerian dinar's convertibility can be analytically divided into three distinct phases.

The preparatory phase (1990–1993) laid the legal and institutional foundations of Algeria's foreign exchange regime. Key reforms—most notably the 1990 Money and Credit Law—granted the Bank of Algeria full autonomy in the conduct of monetary policy, centralized the regulation of foreign exchange, and reaffirmed the principle of a unified exchange rate (Ilmane, 2012; Boucekkine et al., 2021; Madouri, 2023).

Within this framework, the authorities sought to enhance flexibility in exchange controls and capital movement regulations through the gradual introduction of dinar convertibility (Merghit, 2014, 2018). Import liberalization was initiated, the centralized system for allocating foreign currency was dismantled, and private importers were granted direct access to foreign exchange in April 1991. These reforms were subsequently consolidated by Law No. 92-04 (1992), which authorized residents to access foreign means of payment (Corm, 1993; World Bank Group, 1994).

The core phase (1994–2004) marked the effective implementation of commercial convertibility of the dinar within the framework of structural adjustment programs, following the liberalization of import-related payments initiated in 1991. This process was reinforced by the introduction of a fixing mechanism in October 1994 to determine the exchange rate based on foreign exchange market supply and demand, together with the establishment of the interbank foreign exchange market in early 1996 (Talahite, 2000a; Bank of Algeria, 2004). A second step toward current account convertibility began in June 1995 with the authorization of health- and education-related expenditures, subject to documentation and annual limits, and was completed in August 1997 with the authorization of nationals' travel expenditures abroad within an annual ceiling (Bank of Algeria, 2005, 2006).

The process reached a critical milestone in September 1997 with Algeria's ratification of Article VIII of the IMF Articles of Agreement, thereby achieving current account convertibility (Bank of Algeria, 2009). Nevertheless, the authorities maintained a cautious stance toward full capital account convertibility, reflecting concerns over macroeconomic vulnerability and the economy's heavy dependence on hydrocarbon revenues (Boukhezer-Hammiche, 2013).

The enhancement phase (2005–present) reflects improved external economic conditions in Algeria, driven primarily by rising hydrocarbon revenues and increasing foreign exchange inflows. Together with the entry into force of the Euro–Mediterranean Partnership Agreement in 2005, these developments contributed to easing foreign exchange constraints and strengthening external openness (Bank of Algeria, 2006). In this context, the International Monetary Fund emphasized that full current account convertibility of the dinar is essential to fully benefit from external liberalization policies (IMF, 2006).

Since 2005, regulatory reforms have progressively liberalized current account transactions, facilitated transfers of investment income and export proceeds, and gradually relaxed regulations governing repatriation requirements and foreign currency holdings.

Overall, this phase has been characterized by a gradual expansion of convertibility and an improved regulatory framework for foreign exchange transactions, supported by key institutional reforms—most notably the 2023 Money and Credit Law. Consistent with this reform trajectory, the Bank of Algeria issued new regulations governing foreign exchange bureaus in September 2023 (IMF, 2024), while the foreign exchange travel allowance was revised in 2025. Nevertheless, liberalization of the foreign exchange system remains incomplete, reflecting a cautious policy stance aimed at balancing external openness with monetary and financial stability.

These successive phases reflect gradual improvements in the convertibility of the Algerian dinar. Nevertheless, the coexistence of official and parallel foreign exchange markets points to persistent challenges, with potential implications for exchange rate misalignments and inflationary pressures. Table A1 in the appendix summarizes the key regulatory milestones associated with each phase, based on the legislation, regulations, instructions, and annual reports issued by the Bank of Algeria.

4. Parallel exchange rate premium in Algeria (1964–2024): an overview

4.1. Historical evolution of the parallel exchange rate premium in Algeria

As in many developing economies, the emergence and persistence of the parallel foreign exchange market in Algeria can be associated with foreign exchange and trade restrictions, as well as structural conditions in the economy. Figure 1a illustrates the major phases characterizing the evolution of the parallel exchange rate premium in Algeria over the period 1964–2024. These phases are closely associated with shifts in exchange rate regimes, trade policies, and broader macroeconomic conditions.

4.1.1. Emergence of the parallel exchange rate premium (1964–1971)

This initial phase coincided with the adoption of the Algerian dinar as the national currency, which was pegged to the French franc in 1964. Following independence, Algeria remained within the franc zone (May 19, 1962), allowing for free capital mobility. This arrangement was

associated with substantial capital outflows and pressures on the balance of payments, particularly in the aftermath of the departure of European settlers.

In response, the authorities introduced foreign exchange controls through Decree No. 63-411 (1963) and reinforced trade regulation by imposing import quotas under Ordinance No. 63-188 (1963). Specialized institutions—such as National Purchasing Offices and Professional Purchasing Associations—were established to centralize foreign trade operations. These measures were associated with the emergence of a parallel exchange rate premium, estimated at 54.61% in 1969, which reflected foreign currency shortages and the early development of the parallel market (Mutin, 1965; Temmar, 1974; Benissad, 1979; Chiali, 2004; Benbouziane et al., 2005; Ilmane, 2012).

4.1.2. Expansion of the parallel exchange rate premium (1972–1980)

Between 1972 and 1980, the parallel exchange rate premium increased markedly following the adoption of a currency basket peg in 1974 and the consolidation of state monopolies over foreign trade. Professional Purchasing Associations were replaced by state-owned enterprises exercising exclusive control over imports, while the Global Import License (GIL) system was introduced under Ordinance No. 74-12 (1974). Law No. 78-02 (1978) further regulated external trade by reinforcing the role of the state.

These measures restricted access to foreign exchange, resulting in a notable increase in the parallel premium—from 75.35% in 1976 to 182.97% in 1980. The widening divergence may, to some extent, reflect the growing role of the parallel exchange market in the Algerian economy during that period (Pascallon & de Laulanie, 1971; Temmar, 1983; Benissad, 1989; Ajja, 2007).

4.1.3. Explosion of the parallel exchange rate premium (1981–1988)

The period 1981–1988 appears to have been characterized by a pronounced surge in the parallel exchange rate premium, which rose to 334.13% in 1984, 387.78% in 1985, and peaked at 400.78% in 1988. This escalation seems to have been driven largely by the collapse of international oil prices in 1986, which, in turn, considerably weakened Algeria's external position and fiscal revenues. The macroeconomic environment during this phase was marked by widespread shortages, excess liquidity, a relatively fragile banking system, and heightened speculative behavior, all of which appear to have reinforced parallel market activity (Benachenhou, 1993; CNESE, 2004).

In response to these developments, the Bank of Algeria implemented a cumulative devaluation of approximately 31% between 1986 and 1988 and initiated reforms aimed at enhancing the autonomy of public economic institutions under Law No. 88-01 (1988). The foreign exchange allocation system was subsequently restructured, with currencies distributed through five public commercial banks operating under credit ceilings broadly aligned with balance-of-payments objectives. While these measures appear to have contributed to a partial moderation of demand

in the parallel market (IMF, 2005), they were not sufficient to fully eliminate the underlying structural distortions that continued to sustain the parallel exchange rate premium.

4.1.4. Decline of the parallel exchange rate premium (1989–2001)

During the 1990s, Algeria appears to have experienced a notable decline in the parallel exchange rate premium, reflecting a gradual shift toward economic liberalization and macroeconomic stabilization. The premium declined markedly from 271.43% in 1990 to 119.81% in 1991, alongside a substantial depreciation of the dinar of approximately 200%, under the first IMF-supported Stand-By Arrangement (1989–1991). Although temporary monetary expansion may have contributed to a brief resurgence of the premium during 1992–1993, the implementation of the Structural Adjustment Program (SAP) in 1994 appears to have marked an important turning point.

The SAP encompassed trade and price liberalization, tighter monetary and fiscal policies, and the adoption of a managed floating exchange rate regime. Partial convertibility of the dinar was introduced, foreign exchange allocations for imports were abolished, and free conversion was authorized for invisible transactions, including education, healthcare, and travel. Algeria's acceptance of Article VIII obligations in 1997 appears to have further contributed to narrowing the gap between official and parallel exchange rates, with the premium declining to around 50% in 2000 and approximately 15% by 2001 (IMF, 1997; Talahite, 2000b; IMF, 2006; Zouache & Ilmane, 2008; Andreff, 2009; Mezouaghi, 2015).

It is worth noting that, in the early 1990s, the Algerian authorities pursued a gradual approach to foreign exchange liberalization, deferring the introduction of dinar convertibility and exchange rate unification in light of their potential implications for domestic prices and inflation, external debt servicing costs, and the capacity of public enterprises to adjust to greater economic openness and competitive pressures.

4.1.5. Relative stability of the parallel exchange rate premium (2002–2013)

Between 2002 and 2013, the parallel exchange rate premium exhibited a phase of relative stability, supported by favorable macroeconomic conditions and targeted policy interventions. The Supplementary Finance Law of 2005 restricted imports of used vehicles while allowing authorized dealers to finance imports through the official foreign exchange market, contributing to a decline in the premium to approximately 5.5% by 2007.

During this period, current account convertibility was maintained and further reinforced by Regulation No. 05-03 (2005), which established the procedures governing the transfer of dividends, profits, and liquidation proceeds associated with foreign investments, and by Regulation No. 07-01 (2007), which reaffirmed the principle of convertibility for international current transactions conducted through authorized intermediaries. Additional measures introduced under the 2009 Supplementary Finance Law strengthened oversight of external payments and intensified efforts to curb parallel market activity, assigning Algerian banks a

central supervisory role (Bank of Algeria, 2011, 2012). These measures, combined with improved debt indicators, sustained balance-of-payments surpluses, and a relatively stable real effective exchange rate, contributed to a significant reduction in the parallel exchange rate premium.

4.1.6. Resurgence of the parallel exchange rate premium (2014–2024)

The decline in global oil prices beginning in 2014 marked a renewed phase of pressure on Algeria's foreign exchange market. By 2017, the parallel exchange rate premium had risen to 57.2%, reflecting deteriorating external balances and heightened demand for foreign currency. During the COVID-19 pandemic, the premium temporarily declined to 36.78% in 2020, driven by reduced informal market activity and a cumulative depreciation of the dinar of approximately 32.5% against the U.S. dollar between 2014 and 2019 (Bank of Algeria, 2020).

As economic activity resumed, the premium increased steadily, reaching 55.73% in 2023 and 66.46% by early 2024. By October 2024, parallel market exchange rates reached approximately 226 DZD/USD and 258 DZD/EUR, compared with official rates estimated at around 133 DZD/USD and 144 DZD/EUR, respectively.

This resurgence was largely driven by renewed import demand following the authorization to import used vehicles under three years of age, alongside intensified speculative pressures and seasonal foreign currency demand related to tourism.[3]

4.2. Parallel exchange rate premium score and consumer price index (CPI) in Algeria

Following Reinhart (2002), the parallel exchange rate premium can be classified into three categories: low (below 10%, rating 1), medium (between 10% and 50%, rating 2), and high (above 50%, rating 3). As shown in Figure 1b, the premium remained predominantly high during periods characterized by pegged exchange rate regimes, while it shifted to a medium level under the managed floating regime. A low premium was observed only in 2007. Over the sample period, the parallel exchange rate premium persisted at a high level for 33 years, at a medium level for 27 years, and reached a low level in only one year. The persistence of the parallel exchange rate premium at medium and high levels may suggest an overvaluation of the Algerian dinar. [4]

Figure 1 (Panel b) indicates that movements in the Consumer Price Index (CPI) in Algeria are broadly associated with fluctuations in the parallel exchange rate premium over the period 1964–2024, although this association varies across sub-periods. Periods of elevated parallel

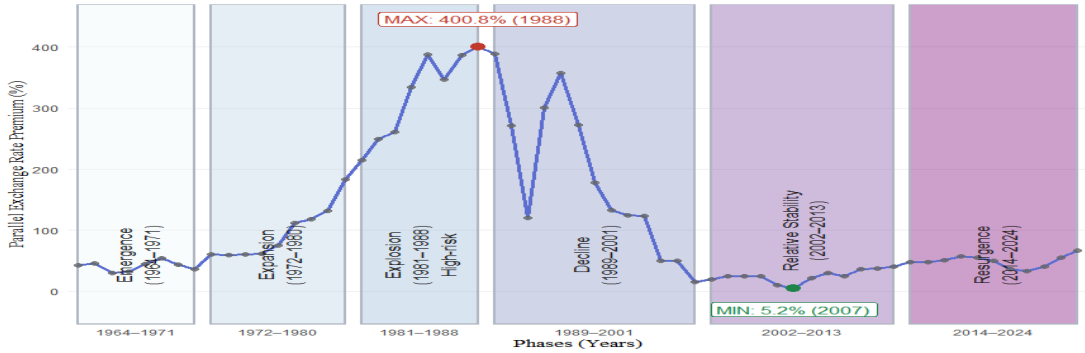
[3] According to the IMF (2018), Algeria's parallel foreign exchange market appears to have expanded significantly in both scale and complexity, driven on the supply side by remittances, external transfers, invoice manipulation, and tourism-related inflows outside official channels, and on the demand side by restricted import financing, capital flight, tax evasion, the use of foreign currency as a store of value, and exchange rate–driven speculative behavior.

[4] In this context, the Bank of Algeria (2020) noted that "the persistent deterioration in certain economic fundamentals indicates that the national currency remains overvalued."

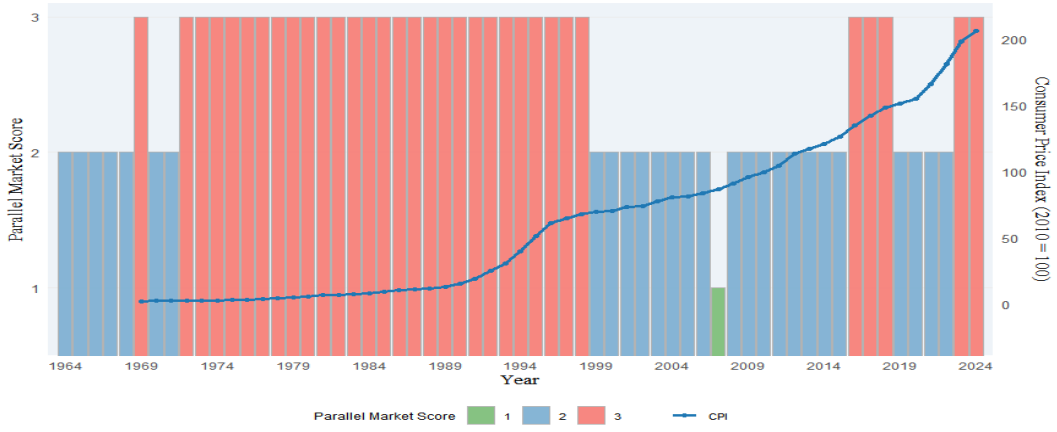
market premia generally coincided with inflationary pressures, particularly during the 1980s, the 1990s, and the post-2014 period. Nevertheless, the CPI continued to rise even during phases of relative stabilization in the premium after the early 2000s. This pattern suggests a role for other monetary and economic factors in shaping domestic prices.

