Unraveling Inflation Dynamics: Evidence of Fisher and Neo-Fisherian Effects in Pakistan Using Time-Varying Models

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Abstract

This research empirically investigated the dynamic relationship between interest rates and inflation in Pakistan, testing the classical Fisher effect and the emerging Neo-Fisherian hypothesis. The results reveal evidence of bi-directional causality and co-integration between inflation and interest rates, as determined using Vector Autoregressive, and Momentum Threshold Autoregressive models, respectively. However, structural stability tests suggest parameter instability. Therefore, we employed Time Varying Parameter models that reveals that from the mid-2015s onward, particularly after the SBP's shift toward an inflation-forecasting regime, inflation often responded positively to policy rate shocks. Furthermore, empirical results also show that interest rate hikes during this period frequently led to upward inflationary pressure in the short to medium term – Neo-Fisherian mechanism, as observed from October and November 2015. These results suggest that under certain conditions, (i) when inflation expectations are unanchored, or (ii) when fiscal dominance is present, then higher nominal interest rates may signal higher future inflation. If the Fisher effect dominates, raising interest rates remains a valid tool for anchoring inflation expectations. However, the existence of Neo-Fisherian episodes warns that raising rates without credible fiscal reform, clear communication strategies, and effective anchoring of expectations may inadvertently reinforce inflationary pressures. Hence, conventional interest rate policies may yield unintended inflationary consequences; therefore, policymakers must adopt a more holistic view of monetary policy transmission – recognizing that under some institutional and macroeconomic conditions.

Keywords: Time varying parameters, Neo Fisher effect

GEL Classification: C32, E52

1. Introduction

Pakistan's macroeconomic stability is a passionately debated topic due to its persistent inflation and volatile interest rates, among other things. For monetary policy and economic planning experts, at the core of this debate lies the seemingly indisputable relationship between interest rates and inflation. Classical economic theory posits the Fisher effect, which suggests that nominal interest rates move one-for-one with expected inflation in the long-run, leaving real interest rates unchanged (Fisher, 1930). However, recent debates have challenged this conventional wisdom.

On the contrary – Neo-Fisherian' effect, argues that a sustained increase in nominal interest rates could *cause* higher inflation, rather than curbing it (Cochrane, 2018). Furthermore, it also views to runs counter to standard policy intuition, raising provocative questions about how central banks' rate hikes might influence inflation expectations and outcomes (Cochrane, 2018; Bouakez & Kano, 2024). The debate is especially relevant for Pakistan, where inflation dynamics have at times visibly defied expectations amid aggressive monetary tightening. For instance, Pakistan's consumer price index inflation surged to a record 38% year-on-year in May 2023 despite steep interest rate hikes by the State Bank of Pakistan (SBP). SBP raised its policy interest rate to an unprecedented 22% in 2023 to reign in inflation. Yet inflation remained elevated, fueling discussion on whether such rate increases were effectively controlling prices or paradoxically feeding into inflation through unanchored expectations and fiscal pressures (Ministry of Finance, 2024; Reuters, 2023). This encourages researchers and policy makers to re-examine and possibly revisit their understanding of the interest rate–inflation relationship through both the traditional Fisher hypothesis and the Neo-Fisherian lens.

Researchers have been exploring the link between the SBP's policy rate and its effect on inflation in Pakistan for quite some time and found the Fisher effect to hold within the context of Pakistan (Hasan, 1999). However, recent studies have found some evidence of the Neo-Fisherian effect post-2015 in the context of Pakistan (Hina, 2024), hinting towards a dynamic bi-directional relationship between interest rate and inflation – a result consistent with the Neo-Fisherian proposition (Cochrane, 2016). This finding contrasts with the earlier decades, where the conventional Fisher effect – nominal rates adjusting to expected inflation – was more pronounced

(Hasan, 1999; Hina, 2024). The ongoing debate on whether policy rate hikes are combating inflation or contributing to it has thus been rekindled by these results.

The purpose of this research is to investigate the relationship dynamics between nominal interest rates and inflation in Pakistan, and if empirical evidence permits, possibly revisit this relationship in the context of contemporary economic conditions in Pakistan under the Neo-Fisherian theoretical paradigm. Therefore, this research aims to determine whether increases in policy-controlled interest rates lead Neo-Fisherian view or the traditional Fisher hypothesis. By analyzing this issue empirically, this study seeks to resolve the seeming puzzle in inflation–interest rate. Hence, this research questions and hypotheses are (i) *Does the conventional Fisher effect hold in Pakistan's economy?* To put it simply, is there a one-to-one relationship from nominal interest rates to expected inflation over time? (ii) *Is there evidence of a Neo-Fisherian effect in Pakistan?* Precisely, in short-to-medium run, do consistent raise in the policy rate lead to higher inflation rather than lower inflation?

This study contribute significantly in academic and practical literature by highlighting the relatively underexplored Neo-Fisherian effect in the context of a developing country like Pakistan, where empirical evidence is scarce, compared to the advanced economies. By testing these ideas empirically for Pakistan's economy, where frequent episodes of high inflation and aggressive monetary tightening in last few years, presents puzzling outcomes where inflation remained high or even accelerated despite higher interest rates. Confirming the existence of the Neo-Fisherian effect (Cochrane, 2018; Bouakez & Kano, 2024) would suggest that traditional policy tools, like raising interest rates to control inflation, may not yield the intended results without also anchoring inflation expectations through credible communication. Contrary, if the Fisher effect dominates (Fama, 1975; Mishkin, 1992), it would reinforce orthodox monetary theory and the SBP's current inflation-targeting framework. Overall, this research, deepening our understanding of inflation–interest rate dynamics in Pakistan, in so doing makes an important contribution to academic literature and enriches the global debate on the Fisher versus Neo-Fisherian effects.

There are five sections in this research. The first introduces the study, its significance, research questions, and objectives. The second reviews the literature, covering the historical development of the Fisher and Neo-Fisherian effects, focusing on interest rate and inflation dynamics, including theory and empirical findings. The third section outlines the data and methodology, followed by the fourth, which presents the empirical results. The final section discusses the findings, their policy implications for Pakistan, and offers recommendations for future research.

2. Literature Review

This section presents a systematic review of existing literature and begins by embedding the subject of this research into a broader monetary/economic perspective. Then it presents the academic journey from Fisherian to Neo Fisherian view, and then contextualizes the debate to Pakistan's economy.

2.1. Monetarism, Modern Central Banking, and the Fisher Effect

Starting with the United States of America, and led by the works of Milton Friedman and others, monetarism began to dominate the national economic policy landscape all over the world in the latter half of the 20th century. They argued that inflation is primarily a monetary phenomenon, with Milton Friedman famously saying that 'inflation is always and everywhere a monetary phenomenon' (Williamson, 2016).

This gave prominence to central banks as key players at the national economic landscape, and resulted in gradual independence and functional autonomy for central banks all over the world. Beginning in the 1980s, the role of central bank's began to evolve from supporting government finances, monetizing government debt, and aiding development policy of the government to primarily controlling inflation and delivering price stability. Accordingly, the central banks around the world began asserting their role in their respective economies and introduced independent monetary aggregates (-basically money supply) targeting frameworks to control inflation (Croce, 2000).

