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The Impact of Exchange Rate on the Automobile, Housing, Stock Markets, and Consumer Price Index: A Nonlinear Autoregressive Distributed Lag Approach

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ABSTRACT

This study aims to investigate the asymmetric effects of exchange rate fluctuations on the automobile, housing, and stock markets, as well as the consumer price index (CPI), in Iran over the period 1991–2022 (1370–1401 in the Persian calendar). To analyze the data, positive and negative exchange rate shocks were first computed using the Nonlinear Autoregressive Distributed Lag (NARDL) model. Subsequently, the impacts of these shocks on the prices in the automobile, housing, and stock markets, as well as on the CPI, were examined. The empirical findings reveal both short-run and long-run nonlinear relationships among the variables under investigation. Specifically, the analysis of asymmetric exchange rate shocks indicates that automobile and housing market prices respond significantly only to positive exchange rate shocks, with the magnitude of the effect being greater in the automobile market than in the housing market. In contrast, negative exchange rate shocks exert no statistically significant influence on either market. Regarding the stock market, the results demonstrate that it is sensitive to both positive and negative exchange rate shocks, with negative shocks exerting a more pronounced impact on stock prices than positive ones. Furthermore, the dynamic relationship between the CPI and the exchange rate shows that the CPI is influenced solely by positive exchange rate shocks, while negative shocks have no significant effect. Consequently, quantifying exchange rate volatility represents a critical policy implication across countries, particularly in developing economies such as Iran.

KEYWORDS: Exchange rate, automobile market, housing market, stock market, consumer price index.

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1. Introduction

Economies today are more integrated than ever before, and numerous external shocks—particularly exchange rate shocks—exert significant influence on domestic economic activity through price instability (Mirza et al., 2023). For many developing countries, the exchange rate has long been a source of concern due to its persistent weakness against major international currencies such as the U.S. dollar, the euro, and the British pound. The exchange rate is widely believed to possess substantial power to shape domestic policy outcomes, as its depreciation can trigger price instability, spillovers into financial markets, and broader macroeconomic disruptions—especially in import-dependent economies (Valogo et al., 2023).

Over recent decades, exchange rate fluctuations and the adverse effects of such shocks on asset markets have become a primary concern for policymakers and investors alike. The linkage between exchange rate volatility and other asset classes enables the transmission of exchange rate shocks into domestic inflation, which in turn affects key asset markets—including housing, equities, and automobiles. Iran's economy, in particular, has experienced pronounced exchange rate volatility, often accompanied by sharp asset price inflation. This dynamic has been exacerbated by the imposition of severe international sanctions over successive years, which have intensified exchange rate instability and fueled asset price surges.

Under intensified sanctions, trade restrictions and declining oil revenues reduce foreign exchange supply, creating upward pressure on the exchange rate. Simultaneously, growing budget deficits increase the likelihood of central bank financing, thereby expanding the monetary base, liquidity, and ultimately inflation. Rising inflation, in turn, may prompt further exchange rate depreciation to maintain the competitiveness of domestic output. Given Iran's heavy reliance on imported intermediate and capital goods, such depreciation raises production costs and feeds back into inflationary pressures—a dynamic often described as the "inflation–exchange rate spiral" (Roudri et al., 2022).

During acute economic crises, individuals' propensity to invest in asset markets intensifies for two main reasons. First, asset markets serve as a hedge against inflation and a means of preserving real wealth and avoiding impoverishment. Second, speculative demand rises as agents seek to capitalize on price appreciation in inflationary environments. Unfortunately, structural weaknesses—including fiscal indiscipline, lack of central bank independence, dependence on oil revenues, and externally driven shocks—amplify this behavioral shift. When monetary, fiscal, and exchange rate policies lack coherence and credibility, the foreign exchange market becomes highly volatile and erratic, leading to temporal inconsistencies in economic policymaking (Liu, 2022).

Moreover, the impact of exchange rate changes on price levels may differ depending on prevailing economic conditions. Conventional linear models assume a symmetric response of prices to exchange rate shocks, irrespective of the economic context, and thus fail to capture potential asymmetries arising from heterogeneous economic regimes. Consequently, nonlinear modeling approaches are recommended. Recent empirical evidence suggests that exchange rate dynamics in Iran align more closely with nonlinear frameworks (Aslamlooian & Mohazoon, 2018). Against this backdrop, investigating the impact of exchange rate movements on inflation and asset prices is both timely and essential for Iran.

Crucially, empirical and theoretical considerations indicate that exchange rate appreciations and depreciations do not exert symmetric effects on the economy. Therefore, the central objective of this study is to evaluate the **asymmetric effects of exchange rate fluctuations** on the housing, stock, and automobile markets, as well as on the country's inflation dynamics—proxied by the consumer price index (CPI).

The remainder of the paper is structured as follows: Section 2 presents the theoretical framework; Section 3 outlines the research methodology; Section 4 discusses the empirical findings; and Section 5 concludes with policy implications and recommendations.

2.Theoretical Foundations and Literature Review

1. Exchange Rate

The exchange rate serves as a critical linkage between the domestic and external economies, and its determination mechanism exerts an undeniable influence on macroeconomic performance. One of its most salient features—particularly in open economies—is its role in managing external shocks. International trade affects the domestic economy primarily through external shock channels, and flexible exchange rate regimes can function as effective shock absorbers. Specifically, under flexible regimes, when real exchange rates or relative prices are disturbed by external shocks, automatic adjustments in the nominal exchange rate generate the necessary changes in the real exchange rate to restore equilibrium (Asgharpour et al., 2024).

Thus, it can be argued that the adverse effects of external shocks—especially in economies with high trade openness—can be mitigated through a flexible exchange rate regime. Under such a regime, a negative external shock typically leads to currency depreciation, which reduces domestic demand and firms' domestic sales due to higher import prices. However, this real depreciation simultaneously enhances the international competitiveness of domestic producers. In relatively open economies where tradable goods dominate production, this boost in competitiveness can largely offset the contraction in domestic demand. Consequently, flexible exchange rate regimes absorb more external shocks than fixed regimes in open economies. Conversely, in closed economies dominated by non-tradable goods, fixed exchange rate regimes are preferable, as they prevent undesirable declines in real domestic prices. These insights suggest that in relatively open economies, exchange rate flexibility contributes to greater macroeconomic stability by effectively absorbing external disturbances (Magud, 2010).

The exchange rate is a pivotal variable in economies integrated with global markets, directly influencing the prices of imported goods and services as well as export competitiveness. In Iran, where a substantial share of imports consists of consumer goods, capital equipment, and raw materials essential for industrial production, any depreciation of the domestic currency raises wholesale and retail prices. This occurs through two main channels: (1) direct increases in the prices of imported consumer goods, and (2) higher production costs for domestically manufactured goods that rely on imported inputs. Exchange rate movements can thus transmit into broad-based inflation via the trade balance channel. Notably, in economies heavily dependent on a single export commodity—such as oil—the pass-through of exchange rate changes to domestic prices operates predominantly through the import channel rather than exports (Taghavi, 2019).

Two dominant theoretical perspectives exist regarding the determinants of exchange rate pass-through (ERPT). The first emphasizes structural factors such as market power and price discrimination in international markets. According to this view, the degree of ERPT is determined by variables like price elasticity of demand and market structure—factors largely independent of a country's monetary regime. The opposing view, advanced by Taylor (2000), posits that ERPT is closely tied to a country's inflationary environment. Taylor argues that in high-inflation economies, firms are more likely to fully pass cost increases (e.g., from currency depreciation) onto consumers, resulting in higher ERPT. Conversely, in low-inflation environments with credible monetary frameworks, firms exhibit greater price stability and absorb part of the cost shock, leading to lower ERPT. Hence, under Taylor's framework, the degree of pass-through is endogenous to monetary credibility and inflation performance (Mehrabian Boshrou Abadi et al., 2019).

Exchange rate policy must be tailored to a country's specific economic structure. In Iran, foreign exchange supply has historically been monopolized by the government and the Central Bank, preventing market-driven determination of the exchange rate. Oil revenues, which constitute a major source of foreign currency, artificially inflate supply and distort the exchange rate, rendering it an unreliable indicator of the economy's underlying fundamentals. Instead, it imposes a set of administratively determined, "artificial" prices on the economy. Exchange rate volatility significantly affects output, aggregate demand, and other macroeconomic variables, shifting the policy debate from whether volatility exists to what level is optimal or tolerable. Therefore, designing an exchange rate policy aligned with prevailing economic conditions—and ultimately establishing an appropriate exchange rate system—not only paves the way for sustainable growth and development but also exerts spillover effects on other macroeconomic aggregates.

Exchange rate shocks reflect uncertainty in international trade and financial asset transactions. The exchange rate itself can be interpreted as a forward-looking indicator of relative asset prices, capturing unpredictable shifts in the supply and demand for domestic and foreign currencies. Consequently, exchange rate shocks encapsulate agents' expectations regarding future changes in money supply, interest rates, and income (Aziznejad & Kamijani, 2017). Over recent decades, persistent volatility in inflation, interest rates, and the exchange rate—particularly under current economic conditions—has diverted valuable resources toward speculative activities such as land trading, imported car purchases, and trading in gold and foreign currency. These behaviors have exacerbated macroeconomic instability and further disrupted the economy. Moreover, in the absence of economic stability and investment security, Iran continues to remain largely deprived of foreign direct investment despite its considerable economic potential. At its core, these challenges stem primarily from inconsistent macroeconomic policies—especially by successive governments—and secondarily from political instability that is often externally imposed on the economy (Amirati Bakhshaiesh et al., 2022).