Figure 1.

(a) Evolution of the parallel exchange rate premium



(b) evolution of the parallel exchange rate premium score and CPI in Algeria



5. Data and methodology

5.1. Data description

This study employs a rigorous multi-stage empirical framework to analyze the dynamic relationships among the official exchange rate, the parallel exchange rate, and inflation in Algeria, using monthly data spanning the period January 1974 to October 2024 (see Table 1 for variable definitions), based on 610 monthly observations.[5]

[5] The parallel exchange rate series (PEXH), expressed in Algerian dinars per US dollar (DZD/USD), was constructed using the parallel exchange rate premium estimates reported by Gamache (2020) , which are derived from the Reinhart and Rogoff database, along with additional sources. The premium is defined as [(parallel exchange rate − official exchange rate) / official exchange rate] × 100. For January 1974–November 2019, in the absence of monthly observations of the parallel exchange rate, monthly values were derived using the end-of-period monthly official exchange rate and the annual premium, which was held constant across all months of each year. For December 2019–October 2024, monthly selling rates of the US dollar against the Algerian dinar were compiled from various sources, including FOREX Algérie.

The analysis begins with descriptive statistics and formal tests of stationarity (ADF and Phillips–Perron) and nonlinearity (BDS) to characterize the time-series properties of the data. Wavelet-based techniques, namely Wavelet Multiple Correlation (WMC) and Wavelet Local Multiple Correlation (WLMC), following Fernández-Macho (2012, 2018), are then employed to examine multiscale co-movements across time scales.

To capture nonlinear and heterogeneous dependence structures among the variables, the study applies the Quantile-on-Quantile Regression (QQR) approach proposed by Sim and Zhou (2015). Robustness is assessed by comparing Quantile Regression (QR) and QQR estimates and by estimating pointwise marginal effects using Kernel-based Regularized Least Squares (KRLS), as illustrated in Figure 2.

Table 1. Variable details

Symbol	Variable Name	Frequency	Source
OEXH	Official Exchange Rate (Domestic Currency per U.S. Dollar, End-of-Period)	Monthly	IMF (IFS)
PEXH	Parallel Exchange Rate (Domestic Currency per U.S. Dollar)	Monthly	Compiled and estimated by the authors based on Gamache (2020) and various sources.
CPI	The price level, measured by the Consumer Price Index (used as a proxy for inflation)	Monthly	IMF (IFS)

Note: All series are expressed in natural logarithms (ln), and exchange rates are quoted indirectly (DZD per USD).

Figure 2. Empirical analysis steps



The empirical framework focuses on three core variables, namely the official exchange rate, the parallel exchange rate, and the consumer price index, to remain aligned with the central research question. Although additional macroeconomic variables could offer further insights, this focused specification is consistent with previous nonlinear and quantile-based studies that used a limited set of core variables (Troster et al., 2018; Ozcelebi, 2021; Mohammed & Mellit, 2023; Bakhsh et al., 2024; Madouri et al., 2026).

5.2. Empirical methodology

5.2.1. Wavelet Multiple Correlation (WMC)

Fernández-Macho (2012) introduced the Wavelet Multiple Correlation (WMC) as a statistical framework for analyzing dynamic interrelationships in multivariate time series. The WMC measures the overall degree of interdependence among a set of variables across different time scales, thereby providing a comprehensive multiscale perspective on their joint behavior in the time-frequency domain.

The estimation of WMC relies on the Maximum Overlap Discrete Wavelet Transform (MODWT), which extends the classical Discrete Wavelet Transform (DWT) to empirical applications. Unlike the DWT, the MODWT preserves the full length of the original time series, avoiding the loss of observations at the boundaries, and exhibits translation invariance, such that shifts in the time series correspond directly to shifts in the wavelet coefficients. In addition, the MODWT offers superior performance at lower-frequency (long-run) scales, allowing for more accurate estimation and improved extraction of long-term dynamics that may be inadequately captured by alternative wavelet approaches.

These properties render the MODWT particularly well suited for the analysis of complex economic and financial time series, where interactions among variables typically evolve across multiple time horizons (Percival & Walden, 2000; Andrieş et al., 2015; Gourene et al., 2019; Tweneboah, 2019; Chekouri et al., 2022).

Let $X_t = (x_{1t}, x_{2t}, \dots, x_{nt})$ denote an n-dimensional stochastic process, and let $W_{jt} = (\omega_{1jt}, \omega_{2jt}, \dots, \omega_{njt})$ represent the corresponding wavelet coefficients at scale λ_j obtained using the MODWT. In the context of this study, X_t represents the vector of variables including the official exchange rate, the parallel exchange rate, and consumer price index. Accordingly, the wavelet coefficients W_{jt} correspond to the multiscale decomposition of these variables across different time horizons.

The Wavelet Multiple Correlation at scale λ_j, denoted by $\phi_X(\lambda_j)$, is defined as:

$$\phi_X(\lambda_j) = \sqrt{1 - \frac{1}{\max \operatorname{diag}(P_j^{-1})}}, \quad (01)$$

where P_j is the correlation matrix of the wavelet coefficients at scale λ_j, and P_j^{-1} denotes its inverse.

For the regression of a given variable z_i on the remaining variables $\{z_k, k \neq i\}$, the coefficient of determination is given by:

$$R_i^2 = 1 - \frac{1}{\rho^{ii}}, \quad (02)$$

where ρ^{ii} denotes the i-th diagonal element of P^{-1}.

Following Fernández-Macho (2012), the WMC can equivalently be expressed as the correlation between the observed wavelet coefficients and their fitted values obtained from multivariate regression at each scale:

$$\phi_X(\lambda_j) = \operatorname{Corr}(\omega_{ijt}, \widehat{\omega}_{ijt}) = \frac{\operatorname{Cov}(\omega_{ijt}, \widehat{\omega}_{ijt})}{\sqrt{\operatorname{Var}(\omega_{ijt}) \operatorname{Var}(\widehat{\omega}_{ijt})}}. \quad (03)$$

The corresponding wavelet covariances and variances are computed as:

$$\mathrm{Cov}(\omega_{ijt}, \widehat{\omega}_{ijt}) = \bar{\gamma}_j = \frac{1}{T_j}\sum_{t=L_j-1}^{T-1} \omega_{ijt}\, \widehat{\omega}_{ijt}, \quad (04)$$

$$\mathrm{Var}(\omega_{ijt}) = \bar{\delta}_j^2 = \frac{1}{T_j}\sum_{t=L_j-1}^{T-1} \omega_{ijt}^2, \quad (05)$$

$$\mathrm{Var}(\widehat{\omega}_{ijt}) = \bar{\xi}_j^2 = \frac{1}{T_j}\sum_{t=L_j-1}^{T-1} \widehat{\omega}_{ijt}^2, \quad (06)$$

where $L_j = (2^j - 1)(L - 1) + 1$ denotes the number of wavelet coefficients affected by boundary conditions for a wavelet filter of length L at scale λ_j, and $T_j = T - L_j + 1$ represents the number of coefficients unaffected by boundary effects.

These definitions ensure consistent and unbiased estimation of multiscale correlations, allowing the WMC to identify dominant sources of interdependence among variables at each time horizon.

5.2.2. Wavelet Local Multiple Correlation (WLMC)

Fernández-Macho (2018) extended the Wavelet Multiple Correlation (WMC) framework by introducing the Wavelet Local Multiple Correlation (WLMC), a methodology designed to capture time-varying co-movement dynamics in multivariate time series. By combining wavelet decomposition with locally weighted regression, WLMC allows the analysis of how multiscale interdependencies evolve over time. Unlike the global WMC, which provides a single correlation measure at each scale for the entire sample, WLMC explicitly accounts for temporal heterogeneity, making it particularly suitable for nonstationary economic and financial data.

Let $\widetilde{\omega}_{ijt}$ denote the MODWT wavelet coefficients for series i at scale λ_j and time t, and let $\widehat{\omega}_{ijt}$ represent the fitted values obtained from the local regression of $\widetilde{\omega}_{ijt}$ on the remaining series. The WLMC at time s and scale λ_j is defined as:

$$\tilde{\phi}_{X,s}(\lambda_j) = \sqrt{1 - \frac{1}{\max \mathrm{diag}\left(\tilde{P}_{j,s}^{-1}\right)}}, \quad (07)$$

where $\tilde{P}_{j,s}$ is the $n \times n$ weighted correlation matrix of the wavelet coefficients W_{jt}, constructed using a kernel weighting function $\theta(t - s)$, and $\max \mathrm{diag}(\cdot)$ selects the largest diagonal element.

Equivalently, WLMC can be expressed in terms of weighted correlations or covariances as:

$$\tilde{\phi}_{X,s}(\lambda_j) = \mathrm{Corr}\left(\theta(t-s)^{1/2}\widetilde{\omega}_{ijt}, \theta(t-s)^{1/2}\widehat{\omega}_{ijt}\right) = \frac{\mathrm{Cov}\left(\theta(t-s)^{1/2}\widetilde{\omega}_{ijt}, \theta(t-s)^{1/2}\widehat{\omega}_{ijt}\right)}{\sqrt{\mathrm{Var}\left(\theta(t-s)^{1/2}\widetilde{\omega}_{ijt}\right)\mathrm{Var}\left(\theta(t-s)^{1/2}\widehat{\omega}_{ijt}\right)}}, \quad s = 1, \ldots, T. \quad (08)$$

In this framework, the series $\widetilde{\omega}_{ijt}$ is selected to maximize $\tilde{\phi}_{X,s}(\lambda_j)$, while $\widehat{\omega}_{ijt}$ denotes the corresponding fitted values from the local regression. This property provides the statistical justification for the term Wavelet Local Multiple Correlation, as the measure captures the strongest local co-movement within the multivariate system.

Applying a MODWT of order J to each univariate series in X yields J vectors of length T containing the wavelet coefficients:
$\widetilde{W}_j = \{\widetilde{W}_{j0}, \dots, \widetilde{W}_{j,T-1}\}, \qquad j = 1, \dots, J.$

Accordingly, the WLMC at a given scale λ_j is a nonlinear function of all $n(n-1)/2$ weighted pairwise correlations among the wavelet coefficients W_{jt}. Alternatively, it can be fully characterized in terms of the corresponding weighted covariances and variances.

Recent empirical studies have increasingly employed the wavelet local multiple correlation (WLMC) framework to examine complex and time-varying interdependencies across a broad range of domains, including the digital economy, renewable energy markets, environmental policy, and global financial systems (Shah et al., 2022; Zhou et al., 2023; Bouri et al., 2023; Ramzan et al., 2024; Hoque et al., 2024). In this study, the WLMC approach complements the global insights provided by the wavelet multiple correlation (WMC) by enabling the identification of specific time horizons and periods during which multivariate relationships intensify or weaken.

5.2.3. Quantile-on-Quantile Regression (QQR)

To investigate the relationship between the quantiles of the dependent variable (y) and those of the explanatory variable (x), we employ the Quantile-on-Quantile Regression (QQR) approach introduced by Sim and Zhou (2015). This methodology enables the analysis of nonlinear and heterogeneous relationships across different segments of the distributions by combining traditional Quantile Regression (QR) with nonparametric estimation techniques.

The QQR model is formally specified as follows (Chang et al., 2022; Alola et al., 2023; Bouri et al., 2023; Zhang et al., 2024):

$$y_t = \beta_0(\theta, \phi) + \beta_1(\theta, \phi)\left(x_t - x^{\phi}\right) + \alpha^{\phi} y_{t-1} + \varepsilon_t^{\theta} \qquad (09)$$

where $\theta, \phi \in [0.05, 0.95]$ denote the quantiles of the dependent and independent variables, respectively, and ε_t^{θ} is the error term whose θ-th conditional quantile is zero.

5.3. Robustness analysis

Alongside the conventional QR estimation, we apply KRLS as a robustness check for the QQR results.

5.3.1. Kernel-based Regularized Least Squares (KRLS)

This study applies the Kernel-based Regularized Least Squares (KRLS) method proposed by Hainmueller and Hazlett (2014) as a robustness and validation tool. KRLS is a machine-learning-based, nonparametric approach that captures complex and nonlinear relationships by estimating pointwise marginal effects across the covariate space (Özkan & Destek, 2025; Alola et al., 2023; Zhou et al., 2022; Ferwerda et al., 2017), thereby enhancing the credibility of the empirical findings. By avoiding restrictive functional form assumptions, KRLS reduces model misspecification bias (Ahmed et al., 2025) and explicitly accounts for nonlinearity and heterogeneity across observations. Consequently, it is well suited for causal inference, prediction, and exploratory analysis in settings where the functional form is unknown (Iorember et al., 2024).

The Kernel-based Regularized Least Squares (KRLS) model is given by:

$$\hat{y} = K(K + \lambda I)^{-1} y \tag{10}$$

where $\hat{y}$ denotes the vector of predicted values, λ is the regularization parameter, K represents the kernel matrix, and I and y denote the identity matrix and the vector of observed responses, respectively.

The kernel function $k(x_i, x_j)$ can be any positive definite function, such as the Radial Basis Function (RBF) kernel, defined as:

$$k(x_i, x_j) = \exp!\left(-\frac{\|x_i - x_j\|^2}{\sigma^2}\right) \tag{11}$$

where σ is a bandwidth parameter that controls the width of the kernel. The KRLS estimator is obtained by minimizing the regularized least squares objective function:

$$\min_{\alpha};\ \|y - K\alpha\|^2 + \lambda \alpha^\top K \alpha \tag{12}$$

where α denotes the vector of coefficients. The solution to the optimization problem is:

$$\alpha = (K + \lambda I)^{-1} y \tag{13}$$

Accordingly, the predicted values are obtained as:

$$\hat{y} = K\alpha = K(K + \lambda I)^{-1} y \tag{14}$$

A key advantage of KRLS is that its results can be interpreted in a manner similar to traditional generalized linear models (GLM). By employing kernel functions as radial basis functions to estimate a flexible surface, KRLS is well suited for modeling heterogeneous effects, nonlinear relationships, and interaction terms (Awan et al., 2022).