However, in the 1990s and beginning with New Zealand, the focus shifted from targeting monetary aggregates to inflation targeting directly. By the 2000s dozens of central banks, including some in developing economies, adopted inflating targeting frameworks (Croce, 2000; Bordo, 2007).

Similarly, the SBP gained gradually enhanced autonomy and independence with legislative amendments in the 1990s and 2000s, and the process is still continuing with latest move towards independence in the form of amendments in the SBP act as recent as in January 2022. Following global trends, the SBP targeted monetary aggregates explicitly from 1990 till mid mid-2000s. Starting around 2005, the central bank of Pakistan gradually shifted its focus on inflation targeting by introducing inflation forecasts in its reports and monetary policy statements. In May 2015, SBP formally introduced Monetary Policy Target Rate for the first time and concluded the shifting to inflation monitoring framework (State Bank of Pakistan, n.d.)

At the theoretical core of monetarism and contemporary inflation targeting frameworks of central banks lies the Fisher Equation. In its simplified form, the equation is as $i = r + E(\pi)$, where i is the nominal interest

rate, r is the real interest rate, and $E(\pi)$ is expected inflation (Dimand & Gomez Betancourt, 2012). The equation states that the nominal interest rate that lenders receive against their principal is a sum of real interest rate and the expected inflation. Since the real interest rate is fixed in an economy, the central bank's controls inflation by managing inflation expectations through setting and tinkering of nominal interest rates. For instance, if a central bank has an inflation target of 8% and believes the long-run real interest rate is 4%, then in the long-run, nominal interest rates should gravitate toward about 12%. Thus, in the long-run, the central bank's target or policy rate would be equal to the economy's real equilibrium interest rate plus the targeted inflation. The Fisher Equation conceptually ties together inflation and interest rate in the economy, and is central to Inflation Targeting Frameworks of central banks (Cochrane, 2018).

2.2. The Fisher Equation

Irving Fisher's contributions around the turn of the 20th century fundamentally shaped how economists and central bankers think about interest rates and inflation. Fisher's 1896 work *Appreciation and Interest*, and later writings (1907, 1930) formalized the idea that the nominal interest rate is the sum of real interest rate and expected inflation (Dimand & Gomez Betancourt, 2012). Previously, it was believed that inflation could affect lenders and borrowers, but Fisher showed that if people expect higher inflation, lenders would demand higher nominal rates to compensate for the loss of purchasing power, while borrowers will be willing to pay higher rates since they repay in cheaper dollars (Dimand & Gomez Betancourt, 2012). This concept is now known as the Fisher effect – in the long-run, an increase in expected inflation should lead to an equal increase in nominal interest rates, leaving the expected real interest rate unchanged (Tsong & Hachicha, 2014).

It has a powerful implication for the monetary policy, i.e., by influencing inflation in the long-run, ultimately determine nominal interest rates in an economy but not real interest rates. The real interest rate is determined by real factors – productivity, time preference, etc., whereas nominal rates simply reflect those real rates plus inflation (Uribe, 2022). Practically, if a central bank be successful in lowering inflation consistently from say 10% to 5%, one would expect nominal interest rates in that economy to eventually fall by roughly 5 percentage points as well – one-to-one long-run relationship (Williamson, 2016). Furthermore, when central banks set inflation targets, they implicitly use the Fisher effect (Dimand & Gomez Betancourt, 2012). For instance, if the real equilibrium interest rate is estimated around 2%, and the inflation target is 3%, policymakers anticipate that in the long-run the nominal policy rate will fall near 5%.

2.3. Empirical Challenges in Validating the Fisher Effect

Historically, validating the Fisher effect empirically has been challenging, especially in the short run or in less developed financial markets. Irving Fisher himself examined U.S. data in the 1890s–1920s and found evidence that interest rates responded to inflation, but not always one-for-one due to adaptive expectations and measurement lags (Fisher: 1930). Over the years, many empirical studies tested the Fisher hypothesis in various countries and periods.

Empirical research on the Fisher effect reveals a consistent pattern that the Fisher effect tends to hold in the long-run but is often weak or absent in the short run. Frederic Mishkin (1992), for example, found that for the United States, nominal interest rates and inflation were co-integrated, but in the short term their movements were not closely related. In other words, high-inflation decades had high interest rates and low- inflation decades had low interest rates, but month-to-month or year-to-year changes in inflation did not immediately translate into one-for-one changes in interest rates. Thus, over the long-run Fisher effect seemed to be in tact but short-run deviations were significant. Mishkin and Simon (1995) reported similar findings for Australia.

Furthermore, the Tsong and Hachicha (2014) in Fisher effect analyze asymmetric effect from interest rate to inflation by examining several developing economies, i.e., at higher inflation levels, a one-to-one relationship does hold, while, at lower inflation levels, nominal rates respond less than proportionally to inflation changes. Consequently, when inflation is modest, other factors may prevent full adjustment, whereas in high-inflation regimes, nominal rates eventually have to catch up fully. This asymmetry has been dubbed a "Fisher effect puzzle", i.e., the traditional tests that assume a constant relationship might be misspecified if the true relationship depends on the inflation regime.

In the case of developing economics, the testing the Fisher effect empirically can be even more complex because of either the asymmetric effects, or the structural factors (regulated interest rates, shallow financial markets, or fiscal dominance can break or obscure the relationship). In Pakistan, for instance, administrative controls and government borrowing needs and not purely dictated by market forces responding to expected inflation have at times influenced interest rates. Empirical studies have yielded mixed conclusions. Some earlier studies suggested only a partial Fisher effect in Pakistan. Using data up to the 1990s, Hassan (1999) says that nominal interest rates did responds to inflation in the long-run, but it is less than one-to-one, indicating an incomplete pass-through of inflation to interest rates. On the other hand, short-term adjustment could reflect a variety of issues: persistently negative real interest rates, at times risk premia, and liquidity constraints affecting interest yields.

2.4. From Fisher to Neo-Fisher: An Emerging Alternative Perspective

Understanding the Fisher effect sets the stage for a more contemporary debate, i.e., the Neo-Fisherian perspective on the relationship between interest rate and inflation. The Neo-Fisherian perspective has emerged over the past decade as something of a counter-intuitive challenge to conventional monetary policy wisdom. It builds directly on the Fisher equation, but flips the usual question of causality. Traditionally, as described, we think of inflation expectations influencing interest rates (the Fisher effect). Neo-Fisherians ask: could the central bank's interest rate policy be influencing the inflation rate in the same direction? That is to say, can an increase in interest rates actually fuel inflation further rather than curbing it? This stands in contrast to the orthodox view that raising rates fights inflation and lowering rates spurs inflation.