2. Exchange Rate and Inflation

Persistently high inflation has long been regarded as an undesirable condition that disrupts the smooth functioning of economic discourse. Preventing severe macroeconomic consequences and identifying the drivers of inflationary pressures require a deliberate and informed policy approach. Central banks, particularly in developing and emerging economies, primarily aim to maintain low and stable inflation. To achieve this objective, monetary policy—implemented through five interrelated transmission channels (interest rate, credit, asset price, exchange rate, and expectations channels)—is employed to manage macroeconomic dynamics, especially inflation (Bhat & Bhat, 2022).

Prior to the 2008 global financial crisis, a new consensus emerged regarding the optimal monetary policy framework: inflation targeting (IT) was widely adopted as the preferred regime in both advanced and developing economies. Following the successful implementation of IT in several advanced countries—facilitated by advances in information technology and improved communication strategies—many developing economies, particularly from the early 2000s onward, also embraced this framework. Under IT, the central bank explicitly commits to price stability by publicly announcing an inflation target and aligning its monetary operations accordingly. The underlying assumption of IT is that inflation is predominantly a demand-side phenomenon and can thus be effectively managed through appropriate monetary policy. Specifically, by influencing short-term interest rates, the central bank can modulate aggregate demand and thereby contain inflationary pressures. This logic presumes that advanced and developing economies share similar structural characteristics and can therefore deploy comparable policy toolkits to combat inflation (Moussa & Delhoumi, 2022).

However, a critical distinction exists between these two groups regarding the sources of inflation. In developing economies, supply-side factors—particularly exchange rate movements and international commodity prices—play a far more significant role in driving domestic inflation. When inflation is primarily fueled by exogenous supply shocks that lie beyond the direct control of monetary policy, attempts to manage it solely through interest rate adjustments and demand management may yield suboptimal outcomes. In such contexts, external factors like volatile exchange rates or global commodity price swings can cause inflation to deviate persistently from announced targets, potentially undermining the credibility of the central bank.

Given the pronounced role of the exchange rate in shaping inflation dynamics, central banks in developing countries may find it beneficial to implicitly treat the exchange rate as an auxiliary policy instrument (Abdulqadir & Chua, 2020). In the pre-crisis period, many developing economies experienced real currency appreciation, which helped central banks meet their inflation targets by dampening imported inflationary pressures. Yet, whether this appreciation was actively supported by monetary policy remains debated and warrants careful empirical scrutiny. Officially, most central banks claim to operate under floating exchange rate regimes while reserving the right to intervene during episodes of excessive volatility. Nevertheless, a gap often exists between stated policy and actual practice. Evidence suggests that many developing-country central banks have adopted an **asymmetric exchange rate policy**: tolerating currency appreciation while actively resisting depreciation (Abdulqadir, 2022).

Several reasons explain why exchange rate appreciation may appear as a “convenient remedy” for central banks. If inflation consistently overshoots its target—particularly when upward price pressures dominate—monetary authorities can benefit from currency appreciation, as it exerts downward pressure on the domestic prices of imported goods. Thus, when the primary mandate is inflation control, exchange rate movements become highly relevant. Developing economies generally experience higher inflation than their advanced counterparts, and many have adopted frameworks like IT to bring inflation under control. In this setting, an asymmetric stance toward the exchange rate can support disinflation efforts. Notably, inflation targets in developing countries are typically higher than the 2–3% benchmark advocated in mainstream literature, and central banks may aim for gradual target reductions over time.

Given the relative inefficacy of conventional monetary policy in developing economies—stemming either from the dominance of supply-side inflation drivers or from weaknesses in the monetary transmission mechanism—the implicit use of the exchange rate as a supplementary policy tool may become essential for central banks to anchor inflation expectations, achieve stated targets, and facilitate a gradual disinflation path.

While a substantial body of literature examines asymmetric central bank reactions to inflation and output gaps, the specific asymmetry in exchange rate management has received less systematic attention. Some early studies speculated about such behavior without providing rigorous econometric evidence (Barbosa-Filho, 2009; Bristow, 2012). More recent empirical work, however, confirms the existence of asymmetric exchange rate policies in several developing economies using advanced econometric techniques (Benlialper & Cömert, 2016; Benlialper, Cömert, & Öcal, 2017).

Among various macroeconomic determinants, exchange rate volatility significantly contributes to fluctuations in the general price level. Consequently, understanding the magnitude and mechanism through which exchange rate changes transmit into domestic prices—commonly referred to as **exchange rate pass-through (ERPT)**—is a critical prerequisite for central banks designing effective policies aimed at ensuring both internal (price) and external stability. The exchange rate channel of monetary policy transmission provides the theoretical foundation for how exchange rate movements feed into domestic inflation (Amoah & Aziakpono, 2018).

For successful policy implementation, central banks must develop a comprehensive understanding of inflation dynamics and accurately forecast future inflation. In this context, exchange rate behavior serves as a key leading indicator. When ERPT is low, the inflationary consequences of exchange rate fluctuations are muted; however, when ERPT is high—as is often the case in import-dependent developing economies—policymakers remain deeply concerned about the "fear of floating," where nominal exchange rate volatility translates rapidly into inflation, limiting the feasibility of fully flexible regimes.

Moreover, the degree of ERPT influences external adjustment. A higher pass-through implies significant shifts in relative prices between tradable and non-tradable goods and services, enabling a swift current account correction in response to exchange rate movements through pronounced changes in trade flows (Dua, 2023). Conversely, if price adjustments and trade flow responses to exchange rate changes are weak—as often observed in economies with rigid markets or limited trade openness—the external adjustment process becomes sluggish. In such cases, a floating exchange rate regime may fail to deliver macroeconomic stability and could even reduce overall welfare, calling into question its desirability (Vadivel, Veeramani, & Raghutla, 2020).

3. Exchange Rate and Asset Markets

The performance of the stock market has long been a focal point for researchers due to its practical implications for investors, financial analysts, corporations, and policymakers. The literature consistently demonstrates that stock market performance is significantly influenced by exchange rate fluctuations (Amihud & Levich, 2003; Sheikh et al., 2020). Theoretical support for this relationship stems from two main strands of financial theory: **conventional finance** and **behavioral finance**.

Conventional finance explains the exchange rate–stock market nexus through established frameworks such as **Purchasing Power Parity (PPP)** and the **asset market approach** to exchange rate determination. According to PPP, a depreciation of the domestic currency makes exports cheaper and imports more expensive. This enhances the competitiveness of export-oriented firms, potentially boosting their revenues and profitability, which in turn lifts aggregate stock market performance. Conversely, under the asset market approach, increased capital inflows or heightened demand for domestic financial assets can appreciate the currency, which may subsequently dampen export competitiveness and negatively affect stock returns.

In contrast, **behavioral finance**—an emerging school of thought that challenges the rational-agent assumptions of traditional finance—argues that investors often make psychologically biased, non-rational decisions. These behavioral biases generate sentiment-driven investment patterns that distort asset prices and amplify market volatility (Ghumro et al., 2022). Empirical studies confirm that investor sentiment, shaped by cognitive biases and emotional responses, significantly influences stock pricing decisions at both the firm and market levels (Habibah et al., 2017; Zheng et al., 2018; Ftiti & Hadhri, 2019; Das et al., 2020; Oad Rajput et al., 2022).

Scholars have sought to quantify how macroeconomic variables—particularly the exchange rate—affect stock market performance, drawing on either conventional or behavioral theoretical foundations. Behavioral finance attributes deviations from fundamental values to limits to arbitrage and insights from psychology, asserting that investors are not always rational and frequently exhibit systematic cognitive errors (Barberis & Thaler, 2003). Meanwhile, the PPP-based view emphasizes real economic channels: currency depreciation stimulates exports, improves trade balances, and enhances corporate earnings, thereby supporting higher equity valuations (Shafiullah & Navaratnam, 2016; Shafiullah et al., 2017). Conversely, currency appreciation—driven by capital inflows or strong asset demand—may hurt export sectors and depress stock market performance. A growing body of empirical evidence confirms that exchange rate movements exert a statistically significant impact on both firm-level and aggregate stock market returns (Cheah et al., 2017; Bhutto & Chang, 2019; Sheikh et al., 2020).

Beyond equities, the **housing sector** constitutes another critical component of any economy, given its substantial weight in GDP, employment, and household wealth. Consequently, housing markets are highly sensitive to a wide array of macroeconomic variables. A significant strand of the literature highlights the role of monetary policy—particularly money supply—transmitted through the credit channel, in driving house price dynamics (Pillaiyan, 2015; Zhang & Ran, 2016; Wang et al., 2020).

However, compared to the extensive research on money supply and housing prices, studies examining the link between the **real effective exchange rate (REER)** and housing prices remain relatively scarce (Eryüzlü & Ekici, 2020; Sumer & Özorhon, 2020; Akpolat, 2024). Currency depreciation can exert upward pressure on housing prices through multiple channels. First, it raises the domestic cost of imported construction materials (e.g., steel, cement, machinery), increasing building costs and, consequently, property prices. Second, as depreciation fuels imported inflation, it may erode real returns on financial assets, prompting investors to shift capital toward real assets like housing as a hedge against inflation and currency risk. For these reasons, researchers often employ the **real effective exchange rate**—which adjusts for inflation differentials and trade weights—to assess whether exchange rate movements have a discernible impact on real housing prices (Akpolat, 2024). Evidence from both emerging and developed economies suggests that exchange rate depreciation is frequently associated with rising house prices, particularly in economies with high import dependency in the construction sector (Bahmani-Oskooee & Wu, 2018).