6. Results and discussion

6.1. Descriptive statistics, stationarity, and (Non)linearity tests

Descriptive statistics and pairwise correlations are reported in Table 2. The results reject the null hypothesis of normality and confirm that all variables are integrated of order one, I(1), based on the Augmented Dickey–Fuller (ADF) and Phillips–Perron tests. The correlation analysis reveals strong positive associations among the series, consistent with underlying macroeconomic linkages.

Table 2. Descriptive statistics and pairwise correlations

	CPI	OEXH	PEXH
Mean	3.6344	3.3714	4.0722
Std. Dev.	1.2952	1.3517	1.0709
Skewness	-0.5178	-0.4893	-0.7603
Kurtosis	1.7782	1.4953	2.2032
Jarque-Bera	65.2065	81.8804	74.8997
Probability	0.0000	0.0000	0.0000
ADF Test (Δ)	-6.7957***	-6.0570***	-25.5142***
Phillips-Perron Test (Δ)	-24.3596***	-17.0480***	-25.5701***
Correlation			
CPI	1.0000		
OEXH	0.9843	1.0000	
PEXH	0.9621	0.9459	1.0000

*Notes: (Δ) denotes the first difference. *** indicates rejection of the null hypothesis at the 1% significance level. All variables are expressed in natural logarithms.*

These positive associations are further supported by the scatter plots in Figure 3 (a–d), which show that changes in the consumer price index are closely associated with movements in both the official and parallel exchange rates. The results also suggest a positive bidirectional relationship between the official and parallel exchange rates.

Figure 3. The relationship between consumer price index and the parallel and official exchange rates (partial relationship)

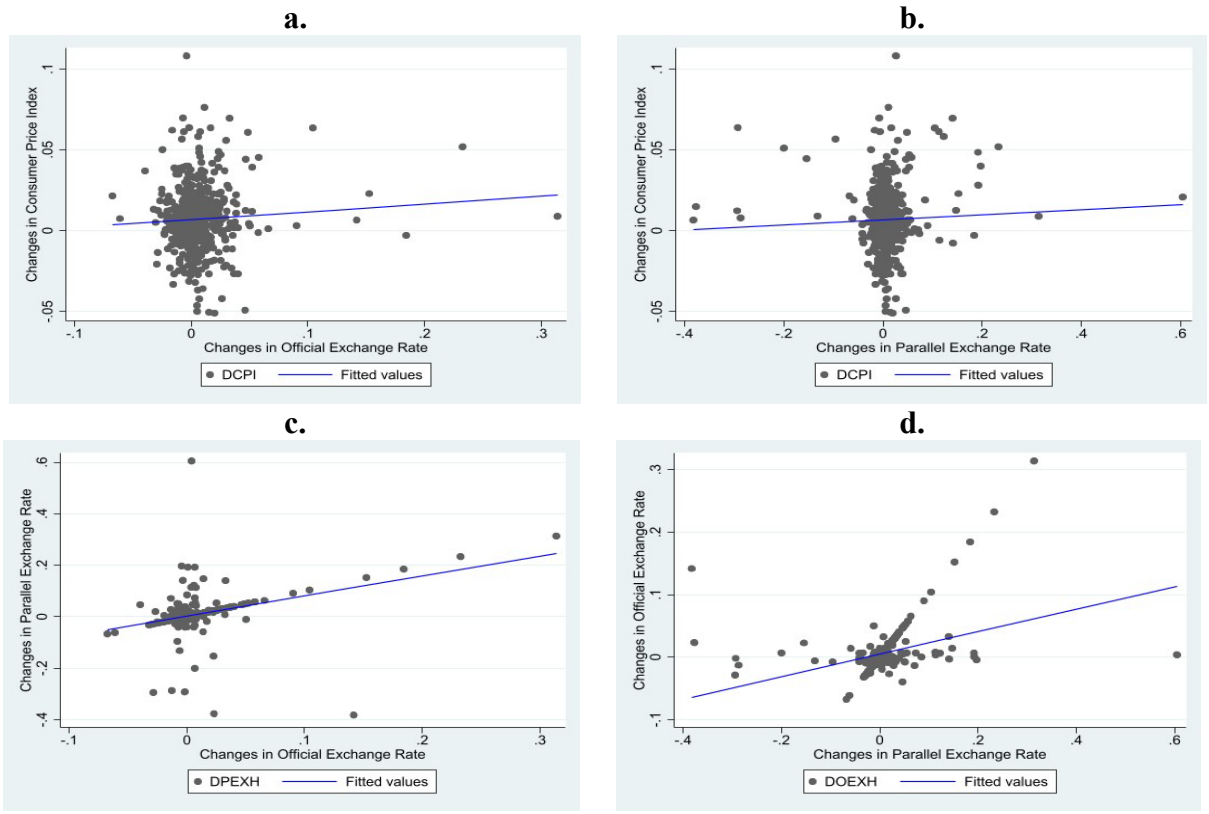


Table 3 reports the BDS test results (Broock et al., 1996), assessing residual independence across embedding dimensions (Dim 2–Dim 6) for the three variables. The test statistics are significant at all examined dimensions ($p < 0.001$), providing strong evidence of serial dependence and underlying nonlinear dynamics. These findings indicate that the residuals deviate from an independently and identically distributed (i.i.d.) process, suggesting that purely linear modeling frameworks may be inadequate to fully capture the variables' dynamic behavior. Consequently, nonlinear approaches such as quantile-on-quantile regression (QQR) are warranted to capture the complex dynamics underlying the relationships among the variables, in line with Alola et al. (2023) and Georgescu and Kinnunen (2025).

Table 3. The results of the BDS test

Variables	Dim 2	Dim 3	Dim 4	Dim 5	Dim 6
CPI	0.2076***	0.3529***	0.4542***	0.5250***	0.5746***
OEXH	0.2085***	0.3536***	0.4544***	0.5244***	0.5729***
PEXH	0.2038***	0.3468***	0.4470***	0.5169***	0.5657***

*Note: Dim denotes the embedding dimension. ***, **, and * indicate rejection of the null hypothesis that the relevant series is independent and identically distributed at the 1%, 5%, and 10% levels, respectively.*

6.2. Wavelet Analysis Results

This section employs Wavelet Multiple Correlation (WMC) and Wavelet Local Multiple Correlation (WLMC) to investigate the multivariate correlation structure and its time-varying dynamics across short-, medium-, and long-run horizons. The primary objective is to identify

potential leading variables within a multivariate system comprising the official and parallel Algerian dinar/U.S. dollar exchange rates (OEXH and PEXH) and consumer price index proxied by the consumer price index (CPI). The analysis is conducted using monthly Algerian data spanning the period from January 1974 to October 2024.

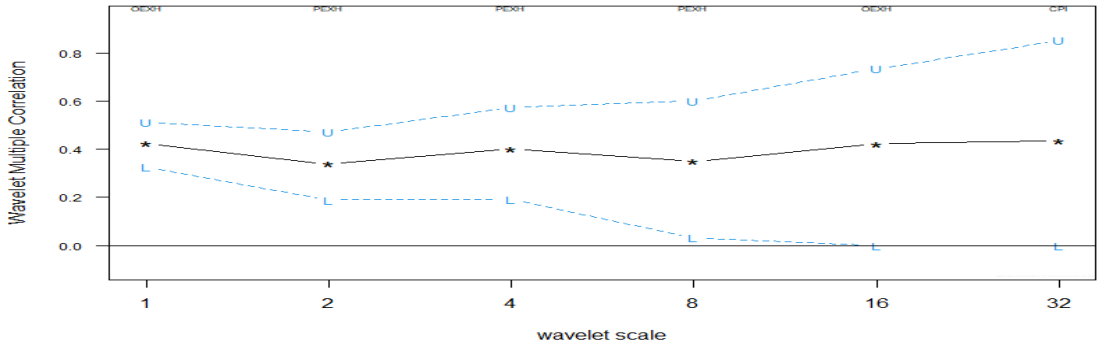
Following Fernández-Macho (2012), Table 4 and Figure 4 report the WMC estimates for the official and parallel DZD exchange rates and CPI across six wavelet scales (J = 1 to J = 6), corresponding to time horizons of 2–4, 4–8, 8–16, 16–32, 32–64, and 64–128 months, respectively. Figure 4 presents the estimated WMC coefficients together with their associated 95% confidence intervals and identifies, for each scale, the variable exhibiting the strongest multivariate correlation, thereby providing insights into the dominant drivers across different frequencies.

Table 4. Wavelet multiple correlation

Level	WMC	Lower bound	Upper bound	Leading variable
J=1	0.423691	0.326773	0.51179	OEXH
J=2	0.338614	0.189636	0.472351	PEXH
J=3	0.400824	0.192791	0.574375	PEXH
J=4	0.348943	0.032933	0.601525	PEXH
J=5	0.422636	0	0.73563	OEXH
J=6	0.434845	0	0.852712	CPI

Notes: Level (J) denotes the time scale, ranging from shorter to longer horizons. WMC represents the degree of correlation among variables. The leading variable is the variable exhibiting the highest WMC at each time scale.

Figure 4. Wavelet multiple correlation for the first log differences of the variables. The dotted lines correspond to the upper and lower bounds of the 95% confidence interval



In the wavelet correlation plots, the plotted curves are interpreted as follows: the upper (U) and lower (L) bounds denote the 95% confidence interval, while the central curve represents the estimated wavelet correlation coefficient (Alkathery et al., 2023).

Figure 4 illustrates the variable that maximizes the multiple correlation among the official exchange rate, the parallel exchange rate, and the consumer price index (CPI) at each wavelet scale.

The multiple wavelet correlations are positive across all scales, ranging from 0.34 to 0.43, indicating moderate co-movements among the variables. They are statistically significant at J

= 1–4. However, significance cannot be confirmed at J = 5 and J = 6, as the lower confidence bounds reach zero, possibly reflecting fewer effective observations at longer scales. Regarding the dominant variable, the parallel exchange rate maximizes the multiple correlation at J = 2–4, while the official exchange rate does so at J = 1 and J = 5, and the CPI at J = 6. The results at J = 5 and J = 6 should therefore be interpreted as indicative rather than conclusive.

In the second step, following Fernández-Macho (2018), the Wavelet Local Multiple Correlation (WLMC) framework is employed to examine the time-varying co-movement among the study variables. The results are presented through a WLMC heat map (Figure 5a) and multiscale time-series plots together with their associated 95% confidence intervals at each wavelet decomposition level (Figure 5b).

Figure 5a displays the WLMC heat map for the official and parallel Algerian dinar exchange rates against the U.S. dollar, together with consumer price index, over the period January 1974–October 2024. Correlation strength is color-coded, with darker red shades indicating stronger co-movement and blue shades representing weaker associations. The results reveal very strong long-term correlations—exceeding 0.8—particularly at the 32–64-month and 64–128-month scales, broadly corresponding to the sub-periods 1974–1999 and 2008–2024. At medium-term horizons (16–32 months), correlations remain relatively strong, generally ranging between 0.6 and 0.8, as reflected by red-to-yellow shading across most sub-periods. By contrast, short-term scales (2–4, 4–8, and 8–16 months) exhibit weaker correlations, predominantly indicated by blue areas, with moderate correlations shown in green. A notable exception occurs during the 2007–2015 period, when short-term correlations intensify (approximately 0.6–0.8), likely reflecting heightened macroeconomic uncertainty associated with the global financial crisis and, more importantly, the 2014 oil price shock. Given the strong dependence of the Algerian economy on hydrocarbon revenues, the sharp decline in oil prices contributed to the deterioration of external balances, the decline in foreign exchange reserves, and mounting pressures on both the official and parallel exchange rates, alongside rising inflationary pressures. These findings are consistent with the analysis presented in Section 4.

Figure 5b identifies the dominant variable across wavelet scales based on its contribution to maximizing the multiple correlation *6. At very short and short horizons (levels 1 and 2), the parallel exchange rate (PEXH) is the dominant variable, highlighting the central role of informal market dynamics and speculative behavior in shaping short-run co-movements. At the short-to-medium horizon (level 3), PEXH remains dominant, while the official exchange rate (OEXH) becomes increasingly important from level 4 onward, as co-movement dynamics become less centered on a single variable. At the medium-to-long-run horizon (level 5), both OEXH and CPI emerge as dominant variables. This pattern may be associated with the growing influence of policy-related adjustments and institutional mechanisms, particularly exchange rate adjustments under the managed float regime. Reports of the Bank of Algeria describe exchange rate adjustments as one of the principal adjustment instruments in the Algerian economy,

[6] One of the key advantages of Wavelet Local Multiple Correlation (WLMC) is its ability to identify the dominant variables that maximize multiple correlation in time–frequency space, as noted by Phiri and Anyikwa (2024).

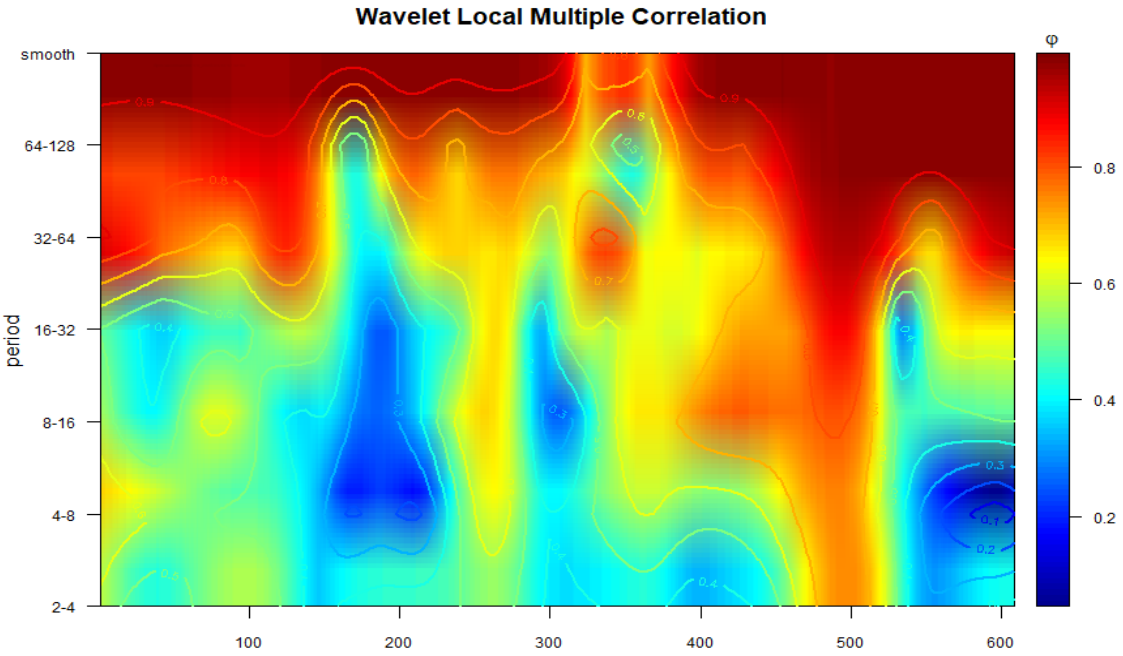
alongside expansionary monetary policy measures, most notably the adoption of unconventional financing in 2017 and the associated expansion in liquidity conditions and relatively higher inflationary pressures. At the long-run horizon (level 6), OEXH and PEXH are jointly dominant. Finally, at the aggregate scale (level S), co-movement among the variables remains persistently strong and positive, reinforcing the presence of sustained interdependencies across time scales. However, a notable exception is observed around 2015 (approximately the 500th observation), when correlations strengthen across different time scales, reflecting the effects of the sharp decline in oil prices during that period, in line with the preceding analysis.