The Neo-Fisherian argument gained attention in the mid-2010s, when many advanced economies were stuck with ultra-low interest rates and inflation persistently remained below target despite years of monetary easing by central banks. After the 2008 global financial crisis, central banks in the U.S., Eurozone, Japan, and elsewhere slashed short-term rates to zero or close to it, and employed unconventional tools to stimulate inflation (Cochrane, 2018). Up till now inflation remained persistently subdued, often below the official targets. By 2015–2016, this "missing inflation" puzzle led some economists to suggest that the prevailing policy paradigm might be missing a crucial insight. As Williamson (2016) described, "many central banks…are experiencing inflation below their targets, and they seem powerless to correct the problem". Proponents of the Neo-Fisherian perspective argued that the solution to too-low inflation might be the opposite of conventional advice, i.e., raise the policy interest rate to increase inflation (Cochrane, 2018). This idea traces back (at least in spirit) to Irving Fisher himself, hence the name "Neo-Fisherian," meaning a new interpretation of Fisher. The term 'Neo-Fisherian' was coined by Miles Kimball in 2013, whereas the idea was conceptually developed and formalized academically by John Cochrane (Kimball, 2013; Cochrane, 2011). Thus, a higher steady nominal rate implies a higher steady inflation rate, all else remaining equal.

It's important to note that the Neo-Fisherian view remains controversial and the jury is still out on this debate. Consensus exists among mainstream economists about the validity of Fisher Equation in the long-run i.e. in the long-run nominal rates and inflation move together. The debate is about the dynamics of this relationship and monetary policy feasibility. Empirical evidence directly testing the Neo-Fisher effect is still emerging. Recent studies have used advanced econometric techniques to detect the direction of causality between interest rates and inflation. One study found moderate support for Neo-Fisherian effects in certain subsamples of U.S. data (particularly when analyzing very low-frequency trends), but not in others (Phiri, 2024). Crowder (2016) found little evidence that nominal rates Granger-cause inflation in the postwar U.S., except potentially when focusing on very long horizons. Uribe (2022) demonstrated that permanent shocks to the Fed's interest rate (interpreted as permanent changes in the inflation target) do lead to inflation moving in the same direction, whereas temporary interest rate shocks do not. This aligns with the theory: only when the change in i is viewed as permanent (affecting the expected long-run π) do we see a Neo-Fisherian outcome. These findings suggest that the neo-Fisher effect is not typically observed in normal cyclical policy changes (which are transitory), but could manifest under regime shifts.

2.4. Empirical Studies Questioning Fisher vs Neo-Fisher Effect

A vast empirical literature has tested the Fisher effect across different countries and time periods. Broadly, evidence suggests that the Fisher effect holds in the long-run for many economies, but short-run relationships between interest rates and inflation are often weak or variable. Early studies focusing on the U.S. and other developed markets found that nominal interest rates do not fully adjust to expected inflation in the short term, leading to deviations in real rates. For example, using U.S. data, Mishkin (1992) reported no support for a short-run Fisher effect – changes in expected inflation did not immediately translate into equal changes in nominal rates – but did find support for a long-run Fisher effect. De Michelis and Iacoviello (2016) studied Japan's experience with raising its inflation target (Abenomics) and found that a credible commitment to higher inflation can indeed shift inflation expectations upward. In their analysis, the persistent component of monetary policy (e.g., a permanently higher interest rate path associated with a higher inflation target) led to a positive co-movement of inflation and interest rates, consistent with the Neo-Fisherian prediction, whereas transitory policy changes did not. Similarly, Azevedo et al. (2019), using data from the U.S. and several European economies, confirmed that nominal rates and inflation share a long-run neutral relationship, with short-run deviations. They added evidence from the Eurozone and other advanced economies that supports the view that only permanent interest rate changes (those affecting the long-run nominal anchor) have positive inflation effects.

Cross-country analyses on developing economies generally verify the Fisher effect but represents heterogeneity magnitude and speed of adjustment. Maghyereh and Al-Zoubi (2006) examined six countries (Argentina, Brazil, Malaysia, Mexico, South Korea, and Turkey), and found that nominal interest rates and inflation exhibited a common nonlinear trend, and but even then confirms the existence of Fisher effect. Literature also employed time-

varying parameter models including other advanced techniques to estimate how the interest rate–inflation relationship changes over time or across regimes. Using time-varying trends in U.S. inflation and nominal interest rates, finding that these permanent components closely co-move over time (Gao et al., 2020). Their empirical evidence confirmed Neo-Fisherian pattern in the low-inflation, low-rate era (e.g. post-2008): with policy rates near zero, inflation trends also drifted downward, consistent with the idea that keeping rates "too low for too long" can entrench low inflation. Another empirical evidence for the U.S. and Japan's economy is presented by Uribe, (2018; 2022), finding that permanent increases in the policy rate lead to rising inflation in the short run, whereas transitory increases have the usual opposite effect. In his estimates, a credible permanent rise in the nominal interest rate caused an immediate jump in inflation and output – Neo-Fisherian – whereas a temporary rate hike caused a recession and deflation. This duality reconciles why empirical findings seem mixed: it depends on whether the interest rate changes are perceived as permanent shifts in the nominal anchor or as temporary policy moves. When agents believe the regime has changed, their expectations shift accordingly, aligning with Fisher's equation in short order.

Recent work also explores the conditions under which a Neo-Fisherian outcome is more likely. New analytical results (Cochrane, 2017; Schmitt-Grohé & Uribe, 2017) indicate that if the monetary/fiscal regime is such that the central bank targets a long-run inflation rate and is willing to stick to an interest rate path consistent with that, then raising the target (and the steady-state nominal rate) can indeed raise inflation. However, if the public doubts the permanence of the policy or if the economy is dominated by backward-looking expectations, the traditional effects dominate.

2.5. Neo-Fisher Question: Evidence from Pakistan

Early empirical work focused on testing the classical Fisher hypothesis in Pakistan (Rehman et al., 2004; Fatima & Sahibzada, 2012). Empirical results of Rehman et al., (2004) supports the existence of the Fisher effect, and suggesting that investors demanded an inflation premium in nominal rates. However, this study found little evidence of a one-to-one short-run adjustment. Another study by Fatima and Sahibzada (2012) examined data from 1980–2010 and confirmed the presence of Fisher effect, by employing co-integration and error-correction models, they found that while nominal treasury bill rates and CPI were co-integrated, the speed of adjustment was slow. Particularly, their estimated coefficient on inflation was close to 1 in the long-run, meaning a 1% rise in inflation would eventually lead to about a 1% rise in nominal interest rates, consistent with Fisherian theory.

SBP Working Paper No. 79 by Hayat and Hanif (2017) examined the "role of money versus interest rate" in driving price stability. They found that while monetary aggregates have historically been linked to inflation, the interest rate has become an increasingly important policy instrument after the adoption of an interest rate targeting framework. Their empirical findings indirectly support the Fisher hypothesis. Another SBP study by Khan *et al.* (2016) highlighted Pakistan's "dominant borrower syndrome," where government borrowing largely influence interest rates. In this case, interest rates may not purely reflect market expectations of inflation but also credit demand by the public sector. This can sometimes mask or distort the Fisher effect in the short run. This empirical evidence are consistent with international literature as well, i.e., environments of very high inflation or weak credibility, *raising interest rates can exacerbate inflation* in the short run.