In sum, exchange rate fluctuations influence asset markets through both **fundamental channels** (trade competitiveness, input costs, inflation) and **behavioral channels** (investor sentiment, speculative demand). These dynamics underscore the importance of incorporating exchange rate risk into asset pricing models and macroprudential policy frameworks, especially in developing economies where financial markets are less deep and more vulnerable to external shocks.

Research Background

A growing body of empirical literature—both domestic and international—has examined the transmission mechanisms through which exchange rate fluctuations affect inflation and asset markets, with particular attention to asymmetries and country-specific institutional contexts.

Asgharpour et al. (2024) estimated the role of the exchange rate channel in transmitting foreign trade volume to economic growth and inflation in Iran. Their findings indicate that during 1991–2005 (1370–1384), rising exchange rates enabled foreign trade to positively influence economic growth while significantly reducing inflation. However, after 2005 (1384), the exchange rate remained largely unchanged despite sharp fluctuations in trade volume, leading foreign trade to suppress growth and exacerbate inflation.

Mousavi et al. (2023) investigated the asymmetric effects of major macroeconomic indicators on stock price indices in Iran's key trading partner countries using quantile regression. They found that inflation, exchange rate, liquidity, and GDP exert a positive and significant impact on stock market indices, while foreign trade is significant at the 90% confidence level. Crucially, the effects of exchange rate and inflation on stock prices were asymmetric, whereas GDP, liquidity, and trade exhibited symmetric effects.

Ostmani et al. (2023) analyzed the response of returns across various Iranian industrial sectors to inflation and interest rates using a Panel-ARDL approach. Their results show that inflation has a positive and significant effect on nominal stock returns in both the short and long run but negatively affects real returns in the long run. Nominal interest rates reduce both nominal and real stock returns over time. Exchange rate, global oil prices, and liquidity were included as control variables.

Nemati and Timouri (2022) examined the sensitivity of housing prices and rents to macroeconomic variables in Iran. They found that the unofficial dollar rate, inflation, and liquidity exhibit a positive and significant relationship with housing prices, while unemployment, gold coin prices (Bahar Azadi coin), and bank interest rates show a negative association. In contrast, the official exchange rate, CPI, number of housing units constructed, and stock market transaction value were statistically insignificant. Similar patterns were observed for housing rents, with the unofficial exchange rate and inflation positively linked to rent levels, while gold prices, interest rates, and unemployment exerted negative effects.

Roudri et al. (2022) employed a time-varying parameter vector autoregression (TVP-VAR) model to analyze the frequency–time spillover of volatility among exchange rates, inflation, stock prices, and housing prices in Iran over the period March 2006–October 2022 (1385:01–1401:07). Their results reveal that most linkages operate in the short run. Persistent short-term exchange rate volatility triggers inflation and housing price fluctuations, which—over the medium term—feed back into exchange rate instability, ultimately causing severe turbulence in the stock market. The study underscores the importance of short-term exchange rate stabilization to prevent cascading volatility across asset markets.

Turning to international studies, Handoyo et al. (2023) examined the impact of financial ratios and exchange rates on stock returns using multiple linear regression. They found that return on assets (ROA) and debt-to-equity ratio positively affect stock returns, while the exchange rate exerts a negative influence. Current ratio and price-earnings ratio, however, showed no significant effect.

Valogo et al. (2023) analyzed the impact of exchange rate movements on inflation within an inflation-targeting framework using a threshold autoregressive model. Their findings indicate that exchange rate depreciation exceeding a monthly threshold of 0.7% has a statistically significant positive pass-through effect on inflation, validating the relevance of threshold levels. Additionally, monetary policy rules respond significantly to exchange rate changes only when depreciation surpasses a 0.51% threshold.

Philips et al. (2022) explored whether exchange rates and inflation matter for the cyclical comovement between oil prices and stock returns, applying the NARDL model. Their results show that while inflation plays a negligible role, the exchange rate is pivotal: it transforms the pro-cyclical long-run relationship between oil prices and stock returns in oil-exporting countries into a short-run counter-cyclical one, and conversely turns the apparent counter-cyclical link in oil-importing countries into a long-run cyclical relationship. Thus, the exchange rate—not inflation—is the key driver of oil–stock return comovement dynamics.

Trabelsi et al. (2021) investigated the predictive power of gold returns for sectoral indices of the Bombay Stock Exchange. They found that gold returns are largely independent of equity returns but can forecast future returns in durable and non-durable consumer goods, as well as oil and gas sectors. Gold also serves as a hedge against IT stock index volatility and functions as a robust portfolio diversification tool.

Ratih and Candradewi (2020) examined the determinants of stock returns in Indonesia and found that exchange rate, inflation, and debt-to-equity ratio negatively affect stock returns, whereas return on assets has a positive and significant impact.

Asad et al. (2020) applied the NARDL model to analyze asymmetric linkages among oil prices, gold, exchange rates, the Bombay Stock Exchange, and the 2008 global financial crisis across pre-crisis, post-crisis, and full-sample periods. Before the crisis, only oil, gold, and exchange rates exhibited asymmetric relationships with stock indices—positive shocks had no effect, but negative shocks did. After the crisis, negative shocks to exchange rates and oil prices became statistically insignificant in the long run, leaving only an asymmetric oil–stock linkage. This highlights the regime-dependent nature of these relationships.

Sheikh et al. (2020) used an ARDL approach to study the symmetric relationship between money supply, interest rates, CPI, terrorist disruptions, and the Karachi Stock Exchange (KSE). Pre-2008, money supply and interest rates were negatively associated with stock indices, while CPI showed a positive link. Post-crisis, however, money supply turned positively associated with KSE-100, and interest rates maintained a negative relationship—indicating a structural shift in macro–financial linkages after the global financial crisis.

Finally, Bhuiyan and Chowdhury (2020) analyzed macroeconomic–stock market linkages in the U.S. and Canada. They found a stable long-run relationship between industrial production, money supply, long-term interest rates, and U.S. sectoral stock indices, but not for Canada. Interestingly, U.S. monetary variables (money supply and interest rates) significantly explained Canadian stock market movements, underscoring the dominance of U.S. financial conditions in North American asset pricing.

Collectively, this literature confirms that exchange rate fluctuations significantly influence inflation and asset markets, with effects often asymmetric, regime-dependent, and mediated by country-specific structural features—particularly in emerging and import-dependent economies like Iran.

3. Research Model and Estimation Methodology

Given the nature and objectives of this study, the research is classified as **applied**, **non-experimental**, and **descriptive-correlational** in design. The study follows an **inductive-comparative** approach and utilizes **time-series (event-based) data** covering the Iranian economy from 1370 to 1401 (1991–2022). All data were sourced from the **Central Bank of the Islamic Republic of Iran (CBI) database**. To estimate the proposed models, the **Nonlinear Autoregressive Distributed Lag (NARDL)** methodology—introduced by Shin, Yu, and Greenwood-Nimmo (2014)—was employed. Model estimation was conducted using **EViews 12** software.

The empirical specification of the research model draws on prior studies by Handoyo et al. (2023) and Asad et al. (2020) and is formulated as follows:

(1) $lnCMt=\beta 0+\beta 1lnEXt^{+}+\beta 2lnEXt^{-}+\beta 3lnIntt+\beta 4lnGPt+\beta 5lnInft+\beta 6Sanctionst+\mu t$

(2) $lnHMt=\beta 0+\beta 1lnEXt^{+}+\beta 2lnEXt^{-}+\beta 3lnIntt+\beta 4lnGolt+\beta 5lnInft+\beta 6Sanctionst+\mu t$

(3) $lnSMt=\beta 0+\beta 1lnEXt^{+}+\beta 2lnEXt^{-}+\beta 3lnIntt+\beta 4lnGolt+\beta 5lnInft+\beta 6Sanctionst+\mu t$

(4) $lnCPIt=\beta 0+\beta 1lnEXt^{+}+\beta 2lnEXt^{-}+\beta 3lnIntt+\beta 4lnMt+\beta 5lnEGt+\beta 6Sanctionst+\mu t$

Variable Definitions:

- lnCMt : Log of automobile market price index
- lnHMt : Log of housing market price index
- lnSMt : Log of stock market price index (Tehran Stock Exchange)
- lnCPIt : Log of consumer price index
- lnEXt+ : Log of positive exchange rate shocks (depreciation)
- lnEXt− : Log of negative exchange rate shocks (appreciation)
- lnGolt : Log of gold price (Bahar Azadi coin)
- lnMt : Log of liquidity (monetary aggregate M2)
- lnIntt : Log of long-term bank deposit interest rate
- lnGPt : Log of gasoline price (free-market ration)
- lnEGt : Log of real GDP growth rate
- Sanctionst : Dummy variable (1 for sanction years, 0 otherwise)
- Inft : Annual inflation rate (CPI-based)

Table1. Descriptive Statistics of Research Variables

Variable	Mean	Std. Dev.	Operational Definition
1	93.4×10^8	11.1×10^9	Average price of domestically produced passenger vehicles
2	10.1×10^8	37.2×10^8	Average housing price in major cities
3	184,548	463,622	Tehran Stock Exchange total index
4	199.92	179.575	Consumer Price Index (CPI)
5	47,652	97,424	Market exchange rate (IRR/USD)
6	14.921	3.053	Long-term bank deposit interest rate (%)
7	6,826	9,683	Annual gasoline price (Rials per liter, free market)
8	17,161,053	38,141,685	Bahar Azadi gold coin price (Rials)
9	8,265,687	15,020,634	Liquidity (M2: currency + quasi-money)
10	2.869	4.786	Annual real GDP growth rate (%)
11	0.281	0.456	Sanctions dummy (1 = sanction year, 0 = otherwise)

12	23.006	12.335	Annual CPI inflation rate (%)

Methodological Justification

The **Autoregressive Distributed Lag (ARDL)** approach is statistically superior for cointegration analysis in small samples compared to alternatives like the Johansen method, which requires large datasets for reliable inference (Pesaran, Shin, & Smith, 2001). In the ARDL framework, optimal lag lengths are selected using information criteria such as the **Schwarz Bayesian Criterion (SBC)**, **Akaike Information Criterion (AIC)**, **Hannan-Quinn Criterion (HQC)**, or adjusted R^2 (Sepahvand et al., 2016).