The 95% confidence intervals, with both lower and upper bounds above zero, confirm that the estimated correlations are positive and statistically significant at the 5% level, providing further evidence of significant co-movements among the variables.

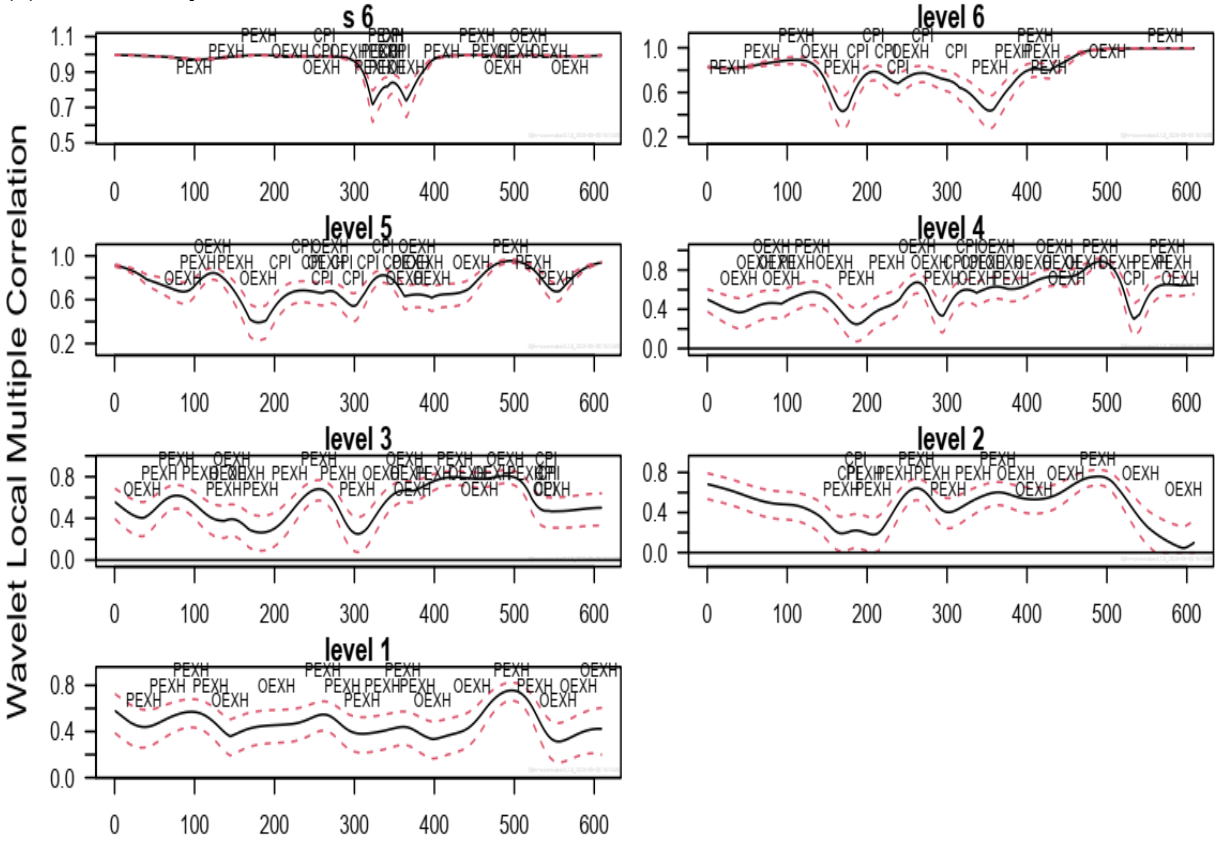
Building on the WMC and WLMC results, which identify the official and parallel exchange rates as the dominant variables across most time scales, the subsequent subsection applies the Quantile-on-Quantile Regression (QQR) approach to investigate the directional relationships among the variables along four dimensions: (i) the effect of the official exchange rate on the consumer price index (CPI), (ii) the effect of the parallel exchange rate on the CPI, (iii) the effect of the parallel exchange rate on the official exchange rate, and (iv) the effect of the official exchange rate on the parallel exchange rate.

Figure 5. Wavelet Local Multiple Correlation for the First Log Differences of the Variables

(a) Wavelet Local Multiple Correlation (WLMC) heat map



(b) WLMC line plots across six wavelet scales



6.3. Quantile-on-Quantile Regression (QQR) results

The Quantile-on-Quantile Regression (QQR) framework[7] is employed to capture the asymmetric, nonlinear, and heterogeneous relationship between official and parallel exchange rates and consumer price index across different quantiles of their conditional distributions. Figure 6 (a–d) presents the QQR estimation results as three-dimensional response surfaces, revealing notable variations in both the magnitude and direction of the estimated coefficients across quantiles. The horizontal axes denote the quantile levels of the explanatory and dependent variables, whereas the vertical axis reports the estimated QQR coefficients. The color gradient represents the range of the estimated QQR coefficients, where dark blue denotes strong negative effects, light blue reflects weak negative effects, green indicates moderate effects, while yellow-to-orange regions represent increasingly strong positive effects.

Figure 6a illustrates the effect of the official exchange rate (indirect quotation) on consumer price index. The results indicate that the official exchange rate exerts a predominantly positive influence on consumer price index across most quantiles, reflecting the well-established link between official currency depreciation and inflationary pressures. This influence is particularly pronounced at lower consumer price index quantiles (0.10–0.15) and remains evident, albeit weaker, around the median consumer price index quantiles (0.50–0.55). The official exchange rate is often used as a key adjustment instrument to absorb oil price shocks in the national economy. However, exchange rate depreciation frequently contributes to higher consumer price index, particularly following periods of declining oil prices and increases in the money supply-to-output ratio, as observed during the 1990s and between mid-2014 and 2021.

By contrast, the findings also reveal negative responses within specific quantile regions. These responses are particularly evident when medium quantiles of the official exchange rate (0.20–0.55) coincide with high consumer price index quantiles (0.80–0.85), suggesting that greater exchange rate flexibility may help mitigate inflationary pressures under certain monetary and macroeconomic conditions. Additional negative responses, although less pervasive, are observed when the exchange rate ranges from low to high quantiles (0.25–0.90) while consumer price index remains at lower quantiles (0.05–0.10). Overall, these findings underscore the heterogeneous nature of exchange rate pass-through to prices across different quantiles.

These findings are consistent with Howard (2025), who found that a 1% depreciation of the Nigerian naira increased inflation by approximately 0.43%, indicating significant exchange rate pass-through. The results also align with Madouri (2023), who reported a positive and statistically significant relationship between exchange rate changes and inflation in Algeria, whereby a 1% increase in the annual exchange rate change led to a 0.61% rise in inflation. Moreover, the findings are in line with Bello et al. (2022), who documented that exchange rate

[7] The conventional bivariate Quantile-on-Quantile Regression (QQR) approach is applied instead of the multivariate specification in order to isolate the direct nonlinear relationship between the variables while minimizing potential joint effects associated with additional regressors.

volatility in Nigeria was positively associated with inflation, the trade balance, and industrial output. Earlier evidence for Algeria provided by Souissi (2017) and Lacheheb and Sirag (2019) likewise showed that exchange rate movements exerted a positive and statistically significant effect on inflation in both the short and long run.

Figure 6b reports the effects of the parallel exchange rate on consumer price index and reveals a predominantly positive relationship across most quantiles. This relationship is particularly pronounced at higher consumer price index quantiles (0.85–0.90), suggesting that depreciation in the parallel market intensifies inflationary pressures during periods of heightened price instability. Moderate positive effects are also observed at medium (0.55–0.60) and lower consumer price index quantiles.

Nevertheless, the findings also reveal negative responses within specific quantile regions. These responses are especially evident when high consumer price index quantiles (0.70–0.80) coincide with low parallel exchange rate quantiles (0.05–0.25), as well as when high consumer price index quantiles interact with medium-to-high parallel exchange rate quantiles (0.55–0.90). Overall, these heterogeneous patterns highlight the nonlinear and state-dependent nature of exchange rate pass-through from the parallel market to prices.

These findings are consistent with Matsvai (2025) and Bouteldja and Faïza (2023), and align with Sirag (2021), who documented asymmetric exchange rate pass-through to consumer price index and a positive, statistically significant effect of the parallel market exchange rate across different regimes.

Figure 6c examines the influence of the parallel exchange rate on the official exchange rate and reveals a predominantly positive effect across most quantiles, indicating that depreciation in the parallel market exerts upward pressure on the official exchange rate. This effect is particularly pronounced when medium official exchange rate quantiles (0.50–0.60) interact with medium-to-high parallel exchange rate quantiles (0.50–0.90), as well as when high official exchange rate quantiles (0.85–0.90) coincide with low-to-medium parallel exchange rate quantiles (0.25–0.60). Negative effects are confined to a limited number of quantile combinations. Overall, these findings may reflect persistent pressures consistent with currency overvaluation. This interpretation is consistent with Madouri and Tchoketch-Kebir (2024), Chibi and Chekouri (2021), and Dorsainvil (2000), as well as earlier evidence reported by Baliamoune-Lutz (2010), Baliamoune-Lutz and Lutz (2008), and Bahmani-Oskooee and Tanku (2006b), while differing from the results of Bui (2018).

Figure 6d reveals a heterogeneous relationship between the official and parallel exchange rates in Algeria, with predominantly positive responses prevailing across most quantiles, although the magnitude of these responses varies considerably. Strong positive impacts are concentrated at the lower (0.10–0.15) and medium (0.50–0.55) quantiles of the parallel exchange rate, whereas moderate positive responses emerge when medium quantiles of the parallel exchange rate interact with medium-to-high quantiles of the official exchange rate. Across the remaining

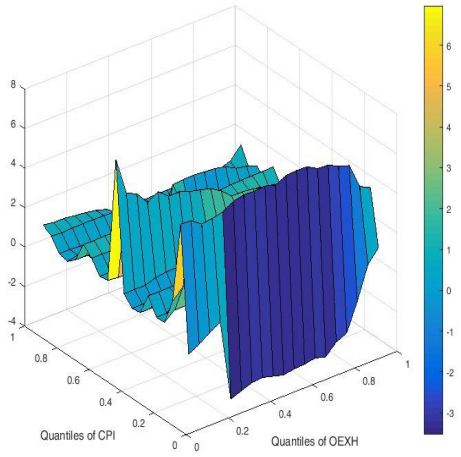
regions, the positive influence appears relatively weaker. These findings are consistent with Bouazizi (2020).

The predominantly positive effects of the official exchange rate on the parallel market rate may suggest that the prevailing exchange rate management framework faces certain challenges in narrowing the gap between the two markets. This pattern is broadly consistent with the findings of Li and Song (2024) and Ogbulu and Torbira (2017), as well as the evidence reported by Nkurunziza (2002), which highlights the important role of depreciation expectations in shaping the parallel market premium.

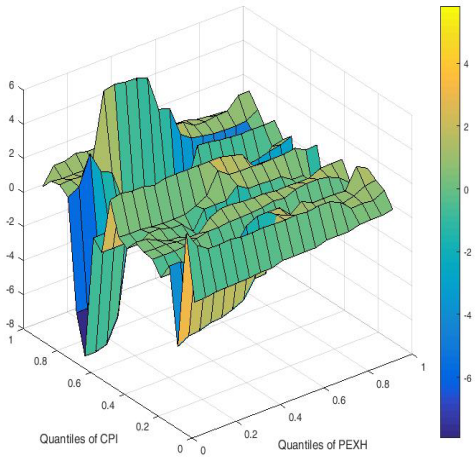
Conversely, negative responses remain confined to limited quantile regions, particularly when low quantiles of the parallel exchange rate interact with low-to-high quantiles of the official exchange rate. Additional negative responses emerge across several medium- and high-quantile interactions, although their magnitude remains comparatively weaker across most parts of the quantile surface. These results suggest that greater exchange rate flexibility may partially narrow the gap between official and parallel exchange rates, particularly when accompanied by a more depreciated yet still managed exchange rate, thereby helping avoid sustained reserve depletion and a widening parallel market premium, as discussed by Gray (2021). Overall, our findings are consistent with Ebaidalla (2017) and IMF recommendations on enhancing exchange rate flexibility to contain the parallel market premium in Algeria (IMF, 2018, 2023).

Figure 6. 3D visualization of the QQR model

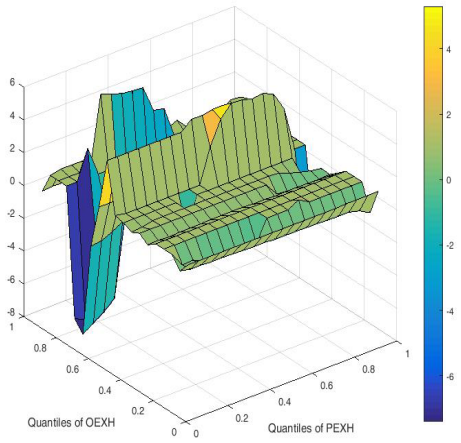
A: Effect of the Official Exchange Rate (*OEXH*) on Consumer price index (*CPI*)



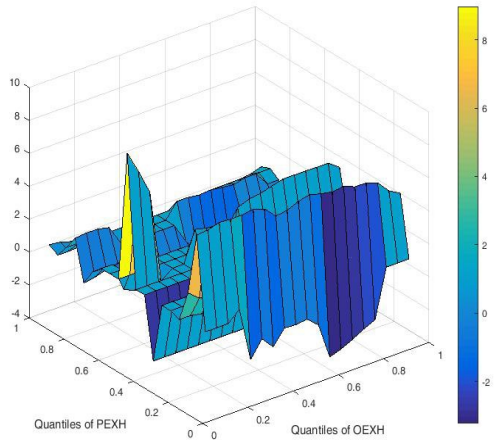
B: Effect of the Parallel Exchange Rate (*PEXH*) on Consumer price index (*CPI*)



C: Effect of the Parallel Exchange Rate (PEXH) on the Official Exchange Rate (OEXH)



D: Effect of the Official Exchange Rate (OEXH) on the Parallel Exchange Rate (PEXH)



6.4. Robustness tests

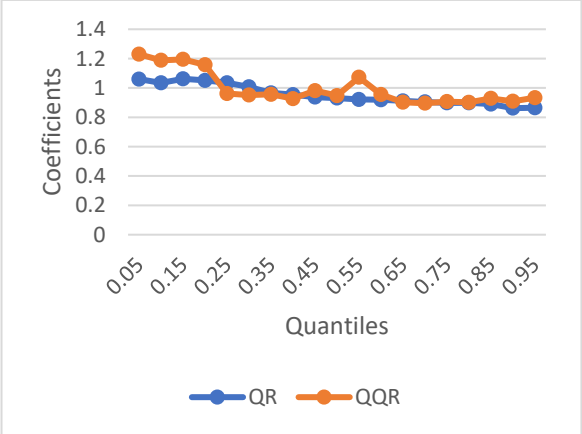
To assess the validity of the QQR estimates, we conduct two robustness checks. First, we employ the conventional quantile regression (QR) model to evaluate the consistency of the QQR results.