Several other literature on Pakistan mostly support the long-run Fisher effect but with cautions. For example, *Agha et al. (2005)* found that monetary policy tightening eventually curbs inflation, but the pass-through is incomplete and slow, partly due to underdeveloped financial markets and administered prices. This implies that while the Fisher effect holds, but short-run adjustments in inflation might not be fully captured by nominal. Other literature also differentiate between various interest rates: e.g., the relationship between market yields and inflation tends to be stronger: whereas the relationship between the SBP policy rate and inflation is complicated by policy reaction. Statistically, in recent years Pakistan's adoption of explicit inflation targeting which implies that the policy rate is often reactive to inflation forecasts, which can obscure simple correlations.

Finally, literature on Turkey is another example high-inflation emerging economy, similar patterns to Pakistan economy. *Tayyar (2019)* analyzed and found one-way causality from the policy rate to the inflation. If high interest rates are driven by fiscal dominance or risk premia, they can coincide with high inflation. This insight is very relevant for Pakistan, where fiscal deficits and public debt often influence monetary conditions. The concept of fiscal dominance has been discussed in Pakistan's context (e.g. by Atif Mian, 2024). Under fiscal dominance, a central bank might be "forced" to keep interest rates high to attract funding and defend the currency, even as the government's debt burden grows. Such a scenario can lead to a vicious cycle: high rates increase debt service costs, which may lead to more money creation or loss of confidence, fueling higher inflation – a mechanism that again mimics a Neo-Fisherian outcome but is driven by fiscal excess. We will return to these issues of expectations and fiscal context in the next section on literature gaps.

2.6. Gap in Literature and Research Contribution

Despite the rich body of work summarized above, there remain important gaps in the literature on the interest rate–inflation relationship, especially in the context of Pakistan. These gaps provide the justification for the present research and define its unique contribution. With the exception of very recent work where time varying econometric models were employed (Hina 2024), earlier studies assumed a single, stable relationship over long samples. Pakistan's economic history suggests there may have been regime shifts – for example, pre- inflation-targeting vs. post-inflation- targeting frameworks. The Fisher effect might hold in one regime and not in another, or the Neo- Fisherian effect might appear only after a certain change. There is a gap in formally testing for structural breaks or different regimes in the interest rate– inflation relationship in Pakistan. Our research will contribute by testing neo-fisherian hypothesis through time-varying techniques and possibly examining the causality in sub-periods. For instance, we suspect that after the SBP gained more autonomy and adopted an inflation-target-like approach (around 2009 onwards), the Fisher effect may have strengthened, and after the policy rate reached very high levels in response to crises (mid-2010s), a Neo-Fisherian pattern emerged. Identifying such regimes will be a novel contribution.

By addressing these gaps, the current study makes several contributions. First, it will provide the first comprehensive assessment of the Neo-Fisherian effect in Pakistan using modern time-series techniques and up-to-date data. Second, it will deepen understanding of how inflation expectations and credibility affect the Fisher effect in a developing country context – an area largely informed by advanced economy research until now. Third, it will inform policymakers about the potential risks of relying solely on conventional wisdom: if indeed raising rates under certain conditions can raise inflation (as the Neo-Fisherites warn), then policymaking must account for expectation channels and fiscal credibility, not just the immediate demand-cooling effect.

2.8. Theoretical Framework

Building on the above insights, this section outlines the conceptual framework guiding our empirical analysis. We integrate elements of the Fisher effect and the Neo-Fisherian hypothesis into a unified framework tailored to Pakistan's economy. The goal is to conclude whether Fisher Effect holds in Pakistan at all times or are there specific periods where data points out the existence of Neo-Fisherian effect in the short-run. While our primary variables are inflation and interest rate, in the presence of control variables.

In this framework, inflation plays a pivotal role. We treat expected inflation as a latent or observed variable that links the Fisher and Neo-Fisherian perspectives. From the Fisher effect side, if inflation expectations rise (due perhaps to external shocks or policy credibility issues), lenders will demand higher nominal interest rates on loans and bonds, pushing up interest rates. This is the traditional direction: from inflation to interest rate. From the Neo-Fisherian side, if the central bank exogenously raises the nominal policy rate and is expected to keep it elevated, agents may revise upward their inflation expectations to be consistent with long-run equilibrium. Thus, increase in interest rates would cause inflation to rise, the Neo-Fisherian causal chain. In our theoretical framework, it represents a feedback loop where nominal interest rate policy influences inflation via expectations and inflation feeds back into nominal rates. This two-way feedback encapsulates the idea that the observed correlation between inflation and interest rates could arise from either direction of causality. A core contribution of our study is to disentangle these directions using econometric tools.

Another element is the monetary policy regime or inflation target. This provides an anchor for long-run expected inflation if credible. In Pakistan, while an official numerical target range has only recently been adopted, the SBP has often signaled a medium-term inflation aim (around 5–7% in recent years). If that target is credible, it pins down inflation in the long-run, and hence via the Fisher effect, the interest rate as well. However, credibility in Pakistan has been tested by fiscal dominance and political interference historically. Our framework allows for regime shifts in credibility: during periods when SBP had higher independence and clearer targets (say post-2015), the Fisher effect might assert itself strongly (with interest rate adjusting to maintain real rates against target inflation). In periods of loose policy or political pressure (say, early 2000s or during heavy government borrowing), expectations might de-anchor, and the link changes.

3. Data and Methodology

3.1. The Data

We use time-series data from June 2005 to March 2025. The data on inflation and the industrial production index as a proxy for output are obtained from the Monthly Bulletin Statistics published by the State Bank of Pakistan (SBP). The base year of inflation and industrial production is 2010.[1] The data on Karachi Interbank Offer Rate (KIBOR) is obtained from the website of SBP and is used as a proxy for the interest rate. The data on international crude oil prices in dollars per barrel are obtained from the Federal Reserve Bank Economic Data

[1] In case Industrial Production index data was available in base years of 2005-2006 and 2015-2016, we then converted into base year June 2010.

(FRED) portal. To remain consistent in the unit of empirical analysis, we convert oil prices into Pakistani Rupees using the monthly exchange rate from the SBP. The data on Broad Money (M2) as a proxy for Money Supply (MS), Real Effective Exchange Rate (REER), and Credit to Private Sector (CRDT) are sourced from the International Financial Statistics (IFS) database of the International Monetary Fund (IMF). A clear trend component was observed in MS and CRDT. To eliminate this trend and focus only on the cyclical fluctuations, both series were detrended using the Hodrick–Prescott (HP) filter.

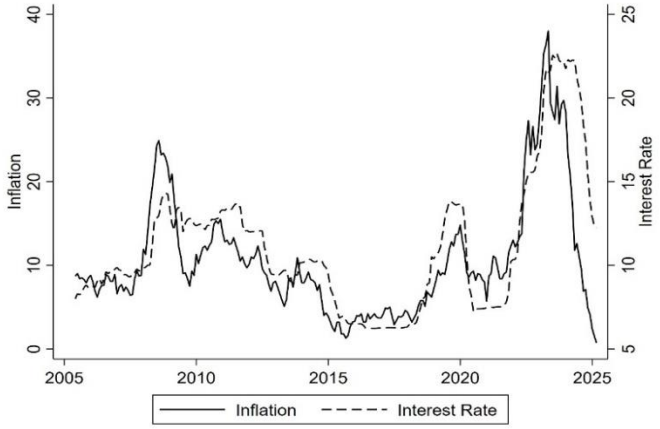


Fig. 1 Relationship between inflation and interest rate in Pakistan.