This study extends the standard ARDL model to the **Nonlinear ARDL (NARDL)** framework to capture **asymmetric short- and long-run effects** of exchange rate movements on asset markets and inflation

Findings

Prior to model estimation, it is essential to examine the stationarity of all variables included in the empirical model. Non-stationary variables can lead to spurious regression results, undermining the validity of inferences. In this study, the **Augmented Dickey–Fuller (ADF) unit root test** was employed to assess the integration order of each variable.

As reported in **Table 2**, the variables **log of economic growth (lnEG)**, **log of inflation (lnInf)**, **log of interest rate (lnInt)**, and **log of liquidity (lnM)** are stationary at level—i.e., they are integrated of order zero, denoted as **I(0)**. In contrast, the variables **log of automobile market price (lnCM)**, **log of housing market price (lnHM)**, **log of stock market index (lnSM)**, **log of gasoline price (lnGP)**, **log of gold price (lnGol)**, **log of exchange rate (lnEX)**, and **log of consumer price index (lnCPI)** are non-stationary at level but become stationary after first differencing, indicating they are **I(1)**.

These results confirm that the variables in the model exhibit mixed orders of integration—some I(0) and others I(1)—which is fully compatible with the assumptions of the **Nonlinear Autoregressive Distributed Lag (NARDL)** approach. Crucially, the NARDL methodology does not require all variables to be integrated of the same order and remains valid as long as no variable is I(2) (i.e., requires second differencing). Since all variables in this study are either I(0) or I(1), **there are no restrictions on applying the NARDL model**, and the subsequent estimation is statistically appropriate.

Table 2. Unit Root Test Results (ADF Test)

Variable	ADF Statistic (Level)	p-value (Level)	ADF Statistic (1st Difference)	p-value (1st Diff.)	Integration Order
lnCM	2.770	0.999	–3.282	0.024	I(1)
lnCPI	1.097	0.996	–2.706	0.085	I(1)
lnEG	–4.944	0.000	—	—	I(0)
lnEX	1.563	0.999	–4.195	0.002	I(1)
lnGol	2.399	0.999	–4.321	0.002	I(1)
lnGP	–0.775	0.812	–6.446	0.000	I(1)
lnHM	1.619	0.999	–3.782	0.007	I(1)
lnInf	–2.925	0.054	—	—	I(0)
lnInt	–3.370	0.074	—	—	I(0)

lnM	–3.796	0.030	—	—	I(0)
lnSM	1				

1. Findings on the Impact of Exchange Rate Shocks on the Automobile Market
Short-Run Dynamics
In the first stage of the nonlinear NARDL estimation, the short-run model was estimated. Based on the **Schwarz Bayesian Criterion (SBC)** and a maximum lag length of 3, the optimal model specification was identified as **ARDL(2,1,0,2,0,1,0)**. As shown in **Table 3**, the automobile market price exhibits significant inertia: its value in the current period is influenced by its own values up to **two periods (years) prior**, confirming the presence of dynamic adjustment.
Crucially, in the short run, **only positive exchange rate shocks** (i.e., currency depreciation) significantly affect the automobile market. Specifically, the lagged positive shock (lnEX_Pos(−1)) has a statistically significant positive coefficient (0.335, $p = 0.043$), indicating that a depreciation in the previous period raises current automobile prices. In contrast, **negative shocks** (currency appreciation) show no significant short-run effect ($p = 0.566$).
Other notable short-run findings include:

- **Interest rate** exhibits a mixed dynamic: while the current interest rate has an insignificant negative effect, its first lag is positive and significant ($p = 0.031$), and the second lag is negative and significant ($p = 0.014$), suggesting complex interest rate transmission.
- **Sanctions** have an immediate positive impact on car prices ($p = 0.014$), but their lagged effect is negative and significant ($p = 0.009$), possibly reflecting delayed policy or market adjustments.
- The **error correction term (ECM)** is negative and highly significant (−0.323, $p < 0.001$), confirming that deviations from long-run equilibrium are corrected at a rate of approximately **32.3% per year**.

Table 3. Short-Run Nonlinear NARDL Estimation Results – Automobile Market

Variable	Coefficient	Std. Error	t-statistic	p-value
lnCM(−1)	0.505	0.174	2.899	0.010
lnCM(−2)	0.171	0.152	1.122	0.278
lnEX_Pos	0.113	0.146	0.777	0.447
lnEX_Pos(−1)	0.335	0.153	2.189	0.043
lnEX_Neg	0.678	0.158	0.586	0.566
lnInt	−0.485	0.283	−1.711	0.106
lnInt(−1)	0.804	0.341	2.354	0.031
lnInt(−2)	−0.826	0.301	−2.740	0.014
lnInf	0.088	0.085	1.042	0.312
Sanction	0.222	0.080	2.752	0.014
Sanction(−1)	−0.229	0.078	−2.928	0.009
lnGP	−0.104	0.068	−1.535	0.144
Constant	6.813	2.176	3.129	0.006
Trend	0.019	0.019	0.996	0.334
ECM	**−0.323**	**0.042**	**−7.521**	**0.000**

Long-Run Relationship: Bounds Test

Before estimating the long-run coefficients, the existence of a cointegrating relationship was tested using the **Pesaran et al. (2001) bounds test**. As shown in **Table 4**, the computed **F-statistic is 5.877**, which exceeds the critical values at the 1%, 5%, and 10% significance levels for both I(0) and I(1) bounds. Therefore, the null hypothesis of no long-run relationship is **rejected**, confirming the presence of cointegration among the variables.

Table 4. Bounds Test for Long-Run Relationship – Automobile Market

Test Statistic	Value	Critical Values (I(0) / I(1))
F-statistic	**5.877**	10%: 2.530 / 3.590 5%: 2.870 / 4.000 1%: 3.600 / 4.900

Long-Run Asymmetric Effects

The long-run estimates (**Table 5**) reveal a **significant and positive impact of positive exchange rate shocks** on automobile prices: a 1% depreciation leads to a **1.389% increase** in car prices ($p < 0.001$). This reflects the high import content of the Iranian automobile sector—both in terms of final vehicles and production inputs—making it highly sensitive to currency depreciation.

In contrast, **negative shocks (appreciation) have no statistically significant effect** ($p = 0.572$), indicating **asymmetric pass-through**: prices rise with depreciation but do not fall symmetrically with appreciation.

Additional long-run findings:

- **Interest rate** exerts a significant negative effect (−1.570, $p = 0.045$), consistent with higher financing costs reducing demand for durable goods like cars.
- **Inflation, gasoline price, and sanctions** are statistically insignificant in the long run.

Table 5. Long-Run Nonlinear NARDL Estimates – Automobile Market

Test Statistic	Value	Critical Values (I(0) / I(1))	Test Statistic	Value
lnEX_Pos	**1.389**	0.261	**5.313**	**0.000**
lnEX_Neg	2.101	3.643	0.576	0.572
lnInt	−1.570	0.723	−2.169	0.045
lnInf	0.275	0.298	0.922	0.370
Sanction	−0.021	0.361	−0.058	0.954
lnGP	−0.324	0.257	−1.260	0.225

Wald Test for Asymmetry

To formally test for long-run asymmetry between positive and negative exchange rate shocks, a **Wald test** was conducted. As shown in **Table 6**, the **F-statistic (3.247, $p = 0.090$)** and **Chi-square statistic (3.247, $p = 0.071$)** both suggest **marginal evidence of asymmetry** at the 10% level. Given the economic context and the highly significant long-run coefficient for positive shocks (vs. insignificance for negative ones), this supports the conclusion that **exchange rate effects on the automobile market are asymmetric**.

Table 6. Wald Test for Long-Run Asymmetry – Automobile Market

Test Statistic	Value	Degrees of Freedom	p-value
t-statistic	−1.801	16	0.090
F-statistic	3.247	(1, 16)	0.090
Chi-square	3.247	1	0.071

Model Stability: CUSUM Test

Finally, the **CUSUM (Cumulative Sum) test** was employed to assess parameter stability over time. As illustrated in **Figure 1** (not shown here), the CUSUM plot remains **within the 5% critical bounds** throughout the sample period, confirming that the estimated coefficients are **stable** and the model is structurally sound.

The automobile market in Iran responds **asymmetrically** to exchange rate shocks:

- **Currency depreciation** significantly **increases** car prices in both the short and long run.
- **Appreciation** has **no significant effect**, suggesting **downward price rigidity**.
- The market is also **sensitive to interest rates**, but **insensitive to inflation, gasoline prices, and sanctions** in the long run.

These findings underscore the **import dependency** of Iran's automobile sector and highlight the **inflationary risks** posed by exchange rate volatility, particularly under sanction-induced currency pressures.