Figure 7 presents four panels (a–d), where the blue lines denote the conventional QR estimates and the red lines represent the corresponding QQR estimates. The comparative trend analysis reveals substantial alignment between the two approaches, with only minor deviations across quantiles, thereby reinforcing the robustness of the QQR framework. This consistency supports the view that QQR captures heterogeneous relationships more effectively than conventional QR. Notably, QR is widely used as a benchmark for validating QQR estimates in recent applied

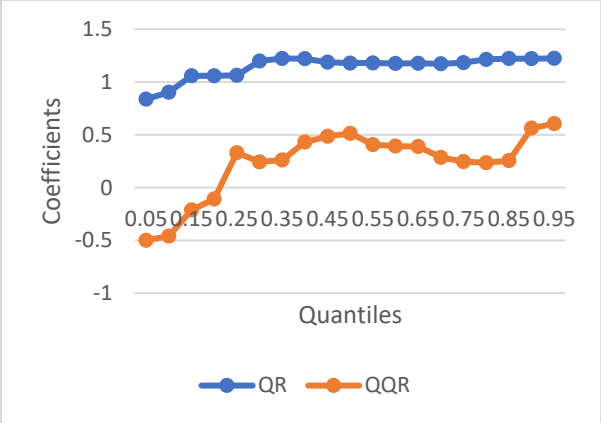
empirical studies (Adebayo et al., 2022; Sinha et al., 2023; Zhang et al., 2023; Jahanger et al., 2024; Rao et al., 2024; Huang et al., 2024).

Figure 7. QR vs. QQR trends

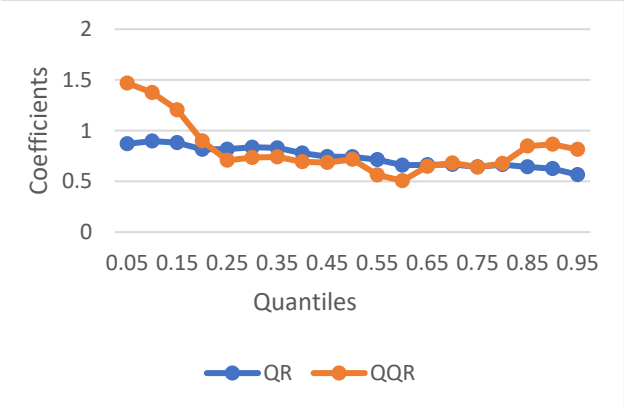
A: Effect of the Official Exchange Rate (OEXH) on Consumer price index (CPI)



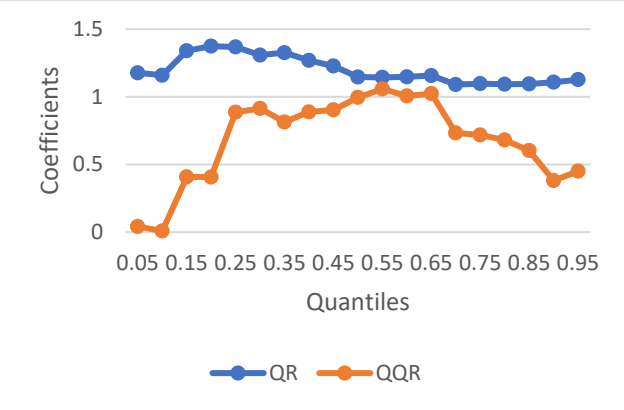
B: Effect of the Parallel Exchange Rate (PEXH) on Consumer price index (CPI)



C: Effect of the Parallel Exchange Rate (PEXH) on the Official Exchange Rate (OEXH)



D: Effect of the Official Exchange Rate (OEXH) on the Parallel Exchange Rate (PEXH)



Second, to further assess the robustness of the QQR estimates, we apply the Kernel-based Regularized Least Squares (KRLS) approach, following Özkan and Destek (2025), Alola et al. (2023), and Awan et al. (2022). Figure 8 illustrates the pointwise marginal effects of the official and parallel exchange rates of the Algerian dinar against the U.S. dollar on consumer price index, together with the bidirectional effects between the two exchange rates. The red line depicts the smoothed marginal responses, while the blue dots represent the observed responses across quantiles of the dependent variable. Table 5 reports the corresponding average marginal effects.

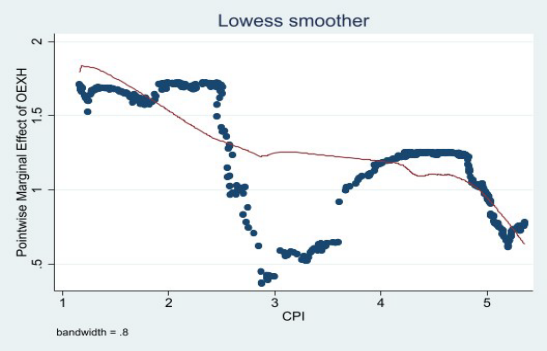
Figure 8 (a–d) shows that both the official exchange rate (OEXH) and the parallel exchange rate (PEXH) exert positive and statistically significant effects on consumer price index (CPI) in Algeria. In addition, bidirectional positive responses are observed between the two exchange rates. Consistent with these findings, Table 5 indicates that, on average, a 1% depreciation in

the official exchange rate and the parallel market exchange rate raises consumer price index by 1.24% and 0.953%, respectively, in line with the exchange rate pass-through mechanism.

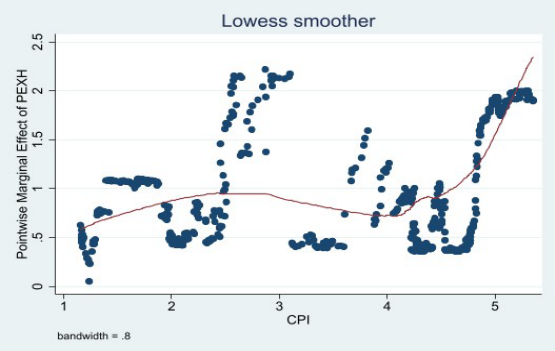
Moreover, a 1% increase in the parallel market exchange rate is associated with a statistically significant 0.789% increase in the official exchange rate, suggesting that developments in the parallel market may influence exchange rate expectations and potentially affect the effectiveness of exchange rate management. In turn, a 1% increase in the official exchange rate is associated with a statistically significant 1.281% rise in the parallel market exchange rate, which may suggest that the current exchange rate regime faces certain challenges in containing parallel market pressures, as discussed earlier.

Figure 8. KRLS pointwise marginal effect plots

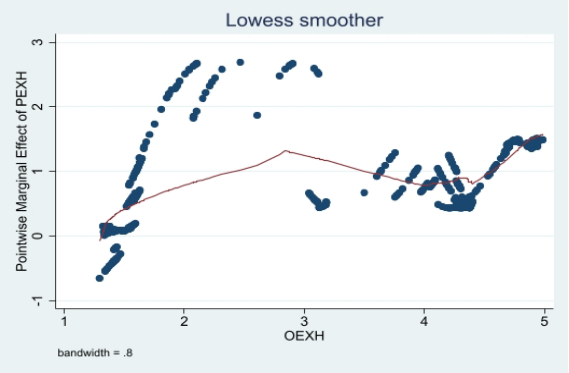
A: Effect of the Official Exchange Rate (OEXH) on Consumer price index (CPI)



B: Effect of the Parallel Exchange Rate (PEXH) on Consumer price index (CPI)



C: Effect of the Parallel Exchange Rate (PEXH) on the Official Exchange Rate (OEXH)



D: Effect of the Official Exchange Rate (OEXH) on the Parallel Exchange Rate (PEXH)

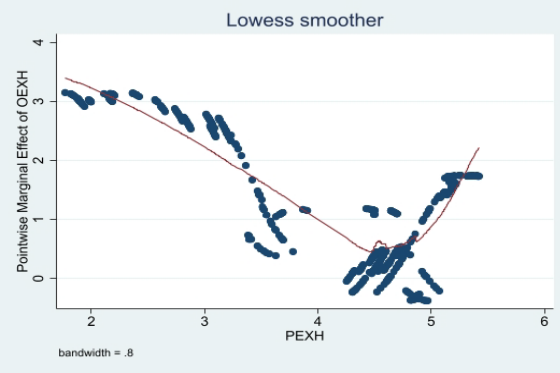


Table 5. KRLS average marginal effects

Dependent Variable	Independent Variable	Avg.	SE	t	P>t	Q25	Q50	Q75
Panel (a)								
CPI	OEXH	1.240***	0.026	47.138	0.000	1.030	1.246	1.617
Diagnostics								
Number of obs = 610	R^2	0.977	Lambda	0.690	Sigma	1	Looloss	18.80
Panel (b)								
CPI	PEXH	0.953***	0.028	34.232	0.000	0.446	0.755	1.366
Diagnostics								
Number of obs = 610	R^2	0.944	Lambda	0.589	Sigma	1	Looloss	44.42
Panel (c)								
OEXH	PEXH	0.789***	0.026	30.368	0.000	0.441	0.599	1.310
Diagnostics								
Number of obs = 610	R^2	0.954	Lambda	0.768	Sigma	1	Looloss	38.74
Panel (d)								
PEXH	OEXH	1.281***	0.030	42.870	0.000	0.212	1.159	2.486
Diagnostics								
Number of obs = 610	R^2	0.964	Lambda	0.290	Sigma	1.000	Looloss	24.35

*Note: *** $p < 0.01$ and ** $p < 0.05$. Q25, Q50, and Q75 represent the quartiles of marginal effects.*

Finally, evidence from the KRLS pointwise marginal effects reinforces the robustness of the QQR estimates and further supports the results obtained from the linear specification presented in Figure 3.

7. Conclusion

Understanding the linkages between the official and parallel exchange rates, and their implications for macroeconomic performance, remains a central challenge for policy formulation and economic assessment in developing economies characterized by segmented foreign exchange markets and persistent uncertainty (Ardakani & Saenz, 2025; Li & Song, 2024). In this context, the present study provides a comprehensive analysis of the dynamic interrelationships and co-movements among the official exchange rate, the parallel exchange rate, and consumer price index in Algeria over the period from January 1974 to October 2024.

As a preliminary step, the study provides an overview of the evolution of Algeria's exchange rate system and dinar convertibility following the monetary reforms of the early 1990s. It also traces the parallel exchange rate premium since 1964, highlighting the factors underlying the persistent divergence between official and parallel exchange rates.

The Wavelet Multiple Correlation (WMC) results show that the parallel exchange rate maximizes the multiple correlation at short- to medium-term horizons (J = 2–4), while the official exchange rate does so at J = 1 and J = 5, and the consumer price index at J = 6. The results are statistically significant at levels 1 to 4, while those at levels 5 and 6 are not statistically significant and should therefore be regarded as indicative.

Consistent with these findings, the Wavelet Local Multiple Correlation (WLMC) results, which are statistically significant across all levels, show that the parallel exchange rate is the variable that maximizes the correlation at short-term horizons, whereas the official exchange rate gradually gains prominence as the variable maximizing the correlation at medium-term horizons. At longer-term horizons, the official exchange rate and consumer price index emerge

as the variables that maximize the correlation at level 5, while the official and parallel exchange rates jointly maximize the correlation at level 6. The WLMC heat map further reveals very strong long-run correlations at the 32–64 and 64–128-month scales, with coefficients exceeding 0.8, indicating sustained structural interdependencies among the variables. Correlations remain relatively strong at medium-term horizons (16–32 months) but comparatively weaker in the short run, except during the 2007–2015 period, when co-movements intensified markedly following the global financial crisis and the 2014 oil price shock.

The Quantile-on-Quantile Regression (QQR) results reveal pronounced nonlinear and state-dependent relationships between exchange rates and the consumer price index (CPI) in Algeria. Both the official exchange rate and the parallel market exchange rate exert positive effects on the CPI across most quantiles, indicating an asymmetric exchange rate pass-through mechanism. Moreover, movements in the parallel foreign exchange market appear to exert upward pressure on the official exchange rate. The official exchange rate, in turn, maintains a positive influence on the parallel market rate.

As a robustness check, the QQR findings remain broadly consistent with the conventional Quantile Regression (QR) estimates. The KRLS estimates further support these results, revealing positive and statistically significant effects of both the official and parallel exchange rates on consumer price index, alongside positive bidirectional effects between the two exchange rates.

Based on these findings, the study advances three main policy recommendations. First, further improving the convertibility of the Algerian dinar may help alleviate pressures in the parallel foreign exchange market. Second, greater exchange rate flexibility over the medium and long term may help narrow the gap between the official and parallel exchange rates through gradual exchange rate convergence, in line with IMF recommendations for Algeria (IMF, 2018, 2023, 2024, 2025). Third, mitigating exchange rate pass-through to domestic prices could help contain inflationary pressures and maintain price stability.

The study focuses on the official exchange rate, the parallel exchange rate, and consumer price index, in line with its central research question. Incorporating additional macroeconomic determinants could provide broader insights into these relationships and offer a valuable avenue for future research to extend the analysis within a more comprehensive empirical framework.

Data Availability Statement: The data used in this study are available from the corresponding author upon reasonable request. WLMC is estimated using the wavemulcor package in R, following Fernández-Macho (2012, 2018), which is available from the CRAN archive at https://cran.r-project.org/src/contrib/Archive/wavemulcor/. QQR is estimated using the replication code provided by Jahanger et al. (2024), accessible via https://doi.org/10.1016/j.eneco.2024.107568. KRLS is estimated using the Stata command developed by Ferwerda et al. (2017), available at https://doi.org/10.18637/jss.v079.i03.