Fig. 1 represents the relationship between inflation and interest rates. The correlation between inflation and interest rate is 0.79, indicating a strong relationship, and is also visible in Fig. 1, but the causality is hard to predict – the main goal of this research. However, the variation in inflation is higher compared to the interest rate. Overall, both series are moving in the same direction with random trends in both directions throughout the time series. In the early years, values are rising till 2008, and followed by a downward trend till 2018, with a random walk. However, there are phases where either upward or downward trends are visible. The periods of 2008–2009, 2019–2020, and 2022–2023 represent three humps of hikes, indicating tight monetary policies in earlier times, and immediately followed by loose monetary policy. Furthermore, in earlier episodes (2007–11 and 2019–20), interest rate hikes mostly followed surges in inflation, reflecting the usual policy reaction where inflation leads and interest rates respond. By contrast, during 2021–2023, both inflation and interest rates climbed together, with inflation remaining high despite record-tight policy. This suggests that persistently high interest rates coincided with higher inflation, especially under weak expectations management or fiscal pressures. Recently, 2024–2025, inflation fell sharply while policy rates adjusted more slowly, giving clues about asymmetry and structural breaks. These shifting patterns make it necessary to use formal, time-varying estimation methods such as time-varying parameter – VAR models to distinguish between Fisher and Neo-Fisher dynamics.

3.2. The Methodology

3.2.1. Unit Root Testing

Before estimating our econometric model, it is essential to examine the stationarity properties of each time series. Most macroeconomic variables, especially level of prices or aggregates, exhibit trends or unit roots that must be addressed to avoid spurious regression results overestimating the significance of the relationships. Stationarity in time-series data refers to the condition where statistical properties of the series such as mean and variance, remains constant over time. Most econometric models, including VAR and TVP-VAR have stationarity as their assumption for estimating a valid model.

3.2.2. Visual Inspection of stationarity

A direct and time-saving approach is to inspect the variables' stationarity visually before moving onto more robust and definitive statistical tests for stationarity. The stationary series exhibits constant mean around a horizontal line, a constant variance and all fluctuations in the time-series data are around a fixed level. Whereas non-stationary series are trending upwards or downwards, or have fluctuations in variance.

3.3. Base-Line Vector Auto-Regression (VAR)

Given the multiple endogenous variables in our study and the feedback loops hypothesized (especially between interest rates and inflation, but also possibly involving output, money, exchange rates, etc.), we adopt a Vector Autoregression (VAR) as a baseline empirical model. A VAR is a system of equations in which all included variables are treated as jointly endogenous, each being explained by lagged values of itself and all the other variables in the system. This approach, introduced by Sims (1980) as an alternative to large structural macro econometric models, allows the data to speak with minimal imposed theory, capturing the dynamic interactions and causal relations in an unrestricted manner. By using a VAR, we avoid having to specify one-way causal directions a priori; instead, we can test and observe how, for example, the interest rate and inflation influence each other over time in a dynamic feedback setting.

The VAR model is specified below:

$$Y_t = C + \sum_{i=1}^{p} B_i Y_{t-i} + \varepsilon_t$$

where:

- Y_t is an n×1 vector of endogenous variables observed at time t. In our empirical analysis, this vector consists of seven macroeconomic variables:
- C is an n×1 vector of constant (intercept) terms, accounting for average growth or drift rates in each variable.
- B_i are n×n matrices of autoregressive coefficients associated with each lag i, capturing dynamic interdependencies between current and past values of all variables.
- P denotes the lag order of the VAR model. In our baseline VAR, the optimal lag order is selected using standard information criteria (e.g., AIC, SBC, or HQC).
- $\mathcal{E}_t$ is an n×1 vector of white-noise error terms or shocks.

Lag selection

Before specifying the econometric model, it is imperative to ascertain the appropriate number of lags to be included in the model. We include a sufficient number of lags (p) to capture the monthly dynamics. We employ two information criteria i.e. Akaike Information Criterion (AIC) (Akaike, 1974) and the Bayesian Information Criterion (BIC) also called SIC Schwarz Information Criteria (Schwarz, 1978) to guide lag selection. These criteria trade off model fit against parsimony. Given our relatively large number of observations (monthly data for 280 months) and the complexity of potential interactions, we expect the optimal lag order to be on the order of several months. Often monthly data often requires a higher lag order than quarterly data to account for cycles and delayed reactions. In practice, we compute the AIC and BIC Criterion for VARs with a range of lag lengths and select the lag p that minimizes these criteria.

Although both the criteria reward higher log-likelihood i.e. better model fit, and penalize complexity i.e. adding more parameters. However, AIC generally recommends higher log selection resulting in higher model complexity and overfitting of the model. Whereas SIC/SIC favors simple' models. The ultimate decision regarding log selection will be based on balancing model fit vs the relative complexity of the model i.e. 'fit-parsimony trade-off'.

Granger Causality Test: named after Clive W. J. Granger (1969) is a statistical hypothesis used to determine whether the values of one variables can predict the values of another in the model. Specifically, it tells you whether past values of one variable can help predict the future values of second variable more accurately, over and beyond what the past values of second variable can predict themselves. Formally, if we say that variable X granger-causes variable Y, we mean that lags of variable X provide statistically significant information about the future values of variable Y, even after controlling for lags of variable Y.

However, granger causality test does not imply truly causality, and even the most significant of results showing granger-causality between two variables don't have theoretical validity. It is purely based on statistical prediction and not based on structural or theoretical causation. It only tells us whether there is enough statistical evidence in determining whether past values of one variable can help predict the future values of another.

Another important aspect of granger causality tests is its ability to check for possibility of reverse causality between variables i.e. bidirectional causality, where past values of both the variables can predict the future values of each other. It is especially relevant in our study as we are studying the dynamic relationship between interest rate and inflation, and where bidirectional causality is theoretically possible. If we are asking the question whether variable X Granger causes Y, then the null and alternate hypothesis of granger causality test are given below:

$$H_0 : \gamma_1 = \gamma_2 = \ldots = \gamma_p = 0$$

(X does not granger cause Y i.e. all lagged values of X have zero coefficients in the equation for Y)

$$H_1 : \text{Atleast one } \gamma_j \neq 0$$

(X granger cause Y i.e., at least one lagged value of X helps predict Y)

Using the granger causality tests, we have specifically asked two questions. 1) Do interest rates granger-cause inflation (-if true, would support the existence of the neo-fisherian effect). 2) Does inflation granger causes inflation (-if true, would suggest that interest rates responds to inflation, weakening neo-fisherian hypothesis).

Furthermore, we have also applied multi-horizon granger causality test to

Impulse Response Functions – Cholesky

Impulse Response Functions (IRFs) constitute an essential analytical tool within the Vector Autoregression (VAR) framework, enabling examination of dynamic interdependencies among macroeconomic variables. Specifically, IRFs depict how endogenous variables respond over time to an unexpected shock in another variable (Lütkepohl, 2005). Given our central research question, the IRF analysis performed on our baseline VAR provides a crucial reference for interpreting the outcomes of our more complex, time-varying models.