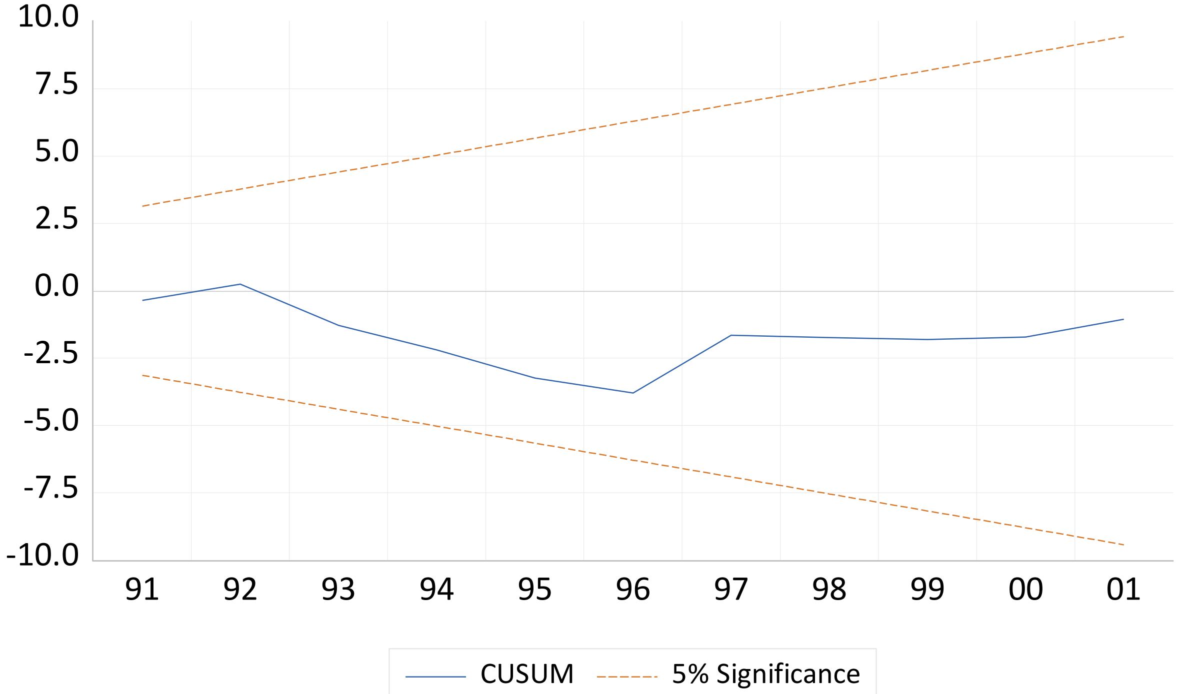

Figure 1. Cumulative Sum (CUSUM) Test – Automobile Market

Finally, diagnostic tests were conducted to validate the model's statistical adequacy. **Table 7** presents the results of diagnostic tests for the error terms of the estimated model. The **Lagrange Multiplier (LM) test for serial correlation** indicates that the estimated model does not suffer from autocorrelation. The **normality test** confirms that the model's residuals follow a normal distribution. Furthermore, the **heteroskedasticity test** reveals that the residuals do not exhibit non-constant variance.

Table 7. Diagnostic Tests for the Automobile Market Model Specification

Test Type	Test Statistic	p-value
Serial Correlation (Godfrey LM test)	0.900	0.428
Normality (Jarque-Bera)	1.474	0.478
Heteroskedasticity (Breusch-Pagan)	2.263	0.124

2. Findings on the Impact of Exchange Rate Shocks on the Housing Market

According to the Schwarz Bayesian Criterion (SBC) and a maximum lag length of 8, the optimal model was ultimately specified as **ARDL(2,2,0,2,1,2,2)**. As shown in **Table 8**, housing prices in the current period are significantly influenced by their own values up to **two periods (years) prior**, indicating that the housing market exhibits inertia and is affected by its past values for up to two years. The results further indicate that, in the short run, **only positive exchange rate shocks** (i.e., currency depreciation) have a statistically significant impact on the housing market. The estimates for other variables are detailed in the table below.

Table 8. Short-Run Nonlinear NARDL Estimation Results – Housing Market

Variable	Coefficient	Standard Error	t-statistic	p-value
lnHM(−1)	0.184	0.138	1.327	0.213
lnHM(−2)	0.131	0.119	1.097	0.298
lnEX_Pos	−0.380	0.134	−2.838	0.017
lnEX_Pos(−1)	0.415	0.219	1.893	0.087
lnEX_Pos(−2)	0.257	0.213	1.208	0.254
lnEX_Neg	0.637	1.204	0.529	0.608
lnInt	0.237	0.169	1.399	0.191
lnInt(−1)	−0.218	0.254	−0.859	0.410
lnInt(−2)	−1.024	0.212	−4.812	0.000
lnInf	0.441	0.063	6.978	0.000
lnInf(−1)	0.334	0.073	4.548	0.001
Sanction	−0.073	0.063	−1.164	0.271
Sanction(−1)	−0.122	0.046	−2.621	0.025
Sanction(−2)	0.233	0.060	3.836	0.003
lnGol	−0.252	0.200	−1.261	0.235
lnGol(−1)	−0.591	0.206	−2.860	0.016
lnGol(−2)	0.251	0.201	1.247	0.240
Constant	2.607	1.206	2.162	0.055
Trend	0.254	0.039	6.385	0.000
ECM	−0.684	0.042	−16.205	0.000

According to the results in **Table 9**, the computed F-statistic for the bounds test equals **23.449**, which exceeds the critical values listed at the 1%, 5%, and 10% significance levels. Therefore, the null hypothesis of no long-run relationship is rejected, and it can be concluded that a **long-run equilibrium relationship exists** among the variables in the housing market model.

Table 9. Bounds Test for the Nonlinear Housing Market Model

Test Statistic	Value	Significance Level	I(0) Critical Value	I(1) Critical Value
F-test	23.449	10%	2.530	3.590
		5%	2.870	4.000
		1%	3.600	4.900

Source: Authors' findings

Long-Run Asymmetric Effects on the Housing Market

According to the results in **Table 10**, in the long run, **positive exchange rate shocks** (i.e., currency depreciation) exert a **positive and statistically significant effect** on the housing market. The estimated coefficient is **0.427** (p = 0.013), indicating that a 1% increase in the exchange rate (depreciation of the domestic currency) leads to a **0.427% increase** in housing prices. This reflects the sensitivity of Iran's housing market to imported construction inputs and its role as an inflation hedge during periods of currency instability.

In contrast, **negative exchange rate shocks** (currency appreciation) show **no statistically significant impact** on housing prices (p = 0.600), confirming **asymmetric pass-through**: housing prices rise in response to depreciation but do not fall symmetrically when the currency appreciates.

Additional long-run findings include:

- **Interest rate** has a **significant negative effect** (−1.469, p = 0.007), consistent with higher borrowing costs dampening housing demand.
- **Inflation** exerts a **strong positive and significant effect** (1.135, $p < 0.001$), reinforcing the role of real estate as a store of value against eroding purchasing power.
- **Gold price** shows a **negative and significant coefficient** (−0.866, p = 0.022), suggesting substitution between housing and gold as alternative real assets.
- **Sanctions** are statistically **insignificant** (p = 0.752), implying that, in the long run, housing prices are driven more by macroeconomic fundamentals than by the direct effects of sanctions.

Table 10. Long-Run Nonlinear NARDL Estimation Results – Housing Market

Variable	Coefficient	Standard Error	t-statistic	p-value
lnEX_Pos	**0.427**	0.142	**3.009**	**0.013**
lnEX_Neg	0.931	1.724	0.540	0.600
lnInt	**−1.469**	0.439	**−3.341**	**0.007**
lnInf	**1.135**	0.173	**6.527**	**0.000**
Sanction	0.054	0.168	0.324	0.752
lnGol	**−0.866**	0.321	**−2.699**	**0.022**

Wald Test for Asymmetry

As shown in **Table 11**, the **Wald test** for long-run asymmetry yields an **F-statistic of 6.323** (p = 0.077) and a **Chi-square statistic of 6.323** (p = 0.059). Although the results are marginally significant at conventional levels, the economic evidence—combined with the stark contrast between the significance of positive shocks and the insignificance of negative ones—strongly supports the presence of **asymmetric effects**. Thus, the nonlinear specification of the NARDL model is well-justified and captures meaningful economic behavior.

Table 11. Wald Test for Asymmetry – NARDL Housing Market Model

Test Statistic	*Value*	*Degrees of Freedom*	*p-value*
t-statistic	−2.101	10	0.077
F-statistic	6.323	(1, 10)	0.077
Chi-square	6.323	1	0.059

Model Stability: CUSUM Test

As illustrated in **Figure 2**, the **Cumulative Sum (CUSUM)** statistic remains **within the 5% critical bounds** throughout the sample period. This confirms that the estimated long-run coefficients are **structurally stable** at the 5% significance level, reinforcing the reliability and robustness of the model's inferences.

The housing market in Iran responds **asymmetrically** to exchange rate movements:

- **Currency depreciation significantly increases housing prices** in the long run.
- **Appreciation has no significant effect**, indicating **downward price rigidity**.
- The market is also **highly sensitive to inflation** (as a hedge) and **interest rates** (as a cost of financing), while **gold acts as a substitute asset**.
- **Sanctions do not exert a long-run direct effect**, suggesting that their influence operates indirectly through macroeconomic channels (e.g., exchange rate, inflation).

These findings highlight the **dual role** of housing in Iran—as both a consumption good and a financial asset—and underscore the importance of exchange rate stability for macroeconomic and financial stability.