References

Acharyya, R. (2001). Exchange rate policy and black-market premium on foreign exchange: Theory and evidence. Economic and Political Weekly, 1984-1990. http://www.jstor.org/stable/4410695

Adebayo, T. S., Agyekum, E. B., Kamel, S., Zawbaa, H. M., & Altuntaş, M. (2022). Drivers of environmental degradation in Turkey: designing an SDG framework through advanced quantile approaches. Energy Reports, 8, 2008-2021. https://doi.org/10.1016/j.egyr.2022.01.020

Adejoh, E. I. (2025). Threshold effects of parallel currency market premium on inflation in Nigeria. NACESTMAK Multidisciplinary Journal, 2(1). https://nigerianjournalsonline.org/index.php/NMJ/article/view/2499/2336

Agénor, P. R. (1990a). Stabilization policies in developing countries with a parallel market for foreign exchange: A formal framework. IMF Staff Papers, 37(3), 560-592. https://doi.org/10.5089/9781557752192.071

Agénor, P. R. (1990b). Parallel currency markets in developing countries: Theory, evidence, and policy implications. IMF Working Paper No. 90/114. https://ies.princeton.edu/pdf/E188.pdf

Agénor, P. R. (1991). A monetary model of the parallel market for foreign exchange. Journal of Economic Studies, 18(4). https://doi.org/10.1108/EUM0000000000153

Agénor, P. R., & Taylor, M. P. (1993). The causality between official and parallel exchange rates in developing countries. Applied Financial Economics, 3(3), 255-266. https://doi.org/10.1080/758535731

Agénor, P.-R. (1990c). Exchange restrictions and devaluation crises. IMF Working Paper No. 1990/084. https://doi.org/10.5089/9781451954340.001

Agénor, P.-R., & Flood, R. P. (1992). Unification of Foreign Exchange Markets. Staff Papers - International Monetary Fund, 39(4), 923. https://doi.org/10.5089/9781451930825.024

Ahmed, Z., Pinzon, S., & Rasheed, M. Q. (2025). Unlocking marginal SDG dynamics: a KRLS machine learning analysis of AI technologies and solar energy. Geoscience Frontiers, 102167. https://doi.org/10.1016/j.gsf.2025.102167

Ajja, J. (2007). The Algerian Experience in Organizing Foreign Trade: From State Monopoly to Private Monopoly. Al-Khaldounia Publishing and Distribution, Algiers. ISBN 978-9961-52-226-4. (In Arabic)

Akgiray, V., Aydogan, K., Booth, G. G., & Booth, L. (1989). A causal analysis of black and official exchange rates: The Turkish case. Weltwirtschaftliches Archiv, 125(2), 337–345. https://doi.org/10.1007/BF02707564

Alkathery, M. A., Chaudhuri, K., & Nasir, M. A. (2023). Dependence between the GCC energy equities, global clean energy and emission markets: Evidence from wavelet analysis. *Energy Economics*, *121*, 106659. https://doi.org/10.1016/j.eneco.2023.106659

Alola, A. A., Özkan, O., & Usman, O. (2023). Examining crude oil price outlook amidst substitute energy price and household energy expenditure in the USA: a novel nonparametric multivariate QQR approach. Energy Economics, 120, 106613. https://doi.org/10.1016/j.eneco.2023.106613

Andreff, W. (2009). Réformes, libéralisation, privatisation en Algérie: point de vue d'un outsider en 1988-1994. Confluences Méditerranée, (4), 41-62. https://doi.org/10.3917/come.071.0041

Andrieş, A. M., Ihnatov, I., & Tiwari, A. K. (2015). Comovement of Exchange Rates: A Wavelet Analysis. Emerging Markets Finance and Trade, 52(3), 574–588. https://doi.org/10.1080/1540496X.2014.998563

Ardakani, O. M., & Saenz, M. (2025). Interdependence Dynamics of Official and Informal Argentine Exchange Rates through Copulas. Computational Economics, 1-18. https://doi.org/10.1007/s10614-025-10965-6

Aron, J., & Elbadawi, I. (1992). Parallel Markets, the Foreign Exchange Auction, and Exchange Rate Unification in Zambia. WPS 909, The World Bank. https://www.researchgate.net/publication/23723871_Parallel_Markets_the_Foreign_Exchange_Auction_and_Exchange_Rate_Unification_in_Zambia

Awan, A., Sadiq, M., Hassan, S. T., Khan, I., & Khan, N. H. (2022). Combined nonlinear effects of urbanization and economic growth on CO2 emissions in Malaysia. An application of QARDL and KRLS. Urban Climate, 46, 101342. https://doi.org/10.1016/j.uclim.2022.101342

Azam, J. P., & Besley, T. (1989). General equilibrium with parallel markets for goods and foreign exchange: Theory and application to Ghana. World Development, 17(12), 1921-1930. https://doi.org/10.1016/0305-750X(89)90271-4

Bahmani-Oskooee, M. (1996). The black-market exchange rate and demand for money in Iran. Journal of Macroeconomics, 18(1), 171-176. https://doi.org/10.1016/S0164-0704(96)80010-3

Bahmani-Oskooee, M., & Shiva, R. (1998). A method of detecting whether a central bank engages in the black market for foreign exchange: Evidence from Iran. Economics Letters, 60(1), 97-103. https://doi.org/10.1016/S0165-1765(98)00078-0

Bahmani-Oskooee, M., & Tanku, A. (2006a). Black market exchange rate, currency substitution and the demand for money in LDCs. Economic Systems, 30(3), 249-263. https://doi.org/10.1016/j.ecosys.2006.04.001

Bahmani-Oskooee, M., & Tanku, A. (2006b). Do the black market and the official exchange rates converge in the long run? Journal of Economics and Finance, 30(1), 57–69. https://doi.org/10.1007/BF02834275

Bakhsh, S., Zhang, W., Ali, K., & Anas, M. (2024). Transition towards environmental sustainability through financial inclusion and digitalization in China: Evidence from novel quantile-on-quantile regression and wavelet coherence approach. Technological Forecasting and Social Change, 198, 123013. https://doi.org/10.1016/j.techfore.2023.123013

Baliamoune-Lutz, M. (2010). Black and official exchange rates in Morocco: An analysis of their long-run behaviour and short-run dynamics (1974–1992). Applied Economics, 42(27), 3481-3490. https://doi.org/10.1080/00036840802112463

Baliamoune-Lutz, M., & Lutz, S. (2008). Official and black market exchange rates in Tunisia. Journal of Business and Behavioral Sciences, 19(1), 113-122. https://ssrn.com/abstract=1405057

Bank of Algeria (2004). Annual report on the economic and monetary developments in Algeria–Year 2003, pp. 1–118. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/02/rapport-ba-2003fr.pdf (accessed April 20, 2025)

Bank of Algeria (2005). Annual report on the economic and monetary developments in Algeria– Year 2004, pp. 1–180. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/02/rapport-ba-2004fr.pdf (accessed April 20, 2025)

Bank of Algeria (2006). Annual report on the economic and monetary developments in Algeria– Year 2005, pp. 1–192. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/01/rapport-annuel-2005-fr.pdf (accessed April 20, 2025)

Bank of Algeria (2009). Annual report on the economic and monetary developments in Algeria– Year 2008, pp. 1–250. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/01/rapport-annuel-2008-fr.pdf (accessed April 20, 2025)

Bank of Algeria (2011). Annual report on the economic and monetary developments in Algeria – Year 2010, pp. 1–178. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/01/rapport-annuel-2010-fr.pdf (accessed April 20, 2025)

Bank of Algeria (2012). Annual report on the economic and monetary developments in Algeria – Year 2011, pp. 1–174. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/01/rapport-annuel-2011-fr.pdf (accessed April 20, 2025)

Bank of Algeria (2019). Annual report on the economic and monetary developments in Algeria – Year 2018, pp. 1–170. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/02/rapport-ba-2018fr.pdf (accessed April 20, 2025)

Bank of Algeria (2020). Annual report on the economic and monetary developments in Algeria – Year 2019, pp. 1–129. (In French) https://www.bank-of-algeria.dz/wp-content/uploads/2023/02/rapport-ba-2019fr.pdf (accessed April 20, 2025)

Bank of Algeria (2025). Annual report on the economic and monetary developments in Algeria– Year 2024, pp. 1–136. (In French) https://www.bank-of-algeria.dz/stoodroa/2025/09/Rapport-2024-fr.pdf

Bello, K. M. (2024). Parallel exchange rate market and macroeconomic performance in Nigeria: SVAR approach. SN Business & Economics, 4(11), 136. https://doi.org/10.1007/s43546-023-00609-y

Bello, K. M., Olayungbo, D. O., & Folorunso, B. A. (2022). Exchange rate volatility and macroeconomic performance in Nigeria. In Macroeconomic Analysis for Economic Growth. IntechOpen. https://doi.org/10.5772/intechopen.100444

Benachenhou, A. (1993). Inflation et chômage en Algérie: les aléas de la démocratie et des réformes économiques. Maghreb-Machrek, (1), 28-41. https://doi.org/10.3917/machr1.139.0028

Benbouziane, M., Benhabib, A., & Ziani, T. (2005). Marché de Change Informel et Mésalignement: Le cas du Dinar Algérien. Les cahiers du mecas, Volume 1, Numéro 1, Pages 118-131. https://asjp.cerist.dz/en/article/12869

Benissad, M. E. (1979). Economie du développement de l'Algérie (1962-1978): sous-développement et socialisme. Economica.

Benissad, M. E. (1989). Algérie : aspects généraux de la réforme économique. Annales de l'université d'Alger 4.1.

Bhagwati, J. N., & Hansen, B. (1975). A Theoretical Analysis of Smuggling: A Reply. The Quarterly Journal of Economics, 89(4), 651. https://doi.org/10.2307/1884699

Biswas, B., & Nandi, S. (1986). The black market exchange rate in a developing economy: The case of India. Indian Economic Journal, 33(3), 23. https://files01.core.ac.uk/download/pdf/19984881.pdf

Blejer, M. I. (1978). Black-market exchange-rate expectations and the domestic demand for money. Journal of Monetary Economics, 4(4), 767–773. https://doi.org/10.1016/0304-3932(78)90028-4

Booth, G. G., & Mustafa, C. (1991). Long-run dynamics of black and official exchange rates. Journal of International Money and Finance, 10(3), 392-405. https://doi.org/10.1016/0261-5606(91)90017-E

Bouazizi, S.E. (2020). The Determinants of the Expansion of the Exchange Rate on the Black Market in the Maghreb. Financial Markets, Institutions and Risks, *4*(1), 32-39. http://doi.org/10.21272/fmir.4(1).32-39.2020.

Boucekkine, R., Laksaci, M., & Touati-Tliba, M. (2021). Long-run stability of money demand and monetary policy: The case of Algeria. The Journal of Economic Asymmetries, 24, 1-20. https://doi.org/10.1016/j.jeca.2021.e00217

Boukhezer-Hammiche, N. (2013). Libéralisation financière et effet sur l'investissement en Algérie. Mondes en développement, 162(2), 131-146. https://doi.org/10.3917/med.162.0131

Bouri, E., Nekhili, R., & Todorova, N. (2023). Dynamic co-movement in major commodity markets during crisis periods: A wavelet local multiple correlation analysis. Finance Research Letters, 55, 103996. https://doi.org/10.1016/j.frl.2023.103996

Bouteldja, A., & Faïza, S. (2023). Black Market Exchange Rate and Macroeconomic Performance in Algeria: What Impact? The Eurasia Proceedings of Educational and Social Sciences, 32, 39-54. https://doi.org/10.55549/epess.1412792

Bouteldja, A., & Sifeeddine, B. (2024). On the Reliability of Black-Market Exchange Rate: Evidence from Algeria. The Eurasia Proceedings of Educational and Social Sciences, 37, 104-113. https://doi.org/10.55549/epess.863

Bouteldja, A., Benamar, A., & Maliki, S. (2013). The black market exchange rate and demand for money in Algeria. MPRA Paper 75280, University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/75280/2/MPRA_paper_75241.pdf

Bouteldja, A., Faïza, S. M., & Sifeeddine, B. (2024). Black Market Exchange Rate, Currency Substitution and Demand for Money. The Eurasia Proceedings of Educational and Social Sciences, 35, 10-18. https://doi.org/10.55549/epess.796

Broock, W. A., Scheinkman, J. A., Dechert, W. D., & LeBaron, B. (1996). A test for independence based on the correlation dimension. *Econometric Reviews*, 15(3), 197-235. https://doi.org/10.1080/07474939608800353

Bui, M. T. (2018). Causality in Vietnam's parallel exchange rate system during 2005–2011: policy implications for macroeconomic stability. Economies, 6(4), 68. https://doi.org/10.3390/economies6040068

Cerra, M. V. (2016). Inflation and the black market exchange rate in a repressed market: A model of Venezuela. International Monetary Fund. https://doi.org/10.5089/9781475523201.001

Chang, L., Taghizadeh-Hesary, F., Chen, H., & Mohsin, M. (2022). Do green bonds have environmental benefits? Energy Economics, 115, 106356. https://doi.org/10.1016/j.eneco.2022.106356

Chekouri, S. M., Chibi, A., & Benbouziane, M. (2022). Identifying Algeria's de facto exchange rate regime: a wavelet-based approach. Journal of Economic Structures, 11(1), 15. https://doi.org/10.1186/s40008-022-00277-5

Cheung, Y. W., & Lai, K. S. (2008). Nominal exchange rate flexibility and real exchange rate adjustment: New evidence from dual exchange rates in developing countries. *Japan and the World Economy, 20*(3), 415–434. https://doi.org/10.1016/j.japwor.2007.01.002

Chiali, H. (2004). Les variations du taux de change réel influencent-elles l'inégalité des revenus entre zones urbaines et rurales en Algérie ? Université de Montréal. https://papyrus.bib.umontreal.ca/xmlui/bitstream/handle/1866/223/a1.1g944.pdf.