We also employ the Cholesky decomposition approach for structural shock identification, which imposes a recursive ordering of variables. This identification scheme assumes that a variable positioned earlier in the ordering contemporaneously influences variables later in the ordering but is not immediately influenced by those variables itself (Christiano, Eichenbaum, & Evans, 1999). In alignment with established monetary policy literature (Bernanke & Mihov, 1998), we place inflation first and the interest rate second, reflecting the plausible assumption that inflation does not immediately respond to contemporaneous interest rate shocks within the same period, while the interest rate is assumed to adjust contemporaneously to inflation developments.

The IRFs are computed to analyze the response of inflation to interest rate shock, and the response of interest rates to inflation shock. These IRFs are tracked across a forecast horizon spanning typically 12 to 24 months (Sims, 1980). The interpretation of these IRFs is straightforward: a positive response of inflation to an interest rate shock at longer horizons would offer empirical support for the Neo-Fisherian hypothesis, indicating that higher interest rates could lead to higher inflation. Conversely, a negative or negligible response would support traditional monetary policy transmission theories, suggesting contractionary policy effects on inflation.

Overall, throughout the VAR modeling, all variables are treated symmetrically – an important strength of the VAR approach noted by Sims (1980). We do not impose, for example, that interest rate only affects inflation but not the other way around; rather, the VAR will let us test and observe these interactions. This is particularly appropriate given the debate on the Fisher vs. Neo-Fisher effect: theory is ambiguous on the direction of causality (traditional view expects inflation expectations drive nominal rates, whereas Neo-Fisherism suggests policy-driven nominal rates might drive inflation). The VAR's flexibility makes it a natural choice for empirically unveiling these relationships in Pakistan's context.

It should be noted that VAR models assume time-invariant parameters over the sample. The coefficients are fixed estimates representing an average relationship over 2002–2025. We will later relax this assumption with a Time-Varying Parameter VAR. However, as a starting point, the VAR provides a benchmark assuming stability. We also implicitly assume the relationships are linear and the shocks are homoskedastic over time (though we allow correlation across equations). In reality, macroeconomic relationships can change due to policy regimes or structural breaks – which motivates our use of more advanced techniques later – but the VAR is a necessary first step for testing for co-integration and understanding baseline dynamics.

3.5. Time Varying Parameter-Vector Auto-Regression (TVP-VAR)

To assess the Neo-Fisherian effect, we employ a Time-Varying Parameter Vector Autoregression (TVP-VAR) model with stochastic volatility following the Bayesian framework of Primiceri (2005). This model allows all VAR parameters (autoregressive coefficients and shock variances) to evolve over-time, capturing potential structural changes in the inflation–interest rate relationship. Formally, the model is specified below:

$y_t = c_t + B_{1,t}\, y_{t-1} + B_{2,t}\, y_{t-2} + \ldots\ldots + B_{p,t}\, y_{t-p} \quad \varepsilon_t \qquad \varepsilon_t \sim (0, \Sigma t)$

where:

- y_t is an n×1 vector of endogenous variables, defined as:

y_t = [INFt, ITt, MSt, CRDTt, IPIt, REERt, OPt]

- Ct is a vector of time-varying intercept terms.
- Bi,t are n×n matrices of time-varying coefficients capturing the dynamic relationships between variables at each lag i (for i=1, 2 ,...,p) at every point in time t.
- εt is an n×1 vector of stochastic error terms, with a time-varying covariance matrix Σt.

Following Primiceri's approach, the VAR coefficients are treated as evolving via random walks and the shock variances follow stochastic volatility processes. This specification lets the model capture gradual shifts in dynamics over time. We assume a recursive (Cholesky) identification for contemporaneous relations among variables, implemented by restricting the covariance matrix to be time- varying diagonal for simplicity. In practice, this means we set the contemporaneous coefficient matrix to an identity matrix (no time-varying off-diagonal terms), so that shocks are (approximately) orthogonal and each equation can be estimated separately. This is a

simplification of Primiceri's original specification (which allowed a time-varying lower-triangular, but it is a common approach to reduce complexity. The trade-off is that we attribute all instantaneous interactions to the chosen ordering of variables (a standard recursive assumption). In our context, the inflation equation is ordered first, so its shock can be interpreted as an inflation-specific shock not contemporaneously affected by others, while the interest rate is ordered second, etc., reflecting a reasonable ordering for monetary transmission.

Time-Varying Impulse Response Functions

To explore how the dynamic effects of interest rate shocks on inflation and other macroeconomic variables evolve, this study employs Time-Varying Impulse Response Functions (TV-IRFs) derived from a Bayesian Time-Varying Parameter VAR (TVP-VAR) model, following the framework of Primiceri (2005). Unlike standard IRFs from constant-parameter VAR models – which assume a fixed transmission mechanism throughout the sample - TV-IRFs allow the IRF to change at each point in time, reflecting evolving macroeconomic relationships, structural shifts, and changing policy regimes.

The standard IRF traces the effect of a one-time structural shock on the future path of endogenous variables, holding all else constant. In the TVP-VAR context, both the autoregressive coefficients and the variance-covariance structure of the shocks vary over time. As a result, each period has its own set of dynamic responses to structural shocks, capturing how the same shock may propagate differently across time depending on prevailing economic conditions, expectations, and institutional settings (Koop, Leon-Gonzalez, & Strachan, 2009).

Granger Causality Test (Sub-Samples)

Although the granger causality test is standard to test the causal direction, but it is sensitive to the structural breaks, therefore we employed Granger causality tests to sub-samples of the full time-series dataset based on the findings of TVP-VAR (Granger, 1969). This recursive estimation across sub-sample improves interpretability by isolating regime-dependent causal patterns that might otherwise be masked in the full sample due to averaging effects or offsetting dynamics (Balcilar et al., 2010). The results of the sub-sample Granger causality tests provide critical temporal insight into the evolving direction of influence between interest rates and inflation. For example, if the interest rate does not Granger-cause inflation in earlier sub-periods but begins to do so in later periods, this may indicate emerging Neo-Fisherian dynamics. Conversely, if inflation persistently Granger-causes the interest rate, this could suggest a backward-looking or reactive policy regime, where the central bank primarily adjusts the interest rate in response to observed inflation, rather than anticipating or controlling it.

By aligning the methodology with the empirical strategy of this thesis, the sub-sample Granger causality tests serve as an important diagnostic tool to justify the use of time-varying models such as the TVP-VAR and enrich our understanding of how the interest rate-inflation nexus has evolved in Pakistan's macroeconomic history.