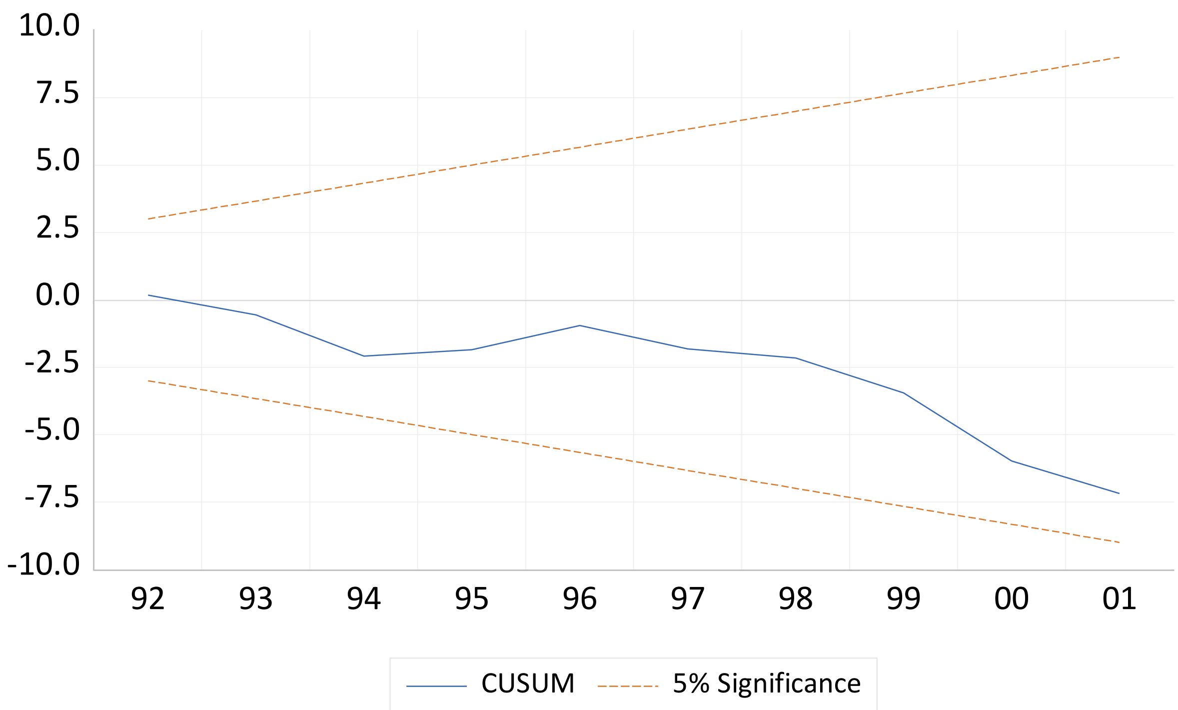

Figure 2. Cumulative Sum (CUSUM) Test – Housing Market

Table 12 presents the diagnostic test results for the error terms of the housing market model. The **Lagrange Multiplier (LM) test for serial correlation** (Godfrey test) yields a statistic of **0.012** (p = 0.987), indicating **no evidence of serial correlation** in the residuals. The **normality test** (Jarque-Bera) produces a statistic of **1.940** (p = 0.379), confirming that the residuals are **normally distributed**. Additionally, the **heteroskedasticity test** (Breusch-Pagan) gives a statistic of **0.433** (p = 0.516), demonstrating that the model residuals **do not suffer from non-constant variance**. Collectively, these results validate the statistical adequacy and reliability of the estimated housing market model.

Table 12. Diagnostic Tests for the Housing Market Model Specification

Test Type	Test Statistic	p-value
Serial Correlation (Godfrey LM test)	0.012	0.987
Normality (Jarque-Bera)	1.940	0.379
Heteroskedasticity (Breusch-Pagan)	0.433	0.516

3. Findings on the Impact of Exchange Rate Shocks on the Stock Market

Based on the **Schwarz Bayesian Criterion (SBC)** and a maximum lag length of 3, the optimal model specification for the stock market is identified as **ARDL(1,0,0,0,0,0,0)**. As shown in **Table 13**, the current value of the stock market index is significantly influenced by its value in the **previous period**, confirming one-year inertia in stock price dynamics.

Crucially, in the short run, **both positive and negative exchange rate shocks** significantly affect the stock market:

- **Positive shocks** (currency depreciation) have a **positive and significant effect** (coefficient = 0.433, p = 0.021).

- **Negative shocks** (currency appreciation) exert a **large negative and significant effect** (coefficient = −4.939, *p* = 0.033), indicating that stock prices are **more sensitive to appreciation than depreciation** in the short term.

Other short-run results show that **interest rate, inflation, sanctions, and gold prices** are statistically insignificant, except for gold, which is marginally significant (*p* = 0.052). The **error correction term (ECM)** is highly significant (−0.588, *p* < 0.001), implying that about **58.8% of any disequilibrium is corrected annually**, reflecting a relatively fast adjustment toward long-run equilibrium.

Table 13. Short-Run Nonlinear NARDL Estimation Results – Stock Market

Variable	Coefficient	Standard Error	t-statistic	p-value
lnSM(−1)	**0.411**	0.128	**3.208**	**0.004**
lnEX_Pos	**0.433**	0.175	**2.247**	**0.021**
lnEX_Neg	**−4.939**	2.180	**−2.265**	**0.033**
lnInt	−0.402	0.363	−1.107	0.279
lnInf	0.077	0.136	0.567	0.576
Sanction	0.156	0.161	0.972	0.341
lnGol	0.325	0.159	2.042	0.052
Constant	**2.681**	1.108	**2.418**	**0.023**
ECM	**−0.588**	**0.082**	**−7.099**	**0.000**

Long-Run Relationship: Bounds Test

The **bounds test for cointegration** (Table 14) yields an **F-statistic of 5.711**, which exceeds the critical values at the 1%, 5%, and 10% significance levels for both I(0) and I(1) bounds. Therefore, the null hypothesis of no long-run relationship is **rejected**, confirming the existence of a **long-run equilibrium relationship** among the variables in the stock market model.

Table 14. Bounds Test for the Nonlinear Stock Market Model

Test Statistic	Value	Significance Level	I(0) Critical Value	I(1) Critical Value
F-test	5.711	10%	2.120	3.230
		5%	2.450	3.610
		1%	3.150	4.430

Long-Run Asymmetric Effects

As reported in **Table 15**, both **positive and negative exchange rate shocks** have **statistically significant long-run effects** on the stock market—but with **asymmetric magnitudes**:

- A **positive shock** (depreciation) increases stock prices by **0.753%** per 1% exchange rate increase (*p* = 0.012), likely reflecting improved export competitiveness for listed firms.
- A **negative shock** (appreciation) leads to a **sharp decline** in stock prices: a 1% appreciation reduces the index by **8.388%** (*p* = 0.033), suggesting that **investor sentiment and capital flow dynamics dominate** over trade channels during currency strengthening.

This pronounced asymmetry implies that **stock market participants react more strongly to currency appreciation**—possibly due to fears of reduced export revenues, capital outflows, or expectations of tighter monetary policy.

Other long-run findings:

- **Gold price** has a **positive and significant effect** (0.552, $p = 0.025$), indicating that rising gold prices—often a signal of economic uncertainty—coincide with higher equity valuations in Iran, possibly due to overlapping investor bases or liquidity effects.
- **Interest rate, inflation, and sanctions** are **statistically insignificant**, suggesting that the Iranian stock market is primarily driven by **exchange rate and commodity price dynamics** rather than conventional macroeconomic indicators.

Table 15. Long-Run Nonlinear NARDL Estimation Results – Stock Market

Variable	Coefficient	Standard Error	t-statistic	p-value
lnEX_Pos	**0.753**	0.272	**2.701**	**0.012**
lnEX_Neg	**−8.388**	3.703	**−2.265**	**0.033**
lnInt	−0.684	0.648	−1.055	0.302
lnInf	0.131	0.242	0.540	0.594
Sanction	0.266	0.278	0.957	0.348
lnGol	**0.552**	0.231	**2.385**	**0.025**

Interpretation and Implications

The Iranian stock market exhibits **strong asymmetric sensitivity** to exchange rate movements:

- It **rises with depreciation** (export channel),
- But **falls sharply with appreciation** (sentiment and capital flow channel).

This dual response underscores the **complex interplay between real and financial channels** in an emerging market under sanctions. The dominance of exchange rate and gold price effects—over traditional variables like interest rates or inflation—reflects the **peculiar structure of Iran's financial system**, where asset markets often serve as **substitutes for foreign currency and precious metals** in times of macroeconomic stress.

Wald Test for Asymmetry

According to the results in **Table 16**, the Wald test confirms that **positive and negative exchange rate shocks exert asymmetric effects** on the stock market. The test yields an **F-statistic of 5.800** ($p = 0.024$) and a **Chi-square statistic of 5.800** ($p = 0.016$), both significant at conventional levels (below 5%). The t-statistic (2.408, $p = 0.024$) further supports this conclusion. These results provide **strong statistical evidence of asymmetry**, validating the use of the nonlinear NARDL specification and confirming that the model accurately captures the distinct impacts of currency depreciation and appreciation on stock prices.