Chibi, A., & Chekouri, S. M. (2021). The Exchange Rate Regime in Oil-Producing Countries: Applying Frankel's (2018) Model to the case of Algeria. Economic Insights Journal, University of El Oued, Algeria, pp. 15–36. (In Arabic) https://asjp.cerist.dz/en/article/175466

Conseil National Economique, Social et Environnemental (CNESE). (2004). Le secteur informel : illusions et réalités, 24-ème Session Plénière, Juin. https://www.cnese.dz/web/content?model=cnese_backend.post_doc&field=document&id=224

Corm, G. (1993). La réforme économique algérienne: une réforme mal aimée? Maghreb-Machrek, (1), 9-27. https://doi.org/10.3917/machr1.139.0009

Culbertson, W. P. (1975). Purchasing power parity and black-market exchange rates. Economic Inquiry, 13(2), 287–296. https://doi.org/10.1111/j.1465-7295.1975.tb00995.x

De Macedo, J. B. (1987). Currency inconvertibility, trade taxes and smuggling. Journal of Development Economics, 27(1–2), 109–125. https://doi.org/10.1016/0304-3878(87)90009-5

Degefa, D. (2001). The parallel foreign exchange market and macroeconomic performance in Ethiopia. AERC Research Paper 107, African Economic Research Consortium, Nairobi. https://aercafrica.org/old-website/wp-content/uploads/2018/07/RP107.pdf

Diamandis, P. F., & Drakos, A. A. (2005). Long-run dynamics of official and black-market exchange rates in Latin America. Global Finance Journal, 15(3), 219-237. https://doi.org/10.1016/j.gfj.2004.05.001

Dornbusch, R., Dantas, D. V., Pechman, C., de Rezende Rocha, R., & Simoes, D. (1983). The Black Market for Dollars in Brazil. The Quarterly Journal of Economics, 98(1), 25. https://doi.org/10.2307/1885565

Dorsainvil, K. (2000). Collapsing exchange rate regimes in the presence of a parallel market. Applied Economics, 32(6), 671-680. https://doi.org/10.1080/000368400322282

Dorsainvil, K. (2001). The parallel market as a policy instrument in collapsing exchange rate regimes. Journal of Economics and Business, 53(1), 27–43. https://doi.org/10.1016/S0148-6195(00)00039-4

Ebaidalla, E. M. (2017). Determinants and Macroeconomic Impact of Parallel Market for Foreign Exchange in Sudan. In Economic Research Forum Working Papers (No. 1155). https://erf.org.eg/app/uploads/2017/11/1155.pdf

Elbadawi, I. (1992). Macroeconomic Management and the Black Market for Foreign Exchange in Sudan (Vol. 859). World Bank Publications. https://documents1.worldbank.org/curated/en/199011468760819394/pdf/multi0page.pdf

Elsafoury, E. Y. (2025). Exchange rate pass-through from parallel foreign exchange markets. Harvard College, Department of Applied Mathematics, Cambridge, MA. https://harvardwiki.atlassian.net/wiki/external/NGY5NDE4ZjgzNTc5NDQzMGIzZWZhMGFlOWI2M2EwYTg

Ezema, C. A. (2018). Responsiveness of foreign exchange parallel premium to selected macroeconomic aggregates in Nigeria, 1981–2017 (Doctoral dissertation, Enugu State University of Science and Technology, Faculty of Management Sciences, Enugu, Nigeria).

Fernández-Macho, J. (2012). Wavelet multiple correlation and cross-correlation: A multiscale analysis of Eurozone stock markets. Physica A: Statistical Mechanics and its Applications, 391(4), 1097-1104. https://doi.org/10.1016/j.physa.2011.11.002

Fernández-Macho, J. (2018). Time-localized wavelet multiple regression and correlation. Physica A: Statistical Mechanics and its Applications, 492, 1226-1238. https://doi.org/10.1016/j.physa.2017.11.050

Ferwerda, J., Hainmueller, J., & Hazlett, C. J. (2017). Kernel-based regularized least squares in R (KRLS) and Stata (krls). Journal of Statistical Software, 79, 1-26. https://doi.org/10.18637/jss.v079.i03

Fofack, H., & Nolan, J. P. (2001). Distribution of parallel exchange rates in African countries. Journal of International Money and Finance, 20(7), 987–1001. https://doi.org/10.1016/S0261-5606(01)00031-6

Frenkel, M. (1990). Exchange rate dynamics in black markets. Journal of Economics, 52(2), 159–176. https://www.jstor.org/stable/41795267

Gamache, N. (2020). The Issue of the Parallel Foreign Exchange Market in Algeria. Doctoral dissertation, Ferhat Abbas University Setif 1, Algeria. (In Arabic)

Georgescu, I., & Kinnunen, J. (2025). Assessing the Impact of Nuclear Energy on Load Capacity, Economic Growth, and Innovation: A Quantile-on-Quantile Analysis for Finland. Journal of Cleaner Production, 145693. https://doi.org/10.1016/j.jclepro.2025.145693

Ghei, N., & Kiguel, M. A. (1992). Dual and multiple exchange rate systems in developing countries: Some empirical evidence (No. 881). The World Bank. https://documents1.worldbank.org/curated/en/329561468741323782/pdf/multi0page.pdf

Goldberg, L. S., & Karimov, I. (1997). Black markets for currency, hoarding activity and policy reforms. Journal of International Economics, 42(3-4), 349–369. https://doi.org/10.1016/S0022-1996(96)01454-7

Gourene, G. A. Z., Mendy, P., & Diomande, L. (2019). Beginning an African stock markets integration? A wavelet analysis. Journal of Economic Integration, 34(2), 370-394. https://doi.org/10.11130/jei.2019.34.2.370

Gray, S. (2021). Official and Parallel Exchange Rates—Recognizing Reality. IMF Working Paper WP/21/25. https://www.imf.org/en/-/media/files/publications/wp/2021/english/wpiea2021025-print-pdf.pdf

Greenwood, J., & Kimbrough, K. P. (1987). Foreign exchange controls in a black market economy. Journal of Development Economics, 26(1), 129-143. https://doi.org/10.1016/0304-3878(87)90055-1

Grosse, R. (1992). Colombia's black market in foreign exchange. World Development, 20(8), 1193-1207. https://doi.org/10.1016/0305-750X(92)90010-S

Gupta, S. (1980). An application of the monetary approach to black market exchange rates. Review of World Economics, 116, 235-252. https://www.jstor.org/stable/40438457

Gurhy, B., Lee, K., & Garimella, S. R. (2025). Potential Drivers of Post-Reform Parallel Market Premium: Federal Democratic Republic of Ethiopia (IMF Selected Issues Paper No. 2025/105). International Monetary Fund. https://doi.org/10.5089/9798229017084.

Hainmueller, J., & Hazlett, C. (2014). Kernel regularized least squares: Reducing misspecification bias with a flexible and interpretable machine learning approach. Political Analysis, 22(2), 143-168. https://doi.org/10.1093/pan/mpt019

Hassan, M. K., Choudhury, K., & Waheeduzzaman, M. (1995b). On black market exchange rate and demand for money in developing countries: The case of Nigeria. Atlantic Economic Journal, 23(1), 35-44. https://doi.org/10.1007/BF02298988

Hassan, M. K., Islam, M. M., & Nakibullah, A. (1995a). Black Market Exchange Rate Expectations and the Demand for Money. The Case of SAARC Countries. In International Finance in the New World Order (pp. 119-130). Pergamon. https://doi.org/10.1016/B978-0-08-042410-1.50015-2

Henni, A. (1987). Monnaie, crédit et financement en Algérie (1962-1987). CREAD, Alger.

Henni, A. (1994). Ajustement, économie parallèle et contre-société. In NAQD, n° 7, Réajustement structurel & systèmes politiques, Alger. https://doi.org/10.3917/naqd.007.0050

Henni, A. (2009). La réforme monétaire et financière en Algérie : enseignements pour une transition vers le marché dans un pays en voie de développement. Confluences Méditerranée, (4), 27-40. https://doi.org/10.3917/come.071.0027

Hoque, M. E., Billah, M., Alam, M. R., & Lucey, B. (2024). Does news related to digital economy and central bank digital currency affect digital economy ETFs? Evidence from TVP-VAR connectedness and wavelet local multiple correlation analyses. Global Finance Journal, 100992. https://doi.org/10.1016/j.gfj.2024.100992

Howard, C. C. (2025). An Analysis of Exchange Rate Fluctuations and Inflation Dynamics in Nigeria. Asian Basic and Applied Research Journal, 7(1), 459-476. https://doi.org/10.56557/abaarj/2025/v7i1189

Huang, S., Gubareva, M., Teplova, T., & Bossman, A. (2024). African forex markets: Modeling their predictability and the asymmetric effects of oil and geopolitical risk. *Energy Economics*, 107679. https://doi.org/10.1016/j.eneco.2024.107679

Huett, H., Krapf, M., & Uysal, S. D. (2014). Price dynamics in the Belarusian black market for foreign exchange. Journal of International Economics, 94(1), 169-176. https://doi.org/10.1016/j.jinteco.2014.06.002

Ilmane, M.-C. (2012). Les trois phases de développement du système bancaire et monétaire algérien. Revue des sciences commerciales et de gestion, 8(1), 217-299. https://asjp.cerist.dz/en/article/155732

IMF. (1997). Press Release: Algeria Accepts Article VIII Obligations (No 97/47). https://www.imf.org/en/news/articles/2015/09/14/01/49/pr9747

IMF. (2005). Algeria: Selected Issues, Report No. 05/52. https://www.imf.org/external/pubs/ft/scr/2005/cr0552.pdf

IMF. (2006). Algérie : Consultations de 2005 au titre de l'article IV (No 06/93). Staff Report; And Statement By The Executive Director For Algeria. https://doi.org/10.5089/9781451811490.002

IMF. (2018). Algeria: 2018 Article IV consultation—Press release (No. 18/168), staff report, and statement by the Executive Director for Algeria. IMF Country Report. https://doi.org/10.5089/9781484361702.002

IMF. (2019). Review of the Fund's policy on multiple currency practices: Initial considerations—Economic context and experiences—Background paper II (No. 21/253). International Monetary Fund. https://doi.org/10.5089/9781498318860.007

IMF. (2023). Algeria: 2023 Article IV consultation—Press release (No. 23/68), staff report, and statement by the Executive Director for Algeria. IMF Country Report. https://doi.org/10.5089/9798400233395.002

IMF. (2024). Algeria: 2024 Article IV consultation—Press release (No. 24/88), staff report, and statement by the Executive Director for Algeria. IMF Country Report. https://doi.org/10.5089/9798400271878.002

IMF. (2025). Algeria: 2025 Article IV consultation—Press release and staff report. IMF Country Report No. 25/270. https://doi.org/10.5089/9798229026000.002

Iorember, P. T., Yusoff, N. Y. M., Abachi, P. T., Usman, O., & Alola, A. A. (2024). Effect of exchange rate uncertainty, energy prices and sectoral spending on agriculture value added, household consumption, and domestic investment. Heliyon, 10(9). https://doi.org/10.1016/j.heliyon.2024.e30138

Jahanger, A., Hossain, M. R., Awan, A., & Adebayo, T. S. (2024). Uplifting India from severe energy poverty accounting for strong asymmetries: Do inclusive financial development, digitization and human capital help reduce the asymmetry? *Energy Economics*, 134, 107568. https://doi.org/10.1016/j.eneco.2024.107568

Kamin, S. B. (1993). Devaluation, exchange controls, and black markets for foreign exchange in developing countries. Journal of Development Economics, 40(1), 151-169. https://doi.org/10.1016/0304-3878(93)90108-Y

Kanas, A., & Kouretas, G. P. (2007). Regime dependence between the official and parallel foreign currency markets for US dollars in Greece. Journal of Macroeconomics, 29(2), 431-449. https://doi.org/10.1016/j.jmacro.2005.11.003

Kiguel, M. A., & O'Connell, S. A. (1995). Parallel Exchange Rates in Developing Countries: Lessons from Eight Case Studies. The World Bank Research Observer, 10(1), 21–52. https://documents1.worldbank.org/curated/en/690401468766186922/pdf/multi0page.pdf

Kouretas, G. P., & Zarangas, L. P. (2001). Black and official exchange rates in Greece: an analysis of their long-run dynamics. Journal of Multinational Financial Management, 11(3), 295-314. https://doi.org/10.1016/S1042-444X(01)00024-X

Krugman, P. (1979). A model of balance-of-payments crises. Journal of Money, Credit and Banking, 11(3), 311–325. https://doi.org/10.2307/1991793

Lacheheb, M., & Sirag, A. (2019). Oil price and inflation in Algeria: A nonlinear ARDL approach. The Quarterly Review of Economics and Finance, 73, 217-222. https://doi.org/10.1016/j.qref.2018.12.003

Li, H., & Song, T. (2024). Regime dependent dynamics of parallel and official exchange markets in China: evidence from cryptocurrency. Applied Economics, 56(41), 4952-4973. https://doi.org/10.1080/00036846.2023.2227418

Lindauer, D. L. (1989). Parallel, fragmented, or black? Defining market structure in developing economies. World Development, 17(12), 1871-1880. https://doi.org/10.1016/0305-750X(89)90267-2

Madouri, A. (2023). Oil Price and Inflation Nexus in Algeria: A nonlinear ARDL Approach. Journal of Development and Economic Policies, 25(1), 41-79. https://doi.org/10.34066/jodep.23.25.1.2

Madouri, A., & Tchoketch-Kebir, H. (2024). Alternative Exchange Rate Systems for Oil-Exporting
Countries: Frankel's Currency-Plus-Commodity Basket Proposal versus the Current System. Financial
Markets, Institutions and Risks, 8(2), 15-36. https://doi.org/10.61093/fmir.8(2).15-36.2024

Madouri, A., Tchoketch-Kebir, H., Chekouri, S. M., & Chibi, A. (2026). Oil prices, exchange rates, and foreign reserves in Algeria: A quantile-based empirical analysis. *SN Business & Economics*, *6*(7), 224. https://doi.org/10.1007/s43546-026-01211-8

Malpass, D. (2023). The parallel exchange rate problem: The World Bank's approach to helping people in developing countries. World Bank Blogs. https://blogs.worldbank.org/en/voices/parallel-exchange-rate-problem-world-banks-approach-helping-people-developing-countries (accessed May 10, 2025).