4. Empirical Results

Table 1 represents the empirical results of the HEGY test. All the variables are stationary at the first difference. Furthermore, all variables exhibit seasonality at both the level and first difference. After unit root testing, it is important to choose an appropriate lag length. Therefore, this research used five different methods of lag selection, and they are presented in Table 2. Mostly, the recommended shorter lag length criteria are SIC – tendency to select simpler models without over-sacrificing model fit. In practice, the lag lengths are selected in the range between the recommendations of AIC and SIC (Lubik & Matthes, 2015; Hina 2024). In our data, AIC recommends 3 lags while SIC recommends 1 lag. Simultaneously, we have applied both forward and backwards variable selection methods to avoid overfitting. For simplicity, we have presented the results of the forward selection method in Table 3. The criteria we used for the variable selection are the RMSE within-sample and the one-step ahead forecast. Based on the RMSE, the best model is 3rd, where we have five variables in our VAR model specification. Compared to the 3rd model, all other models have relatively high RMSE. In the case of the 5th model, the in-sample RMSE is minimum, but the out-of-sample RMSE is high. Hence, the 3rd model is best. Furthermore, Fig. 2 represents the out-of-sample forecasts based on 3rd model. To test the unbiasedness of this forecast using a one-sample t-test, it is found that the mean forecast error is –0.90 ($t = -1.63,\ p = 0.116$). Since the null hypothesis of zero mean error cannot be rejected, the forecasts are statistically unbiased. Due to the richer dynamics captured and in line with the recommendation of the AIC criterion, we have decided to proceed with a lag length of three in our empirical VAR and TVP-VAR models.

Table 1 Unit root test.

	At Level		At 1st Difference	
Variable	Unit Root	Joint Seasonal F	Unit Root	Joint Seasonal F
REER	-0.22	17.13**	-3.81***	17.18**
Output	-1.26	6.67**	-5.59***	6.78*
Credit	-0.09	4.94*	-4.48***	8.49**
Inflation	-1.36	76.56***	-6.22***	83.67***

Oil Prices	-0.61	343.44***	-4.99***	25.67**
Interest Rate	-0.27	14.42**	-3.78***	14.56**
Money Supply	-1.16	8.38**	-5.89***	4.41*

Note. **, **, and * represent the significance level at 1%, 5% and 10%, respectively. We used the detrended series of Credit and Money Supply.

Table 2 *Lag Selection Test Results (Sample: 2005m10 – 2025m3)*

Lag	LogL	LR	FPE	AIC	SIC
0	-3025.38		425.249	25.9178	26.0212
1	-1311.34	3428.1	0.000281	11.6867	12.5136*
2	-1221.97	178.75	0.000199	11.3416	12.8921
3	-1148.35	147.25	0.000162*	11.1312*	13.4052
4	-1104.08	88.532*	0.000169	11.1716	14.1692

Note. LR represents the sequential modified LR test statistic (each test at 5% level). FPE is the Final prediction error. AIC is the Akaike information criterion, and SIC is the Schwarz information criterion. * represents the lag order selected by the criterion.

Table 3 *Model Selection Strategy (Forward Selection) Results*

Model	Variables Included	Number of Variables	In-Sample RMSE	Out-of-Sample RMSE (Forecast)
1	Interest Rate, Inflation	2	3.08	3.08
2	Interest Rate, Inflation, REER	3	4.31	2.87
3	Interest Rate, Inflation, REER, Oil Prices, Domestic Credit	5	3.85	2.79
4	Interest Rate, Inflation, REER, Oil Prices, Domestic Credit, Money Supply	6	3.93	2.85
5	Interest Rate, Inflation, REER, Oil Prices, Domestic Credit, Money Supply, Output	7	2.92	3.15

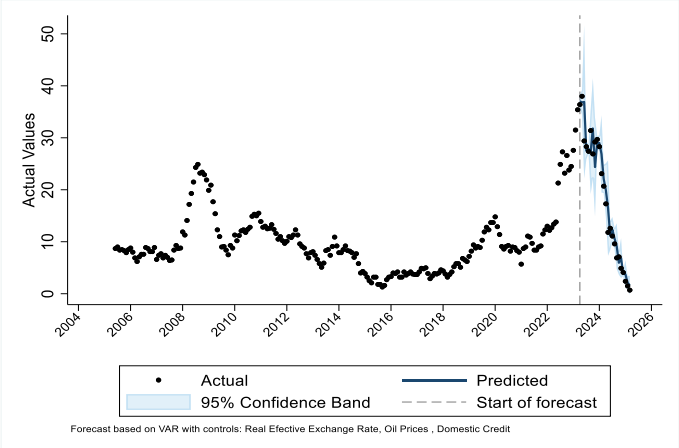


Fig. 2 Forecast of the 3rd model in Table 2.

Table 4 presents the empirical results of the causality test, divided into two panels. The first panel is based on the Granger causality test, while the second panel is based on the Multi-Horizon Granger causality. The null hypothesis of no causality is rejected in both directions of the Granger causality test, which implies the bi-directional causality between inflation and interest rates, indicating both classical Fisher and neo-Fisher effects. Subsequently, the multi-horizon Granger causality test further reinforces the same conclusion – classical Fisher and neo-Fisher perspectives yield statistically significant results across horizons of 1, 3, 6, and 12 months. Furthermore, the joint evidence confirms that the relationship between inflation and interest rates in Pakistan is mutually reinforcing and time-dependent, consistent with both the traditional Fisher effect and emerging Neo-Fisherian dynamics.

Table 4 Causality tests *results*

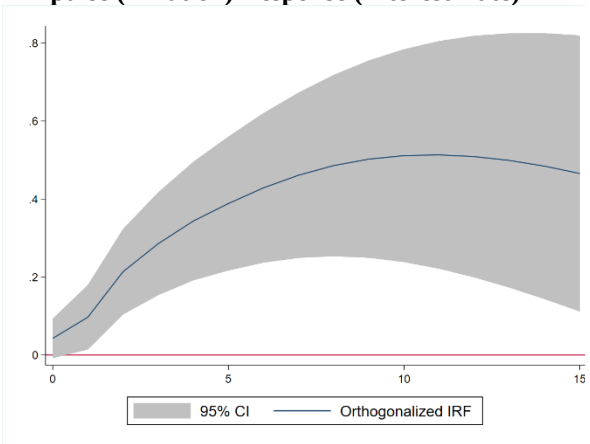
	Dependent Variable	Excluded Variable	Chi-Square	Decision
Panel 1: *Granger Causality*	Inflation	Interest Rate	18.99***	Reject H_0 → Interest rate → Inflation ✓
	Interest Rate	Inflation	30.84***	Reject H_0 → Inflation → Interest rate ✓
	Horizon (h months)	**Classical Fisher**	**Neo-Fisher**	**Decision**
Panel 2: Multi-Horizon Granger Causality	1	18.26***	8.86***	Bidirectional causation
	3	23.26***	8.23***	Bidirectional causation
	6	28.22***	1.20***	Bidirectional causation
	12	20.57***	6.32***	Bidirectional causation

Note. The null hypothesis (no causality) is rejected at all horizons in both directions. The results provide strong evidence of **bi-directional causality** between inflation and interest rates: The **Classical Fisher effect** (inflation → interest rate) and the **Neo-Fisher effect** (interest rate → inflation)

To explore the short-run dynamic interaction between nominal interest rates and inflation in Pakistan, we estimate orthogonalized IRFs based on a Cholesky decomposition of the residual variance-covariance matrix from our VAR model. The IRFs trace the effect of a one standard deviation structural shock in one variable (impulse) on the future path of another variable (response) over a fifteen-period horizon, while controlling for all other variables in the system.