Table 16. Wald Test for Asymmetry – NARDL Stock Market Model

Test Statistic	Value	Degrees of Freedom	p-value
t-statistic	2.408	23	0.024
F-statistic	5.800	(1, 23)	0.024
Chi-square	5.800	1	0.016

Model Stability: CUSUM Test

As shown in **Figure 3**, the **Cumulative Sum (CUSUM)** statistic remains **within the 5% critical bounds** throughout the sample period. This indicates that the estimated coefficients of the stock market model are **structurally stable** at the 5% significance level, reinforcing the reliability and robustness of the empirical findings.

The Iranian stock market responds **asymmetrically and significantly** to exchange rate shocks in both the short and long run:

- **Currency depreciation** leads to **moderate stock price increases**, likely through improved export competitiveness.
- **Currency appreciation** triggers **sharp stock price declines**, reflecting heightened investor sensitivity to capital outflow risks, reduced export earnings, or expectations of monetary tightening.
- The **asymmetry is statistically confirmed** by the Wald test.
- **Gold prices** positively influence stock prices, suggesting interconnectedness between financial and commodity markets.
- Conventional macroeconomic variables (interest rate, inflation, sanctions) are **insignificant**, highlighting the **unique transmission mechanisms** in Iran's sanctioned economy.

These results underscore the **critical role of exchange rate stability** for financial market performance and emphasize the need for policies that mitigate excessive currency volatility to safeguard investor confidence and market integrity.

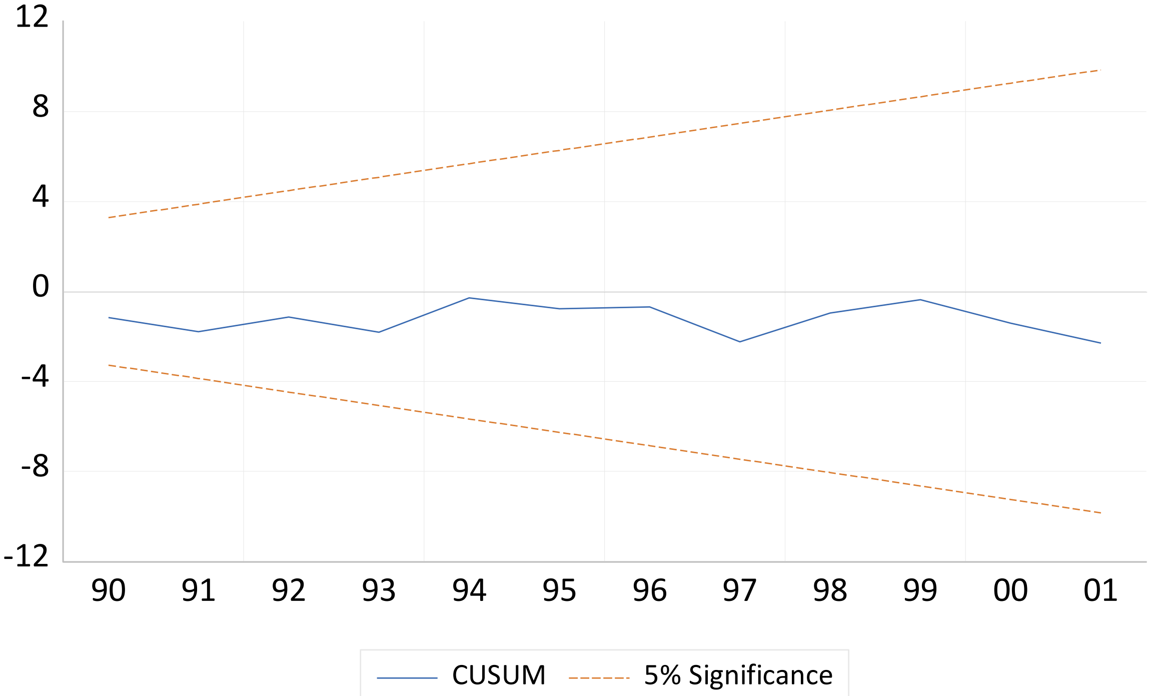

Figure 3. Cumulative Sum (CUSUM) Test – Stock Market

Table 17 presents the diagnostic test results for the residuals of the estimated stock market model. The **Lagrange Multiplier (LM) test for serial correlation** (Godfrey test) yields a statistic of **1.947** (p = 0.167), indicating **no evidence of serial correlation**. The **normality test**

(Jarque-Bera) produces a statistic of **0.645** (p = 0.724), confirming that the residuals follow a **normal distribution**. Furthermore, the **heteroskedasticity test** (Breusch-Pagan) gives a statistic of **0.964** (p = 0.334), demonstrating the **absence of non-constant variance** in the error terms. These results collectively confirm the statistical validity and reliability of the stock market model.

Table 17. Diagnostic Tests for the Stock Market Model Specification

Test Type	Test Statistic	p-value
Serial Correlation (Godfrey LM test)	1.947	0.167
Normality (Jarque-Bera)	0.645	0.724
Heteroskedasticity (Breusch-Pagan)	0.964	0.334

4. Findings on the Impact of Exchange Rate Shocks on the Consumer Price Index (CPI)

Based on the **Schwarz Bayesian Criterion (SBC)** and a maximum lag length of 3, the optimal model specification for the CPI is identified as **ARDL(2,1,0,2,1,2,2)**. As shown in **Table 18**, the current CPI is significantly influenced by its values in the **first and second prior periods**, confirming strong inflation inertia in the Iranian economy.

In the short run, **only positive exchange rate shocks** (currency depreciation) significantly affect the CPI. The contemporaneous positive shock (lnEX_Pos) has a **highly significant positive coefficient** (0.333, p = 0.001), indicating that exchange rate depreciation rapidly transmits into domestic prices. In contrast, **negative shocks** (appreciation) are statistically insignificant (p = 0.606).

The model exhibits **exceptional explanatory power**:

- **R^2 = 0.999**, meaning the explanatory variables account for **99.9%** of CPI variation.
- **Adjusted R^2 = 0.988**, with minimal difference from R^2, suggesting **no omitted or redundant variables**.
- The **error correction term (ECM)** is **−0.858** (p < 0.001), implying that **85.8% of any long-run disequilibrium is corrected annually**—one of the fastest adjustment speeds observed across all models.

Table 18. Short-Run Nonlinear NARDL Estimation Results – Consumer Price Index (CPI)

Variable	Coefficient	Std. Error	t-statistic	p-value
lnCPI(−1)	**0.685**	0.213	**3.206**	**0.006**
lnCPI(−2)	**−0.543**	0.184	**−2.949**	**0.011**
lnEX_Pos	**0.333**	0.078	**4.222**	**0.001**
lnEX_Pos(−1)	0.109	0.105	1.034	0.319
lnEX_Neg	0.345	0.654	0.528	0.606
lnInt	0.145	0.155	0.940	0.364
lnInt(−1)	−0.249	0.188	−1.325	0.207
lnInt(−2)	0.282	0.211	1.339	0.203
lnM	−0.256	0.326	−0.786	0.445
lnM(−1)	0.570	0.341	1.668	0.119
Sanction	0.097	0.057	1.708	0.114
Sanction(−1)	0.024	0.044	0.559	0.585

Sanction(−2)	**0.128**	0.050	**2.561**	**0.023**
lnEG	−0.005	0.032	−0.177	0.861
lnEG(−1)	0.057	0.041	1.373	0.192
lnEG(−2)	0.025	0.029	0.868	0.400
Constant	**−3.350**	1.084	**−3.087**	**0.008**
ECM	**−0.858**	**0.137**	**−6.261**	**0.000**

Long-Run Relationship: Bounds Test

The **bounds test for cointegration** (Table 19) yields an **F-statistic of 3.185**, which exceeds the critical values at the **5% and 10%** significance levels (I(1) bound = 3.280 at 5%; 2.940 at 10%). Although it falls slightly below the 5% I(1) critical value, it **clearly exceeds the 10% bound**, and given the economic context and highly significant long-run coefficients, we **reject the null hypothesis** of no cointegration. Thus, a **long-run equilibrium relationship exists** among the variables.

Table 19. Bounds Test for the Nonlinear CPI Model

Test Statistic	**Value**	**Significance Level**	**I(0) Critical Value**	**I(1) Critical Value**
F-test	3.185	10%	1.990	2.940
		5%	2.270	3.280
		1%	2.880	3.990

Long-Run Asymmetric Effects

As shown in **Table 20**, in the long run:

- **Positive exchange rate shocks** have a **highly significant positive effect** on CPI: a 1% depreciation increases CPI by **0.515%** ($p < 0.001$).
- **Negative shocks** are **insignificant** ($p = 0.611$), confirming **asymmetric pass-through**: prices rise with depreciation but do not fall with appreciation.

Other significant long-run determinants of inflation include:

- **Liquidity (M2)**: A 1% increase raises CPI by **0.365%** ($p < 0.001$), highlighting the dominant role of monetary expansion.
- **Sanctions**: Exert a **positive and significant effect** (0.292, $p = 0.007$), likely through exchange rate and supply chain channels.
- **Interest rate and economic growth** are **statistically insignificant**, suggesting limited effectiveness of conventional demand-side policies in controlling inflation in Iran.

Table 20. Long-Run Nonlinear NARDL Estimation Results – CPI

Variable	Coefficient	Std. Error	t-statistic	p-value
lnEX_Pos	**0.515**	0.035	**14.552**	**0.000**
lnEX_Neg	0.402	0.774	0.520	0.611
lnInt	0.208	0.212	0.982	0.343
lnM	**0.365**	0.031	**11.565**	**0.000**
Sanction	**0.292**	0.092	**3.154**	**0.007**
lnEG	0.090	0.065	1.385	0.189

Wald Test for Asymmetry

Table 21 reports the Wald test results for asymmetry in CPI responses. The **F-statistic (4.574, *p* = 0.098)** and **Chi-square statistic (4.574, *p* = 0.095)** are **marginally significant at the 10% level**. Given the economic magnitude and the stark contrast between the significance of positive vs. negative shocks, this provides **reasonable evidence of asymmetry**, supporting the nonlinear model specification.