Matsvai, S. (2025). Exchange Rates and Inflation Dynamics in Multicurrency Regimes: The Case of Zimbabwe (2014 to 2024). International Journal of Financial Studies, 13(2), 93. https://doi.org/10.3390/ijfs13020093

Merghit, A. (2014). Foreign exchange control in Algeria: Incentive or obstacle to meeting economic development requirements? Al-Hikma Journal of Economic Studies, 2(3), 55–75. (In Arabic) https://asjp.cerist.dz/en/article/40114

Merghit, A. (2018). Exchange rate management in Algeria in light of the transition to a flexible exchange rate system: An analytical and evaluative study (Doctoral dissertation, Ferhat Abbas University, Setif 1), pp. 1–325. (In Arabic)

Mezouaghi, M. (2015). L'économie algérienne : chronique d'une crise permanente. Politique étrangère, (03), 17-29. https://doi.org/10.3917/pe.153.0017

Mohammed, K. S., & Mellit, A. (2023). The relationship between oil prices and the indices of renewable energy and technology companies based on QQR and GCQ techniques. Renewable Energy, 209, 97–105. https://doi.org/10.1016/j.renene.2023.03.123

Morris, S. (1995). Inflation dynamics and the parallel market for foreign exchange. Journal of Development Economics, 46(2), 295-316. https://doi.org/10.1016/0304-3878(94)00065-K

Mutin, G. (1965). Le commerce extérieur de l'Algérie en 1964. In : Revue de géographie de Lyon, 40(4), 345-365. https://www.persee.fr/doc/geoca_0035-113x_1965_num_40_4_1786

Nkurunziza, J. D. (2002). Exchange rate policy and the parallel market for foreign currency in Burundi. AERC Research Paper No. 123. African Economic Research Consortium. https://aercafrica.org/old-website/wp-content/uploads/2018/07/RP123.pdf

Noorbakhsh, A., & Shahrokhi, M. (1993). The official and black (parallel) foreign exchange markets: Causal relationships: Empirical evidence. Global Finance Journal, 4(1), 65-76. https://doi.org/10.1016/1044-0283(93)90014-P

Nowak, M. (1984). Quantitative Controls and Unofficial Markets in Foreign Exchange: A Theoretical Framework. Staff Papers-International Monetary Fund, 404-431. https://www.elibrary.imf.org/view/journals/024/1984/002/article-A005-en.xml

Ogbulu, O. M., & Torbira, L. L. (2017). Transmission effect of the interaction between parallel and official foreign exchange markets in Nigeria. International Journal of Economics and Financial Research, 3(6), 76-90

Ogun, O. (2015). Determination of parallel market exchange rate premium. Modern Economy, 6(2), 268–279. https://doi.org/10.4236/me.2015.62026

Onour, I. A., & Cameron, N. E. (1997). Parallel market premia and misalignment of official exchange rates. Journal of Economic Development, 22(1). https://ssrn.com/abstract=629541

Ozcelebi, O. (2021). Assessing the impacts of global economic policy uncertainty and the long-term bond yields on oil prices. Applied Economic Analysis, 29(87), 226–244. https://doi.org/10.1108/AEA-05-2020-0046

Özkan, O., & Destek, M. A. (2025). Assessing Energy Transition Effectiveness in CO2 Emission Reduction: A Novel Indicator for BRIC Nations. Sustainable Futures, 100773. https://doi.org/10.1016/j.sftr.2025.100773

Pascallon, P., & de Laulanie, J. F. (1971). L'expérience monétaire algérienne, du satellisme à l'indépendance monétaire. Revue Algérienne des Sciences Juridiques, Economiques et Politiques, (1), 43.

Percival, D. B., & Walden, A. T. (2000). Wavelet Methods for Time Series Analysis. Cambridge University Press, Cambridge, England. https://doi.org/10.1017/CBO9780511841040

Phiri, A., & Anyikwa, I. (2025). A multiscale analysis of returns and volatility spillovers in cryptocurrency markets: A post-COVID perspective. Investment Analysts Journal, 54(1), 21–41. https://doi.org/10.1080/10293523.2024.2333069

Pinto, B. (1988). Black markets for foreign exchange, real exchange rates, and inflation: overnight versus gradual reform in sub-Saharan Africa (Vol. 84). World Bank Publications. https://documents1.worldbank.org/curated/en/675851468742830474/pdf/multi0page.pdf

Pinto, B. (1991). Black markets for foreign exchange, real exchange rates and inflation. Journal of International Economics, 30(1-2), 121–135. https://doi.org/10.1016/0022-1996(91)90008-T

Pitt, M. M. (1984). Smuggling and the black market for foreign exchange. Journal of International Economics, 16(3-4), 243-257. https://doi.org/10.1016/S0022-1996(84)80003-3

Ramzan, M., Razi, U., Kanwal, A., & Adebayo, T. S. (2024). An analytical link of disaggregated green energy sources in achieving carbon neutrality in China: a policy based novel wavelet local multiple correlation analysis. Progress in Nuclear Energy, 167, 104986. https://doi.org/10.1016/j.pnucene.2023.104986

Rao, J., Ali, S., Nazar, R., & Anser, M. K. (2024). From darkness to light: Unveiling the asymmetric nexus between energy poverty and environmental quality in South Asia. Heliyon, 10(5). https://doi.org/10.1016/j.heliyon.2024.e27100

Rehman, H. U., & Afzal, M. (2003). The black-market exchange rate and stability of demand for money in Pakistan: A cointegration analysis. Pakistan Economic and Social Review, 13-28.

Reinhart, C. (2002). A modern history of exchange rate arrangements: Parallel markets and dual and multiple exchange rates, MPRA Paper 13194, University Library of Munich, Germany. https://mpra.ub.uni-muenchen.de/13194/1/MPRA_paper_13194.pdf

Shachmurove, Y. (1999). The premium in black foreign exchange markets: evidence from developing economies. Journal of Policy Modeling, 21(1), 1-39. https://doi.org/10.1016/S0161-8938(97)00091-4

Shah, M. I., Foglia, M., Shahzad, U., & Fareed, Z. (2022). Green innovation, resource price and carbon emissions during the COVID-19 times: New findings from wavelet local multiple correlation analysis. Technological Forecasting and Social Change, 184, 121957. https://doi.org/10.1016/j.techfore.2022.121957

Sheikh, M. A. (1976). Black market for foreign exchange, capital flows and smuggling. Journal of Development Economics, 3(1), 9–26. https://doi.org/10.1016/0304-3878(76)90038-9

Siddiki, J. U. (2000). Black market exchange rates in India: an empirical analysis. Empirical Economics, 25, 297-313. https://doi.org/10.1007/s001810000020

Sim, N., & Zhou, H. (2015). Oil prices, US stock return, and the dependence between their quantiles. Journal of Banking & Finance, 55, 1-8. https://doi.org/10.1016/j.jbankfin.2015.01.013

Sinha, A., Ghosh, V., Hussain, N., Nguyen, D. K., & Das, N. (2023). Green financing of renewable energy generation: Capturing the role of exogenous moderation for ensuring sustainable development. *Energy Economics*, 126, 107021. https://doi.org/10.1016/j.eneco.2023.107021

Sirag, A. (2021). Modelling the Effect of the Parallel Exchange Rate on Inflation Dynamic, Arab Monetary Fund. https://www.amf.org.ae/sites/default/files/publications/2021-12/modeling-effect-parallel-exchange-rate-dynamics-inflation-english.pdf

Souissi, M. (2017). Determinants of inflation. In Algeria: Selected issues (IMF Country Report No. 17/142). International Monetary Fund. https://doi.org/10.5089/9781484302675.002

Talahite, F. (2000a). La réforme bancaire et financière en Algérie. Cahiers du CREAD, (52), 93-122. https://asjp.cerist.dz/en/article/13582

Talahite, F. (2000b). Economie administrée, corruption et engrenage de la violence en Algérie. Revue tiers Monde, 49-74. https://www.persee.fr/doc/tiers_1293-8882_2000_num_41_161_1050

Temmar, H. M. (1974). Structures et modèle de développement de l'économie de l'Algérie. SNED, Alger.

Temmar, H. M. (1983). Stratégie de développement indépendant : le cas de l'Algérie, un bilan. OPU, Alger.

Troster, V., Shahbaz, M., & Uddin, G. S. (2018). Renewable energy, oil prices, and economic activity: A Granger-causality in quantiles analysis. Energy Economics, 70, 440–452. https://doi.org/10.1016/j.eneco.2018.01.029

Tweneboah, G. (2019). Dynamic interdependence of industrial metal price returns: evidence from wavelet multiple correlations. Physica A: Statistical Mechanics and Its Applications, 527, 121153. https://doi.org/10.1016/j.physa.2019.121153

World Bank Group. (1994). Algeria - Country economic memorandum: The transition to a market economy (Report No. 12048-AL). The World Bank. https://documents1.worldbank.org/curated/en/891481468742871622/pdf/multi0page.pdf (accessed May 10, 2025).

Zhang, J., Ali, S., & Ping, L. (2023). Asymmetric linkages between nuclear energy and environmental quality: Evidence from Top-10 nuclear energy consumer countries. Nuclear Engineering and Technology, 55(5), 1878-1884. https://doi.org/10.1016/j.net.2023.01.006

Zhang, W., Bakhsh, S., Ali, K., & Anas, M. (2024). Fostering environmental sustainability: An analysis of green investment and digital financial inclusion in China using quantile-on-quantile regression and wavelet coherence approach. Gondwana Research, 128, 69-85. https://doi.org/10.1016/j.gr.2023.10.014

Zhou, R., Abbasi, K. R., Salem, S., Almulhim, A. I., & Alvarado, R. (2022). Do natural resources, economic growth, human capital, and urbanization affect the ecological footprint? A modified dynamic ARDL and KRLS approach. Resources Policy, 78, 102782. https://doi.org/10.1016/j.resourpol.2022.102782

Zhou, Y., Adebayo, T. S., Yin, W., & Abbas, S. (2023). The co-movements among renewable energy, total environmental tax, and ecological footprint in the United Kingdom: Evidence from wavelet local multiple correlation analysis. *Energy Economics*, 126, 106900. https://doi.org/10.1016/j.eneco.2023.106900

Zouache, A., & Ilmane, M. C. (2008). Central bank independence in a MENA transition economy. Monetary policy and central banking in the Middle East and North Africa, 85. http://ndl.ethernet.edu.et/bitstream/123456789/51729/1/44.pdf.pdf

Appendix

Table A1: Phases of Dinar Convertibility

Phases	Legislation, Regulations, Instructions, and Annual Reports of the Bank of Algeria
Preparatory Phase (1990–1993)	• Law No. 90-10 of April 14, 1990, concerning Money and Credit regulated the foreign exchange market and capital movements in Chapter VI. The Law allowed non-residents to transfer capital to Algeria and to repatriate it abroad, subject to the conditions stipulated in Articles 183 and 184. It also permitted residents to transfer capital abroad, subject to the conditions set forth in Article 187. Article 188 designated the Central Bank as the authority responsible for regulating the foreign exchange market, while Article 189 prohibited the application of multiple exchange rates for the Algerian dinar. • Regulation No. 90-05 of 30 December 1990 establishing partial convertibility of the dinar through mandatory bond investments. • Regulation No. 91-03 of 20 February 1991 on the conditions for carrying out transactions involving the importation of goods into Algeria and their financing. • Regulation No. 91-07 of 14 August 1991 establishing foreign exchange rules and conditions. • Regulation No. 92-04 of 22 March 1992 on foreign exchange controls. Article 25 allowed every resident in Algeria to acquire and freely hold foreign currency payment instruments within Algeria, subject to the prescribed conditions.
Core Phase	• Regulation No. 94-11 of 12 April 1994 amending Regulation No. 91-03 of 20 February 1991 on the conditions for carrying out transactions involving the importation of goods into Algeria and their financing. • Regulation No. 95-07 of 23 December 1995 amending and replacing Regulation No. 92-04 of 22 March 1992 on foreign exchange controls. • Instruction No. 08-96 of 18 December 1996 setting out the conditions for the establishment and licensing of foreign exchange offices. • Instruction No. 09-96 of 19 December 1996 establishing a foreign exchange entitlement for resident nationals pursuing their studies abroad. • Instruction No. 10-96 of 19 December 1996 establishing a foreign exchange entitlement for resident nationals requiring medical treatment abroad. • Instruction No. 02-97 of 30 March 1997 on the export of foreign currency. • Instruction No. 08-97 of 28 August 1997 on the foreign exchange entitlement for travel abroad. • According to Bank of Algeria reports (2009, 2011), the process of establishing current account convertibility of the Algerian dinar was completed in 1997, following Algeria's acceptance of the obligations under Article VIII of the Articles of Agreement of the International Monetary Fund (IMF). The provisions of Regulation No. 95-07 also played an important role in reinforcing the dinar's current account convertibility.
Enhancement Phase (2005–Present)	• Regulation No. 2005-03 of 6 June 2005 on foreign investment establishes the procedures for converting dividends, profits, and net proceeds arising from the disposal or liquidation of foreign investments executed in the economic activity sector. • Regulation No. 2007-01 of 3 February 2007 on the rules applicable to current transactions with foreign countries and foreign currency accounts. • Instruction No. 02-2007 of May 31, 2007, precisely defines the scope of current transactions eligible for convertibility. These include nine main categories: foreign trade in goods, transportation operations, insurance and reinsurance activities, financial services, travel, technical assistance and production-related operations, telecommunications, income, and other current transactions. • Instruction No. 05-2007 of 11 June 2007 amending and supplementing Instruction No. 02-07 on transactions relating to current transactions with foreign countries. • Regulation No. 2011-06 of 19 October 2011 amending and supplementing Regulation No. 07-01 of 15 Muharram 1428, corresponding to 3 February 2007, on the rules applicable to current transactions with foreign countries and foreign currency accounts. • Regulation No. 2016-01 of 6 March 2016 amending and supplementing Regulation No. 2007-01 of 3 February 2007 on the rules applicable to current transactions with foreign countries and foreign currency accounts. • Regulation No. 2016-02 of 21 April 2016 setting the declaration threshold for the importation and exportation of banknotes and/or negotiable instruments denominated in freely convertible foreign currencies by residents and non-residents. • Regulation No. 2016-04 of 17 November 2016 amending and supplementing Regulation No. 2007-01 of 3 February 2007 on the rules applicable to current transactions with foreign countries and foreign currency accounts. • Law No. 23-09 of June 21, 2023 on Monetary and Banking Law constitutes the regulatory framework governing the management and operation of the Bank of Algeria and defining its responsibilities and operations. Chapter VII of the Law addresses matters relating to external financial relations and foreign exchange. • Regulation No. 23-01 of September 21, 2023, governs the licensing, accreditation, and operation of foreign exchange offices. • Regulation No. 24-05 of 13 October 2024 amending and supplementing Regulation No. 16-02 of 21 April 2016 setting the declaration threshold for the importation and exportation of banknotes and/or negotiable instruments denominated in freely convertible foreign currencies by residents and non-residents. • Instruction No. 05-2025 of 17 July 2025 on the foreign exchange allowance for travel abroad.

Source: Compiled by the authors based on the laws, regulations, instructions, and annual reports issued by the Bank of Algeria. For more detailed information, please consult the following official links: https://www.bank-of-algeria.dz/loi-monnaie-et-credit/ | https://www.bank-of-algeria.dz/devises-reglement/ | https://www.bank-of-algeria.dz/importations-exportations-instruction/ https://www.bank-of-algeria.dz/rapports-annuels/