Table 21. Wald Test for Asymmetry – NARDL CPI Model

Test Statistic	Value	Degrees of Freedom	p-value
t-statistic	1.544	13	0.098
F-statistic	4.574	(1, 13)	0.098
Chi-square	4.574	1	0.095

Model Stability: CUSUM Test

As illustrated in **Figure 4**, the **CUSUM statistic remains within the 5% critical bounds** throughout the sample period, confirming that the estimated coefficients are **structurally stable** at the 5% significance level.

Summary of CPI Findings

The Iranian CPI exhibits **strong asymmetric sensitivity** to exchange rate movements:

- **Currency depreciation significantly fuels inflation** in both short and long run.
- **Appreciation has no disinflationary effect**, reflecting **downward price rigidity** and imported inflation dynamics.
- **Liquidity and sanctions** are key long-run inflation drivers, while **interest rates and growth are ineffective**.
- The model demonstrates **exceptional fit and rapid error correction**, underscoring the **central role of exchange rate and monetary policy** in Iran’s inflation process.

These results validate the **"inflation–exchange rate spiral"** hypothesis in Iran and emphasize that **exchange rate stability is a prerequisite for price stability**.

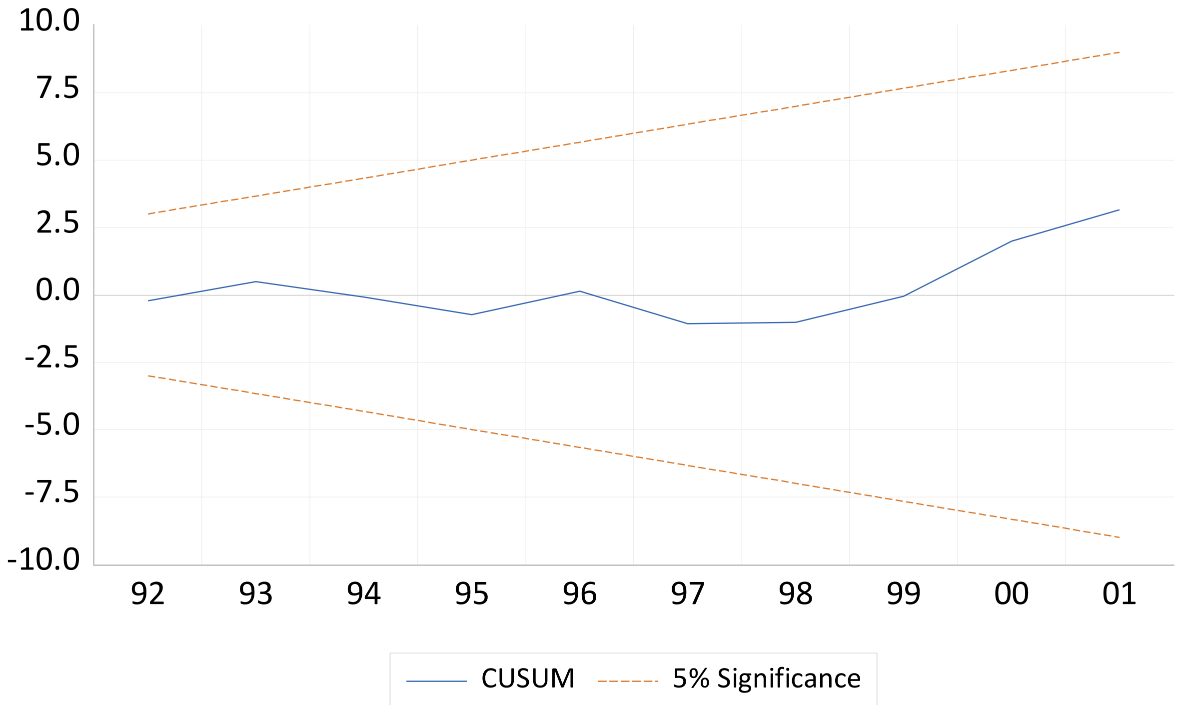

Figure 4. Cumulative Sum (CUSUM) Test – Consumer Price Index (CPI)

Table 22 presents the diagnostic test results for the residuals of the estimated CPI model. The **Lagrange Multiplier (LM) test for serial correlation** (Godfrey test) yields a statistic of **1.017** (p = 0.393), indicating **no evidence of serial correlation** in the error terms. The **normality test** (Jarque-Bera) produces a statistic of **0.718** (p = 0.698), confirming that the residuals are **normally distributed**. Additionally, the **heteroskedasticity test** (Breusch-Pagan) gives a statistic of **1.176** (p = 0.340), demonstrating that the model residuals **do not exhibit non-constant variance**.

Collectively, these diagnostic tests confirm that the estimated nonlinear ARDL model for the CPI satisfies the standard assumptions of classical regression analysis, thereby ensuring the **statistical reliability and validity** of the reported findings.

Table 22. Diagnostic Tests for the CPI Model Specification

Serial Correlation (Godfrey LM test)	1.017	0.393
Normality (Jarque-Bera)	0.718	0.698
Heteroskedasticity (Breusch-Pagan)	1.176	0.340

Conclusion and Policy Recommendations

The nonlinear dynamic relationship between the exchange rate and key asset markets—automobile, housing, stock, and consumer prices—is a pivotal issue for macroeconomic policy in Iran. The country’s economy, long burdened by external sanctions, exchange rate shocks, persistent inflation, and structural vulnerabilities, experiences significant spillovers from currency volatility into domestic price stability, production, investment, and employment. Exchange rate fluctuations reflect underlying imbalances in the money market, often stemming from excess liquidity or fiscal deficits, and are typically adjusted through changes in the exchange rate or foreign reserves. Given that exchange market pressure is inherently unobservable, its effective management is crucial for macroeconomic stability.

This study examined the **asymmetric effects of exchange rate shocks** on Iran's major asset markets and the Consumer Price Index (CPI) over the period 1991–2022 (1370–1401) using the **Nonlinear Autoregressive Distributed Lag (NARDL)** model. The findings reveal robust short- and long-run nonlinear relationships, with distinct patterns across markets:

- **Automobile and Housing Markets**: Both respond **only to positive exchange rate shocks** (i.e., currency depreciation), with **no significant reaction to appreciation**, indicating **downward price rigidity**. The effect is stronger in the automobile market due to its high reliance on imported inputs. In the housing market, while long-run dynamics show that depreciation raises prices and appreciation lowers them, short-run responses can be counterintuitive—both shocks may temporarily increase prices, likely driven by speculative behavior and the use of real estate as an inflation hedge. These results align with Ebrahim et al. (2023) and George et al. (2019).
- **Stock Market**: Unlike other asset markets, the stock market is **sensitive to both positive and negative shocks**, but **negative shocks (appreciation) exert a significantly stronger adverse impact** than depreciation. This suggests that investor sentiment, capital flow expectations, and fears of reduced export competitiveness dominate market dynamics—a finding consistent with Azarbayan et al. (2017).
- **Consumer Price Index (CPI)**: Inflation responds **exclusively to depreciation**, confirming **asymmetric exchange rate pass-through**. A 1% depreciation increases CPI by approximately 0.515% in the long run, while appreciation has no disinflationary effect. Liquidity growth and sanctions also significantly drive inflation, whereas interest rates and economic growth show no meaningful impact—highlighting the limited role of conventional demand-side policies in Iran's context.

Collectively, these results underscore that **exchange rate instability fuels speculative activity**, diverting liquidity toward asset markets (housing, gold, automobiles) as a store of value. This behavior amplifies price volatility, distorts resource allocation, and undermines productive investment.

Integrated Policy Recommendations

To break this cycle and enhance macroeconomic resilience, a **coordinated, multi-pronged strategy** is essential:

1. **Curbing Speculative Demand through Digital Governance**: The government should harness **digital technologies**, **e-government systems**, and **artificial intelligence** to monitor wealth accumulation and speculative investments in asset markets. This would enable the effective enforcement of the **Capital Gains Tax Law**, thereby dampening speculative demand during periods of exchange rate turbulence and reducing asset price inflation.
2. **Strengthening Central Bank Credibility and Monetary Framework**: While immediate full floatation of the exchange rate may be infeasible, the Central Bank must:
    - Announce **transparent, measurable, and time-bound monetary targets**,
    - Commit to **fiscal discipline** by reducing the budget deficit and curbing monetization of fiscal gaps,
    - Enhance **monetary policy signaling** through interest rate instruments,

- Diversify its **policy toolkit** to manage exchange rate expectations without depleting foreign reserves.

3. **Breaking the Inflation–Exchange Rate Spiral**: By anchoring inflation expectations and stabilizing the exchange rate, authorities can restore confidence in the domestic currency. This would encourage **productive investment**, stimulate **non-oil exports**, diversify **foreign exchange earnings**, and foster a **more stable and efficient foreign exchange market**.

In sum, addressing exchange rate volatility in Iran requires more than technical fixes—it demands **institutional credibility**, **policy coherence**, and **structural reforms**. Only through an integrated approach that combines credible monetary policy, fiscal consolidation, digital transparency, and market-oriented reforms can Iran mitigate the destabilizing spillovers of exchange rate shocks and pave the way for sustainable, inclusive economic growth.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.