Figure 3 represents the IRF. In Panel A, the interest rate rising steadily across the first several periods, reaching a peak increase of nearly 0.5 points before stabilizing in the medium term – Fisher effect. The sustained upward path suggests that inflationary shocks in trigger a tightening monetary stance, reflecting an effort by the central bank to re-anchor inflation expectations. However, the gradual and persistent adjustment may also indicate the presence of policy lags, limited transmission channels, or fiscal constraints that reduce the immediate effectiveness of interest rate hikes. Panel B implies that the response is speedy and significant, with interest rates increasing sharply in the first two periods by nearly 0.35 points. However, the effect begins to dissolve gradually over time, returning toward zero by the 6th period, indicating the Neo-Fisherian hypothesis, which posits that higher nominal interest rates can lead to higher inflation when expectations adjust accordingly or when policy credibility is low. The rising inflation path may also reflect backward-looking pricing behavior, where agents interpret higher interest rates as indicators of future inflation.

Panel A: Fisher
Impulse (Inflation) Response (Interest Rate)



Panel B: Neo-Fisher
Impulse (Interest Rate) Response (Inflation)

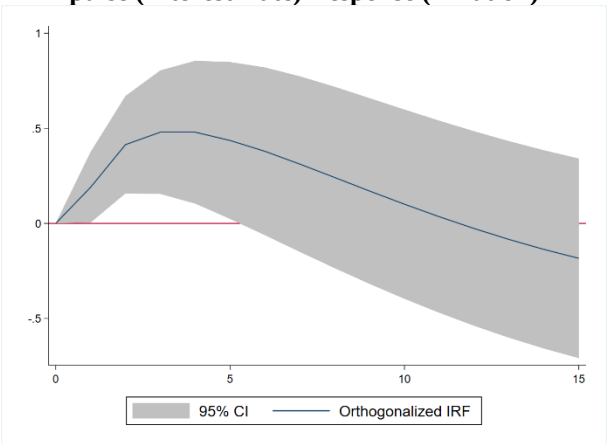


Fig. 3 Impulse response function based on the VAR model.

Table 5A and Table 5B represent the structural break test results along with the dates for the Fisher model. Both tables confirmed that there are five structural breaks and are presented in Fig. 4. The structural break analysis reveals both overlap and divergence between the Fisher and Neo-Fisher frameworks. Despite minor differences in the timing of breaks, both models consistently highlight critical episodes in Pakistan's monetary history. The break of 2008–2009 is align with the global financial crisis, the break of 2012–2013 correspond to IMF program-led monetary adjustments, the break of 2015m10–2015m11 coincide with the global oil price collapse, which sharply reduced inflation. The 2019m5–2020m4 breaks capture the monetary tightening cycle followed by the COVID-19 pandemic shock. Finally, the 2022m4 break, common to both models, reflects the post-pandemic

inflation surge, global commodity shocks, and domestic macro-fiscal pressures. Overall, while the Fisher and Neo-Fisher frameworks differ slightly in the precise dating of breaks, they converge on the same macroeconomic episodes, underscoring the regime-dependent nature of Pakistan's Fisherian dynamics.

Table 5A Empirical results of structural break in the Fisher Model

Test Type	s (Breaks)	Test Statistic	Estimated Break Dates
	1	99.00 ***	2022m4
	2	71.52***	2015m4, 2022m4
SupF	3	63.72***	2009m3, 2015m10, 2022m4
	4	53.86***	2008m5, 2012m7, 2015m10, 2022m4
	5	7.77***	2008m5, 2012m7, 2015m10, 2019m5, 2022m4
UDmax	–	99.00***	$1 \leq s \leq 5$
WDmax	–	99.00***	$1 \leq s \leq 5$

Note. SupF represents the Supremum F-test. UDmax represents the Unweighted Double Maximum test. WDmax represents the Weighted Double Maximum test. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

Table 5B Empirical results of structural break in the Fisher Model

Tests	Breaks	2008m5	2012m7	2015m10	2019m5	2022m4
Chow	t-Statistic	5.62***	7.31***	6.98**	9.15***	99.00***
Sequential	t-Statistic	99.00***	42.51***	55.22***	71.89***	81.75***

Note. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

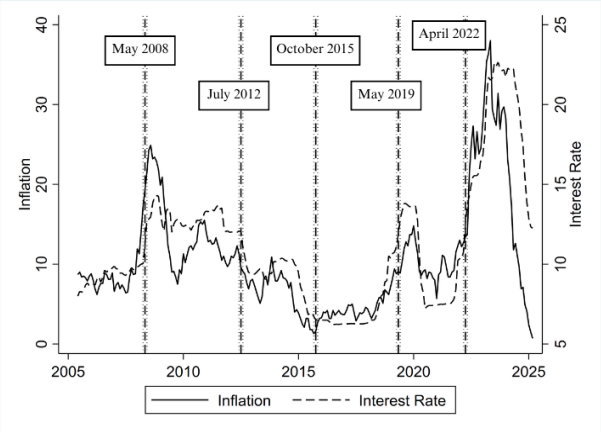


Fig. 4 represents the structural breaks in the classical Fisher model.

Table 6A and Table 6B represent the structural break test results along with the dates for the neo-Fisher model. Using the Supremum F-test, Unweighted Double Maximum, Weighted Double Maximum tests, and the Sequential test are strongly indicative of five multiple statistically significant breaks. On the contrary, the Chow test shows that the structural breaks of January 2013 and April 2022 are insignificant. Subsequently, Fig. 5 represents the structural breaks in the neo-Fisher model.

The break in March 2009 coincides with the aftermath of the global financial crisis, during which the State Bank of Pakistan raised interest rates to defend its reserve position and counteract surging inflation (IMF, 2009; SBP, 2009). January 2013 reflects IMF program-led monetary and fiscal adjustments, following the approval of a three-year Extended Fund Facility by the IMF (IMF, 2013). The November 2015 break aligns with sharp falls in global oil prices that suppressed inflation domestically (The Express Tribune, 2015). More recent structural shifts around April 2020 and April 2022 are associated with COVID-19-induced disruptions and global commodity shocks, as reflected in economic analysis reports (IMF, 2020).

Table 6A Empirical results of structural break in the Neo-Fisher Model.

Test Type	s (Breaks)	Test Statistic	Estimated Break Dates
	1	22.96***	2009m3
	2	16.88***	2009m3, 2020m4
SupF	3	12.17***	2009m3, 2020m4, 2022m4
	4	9.77***	2009m3, 2015m112020m4, 2022m4
	5	7.77***	2009m3, 2013m1, 2015m11 2020m4, 2022m4

UDmax	–	22.79***	$1 \leq s \leq 5$
WDmax	–	22.79***	$1 \leq s \leq 5$

Note. SupF represents the Supremum F-test. UDmax represents the Unweighted Double Maximum test. WDmax represents the Weighted Double Maximum test. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

Table 6B Empirical results of structural break in the Neo-Fisher Model.

Tests	Breaks	2009m3	2013m1	2015m11	2020m4	2022m4
Chow	t-Statistic	22.79***	1.80	3.46**	4.90***	0.86
Sequential	t-Statistic	22.79***	13.43**	254.43***	265.43***	277.77***

Note. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

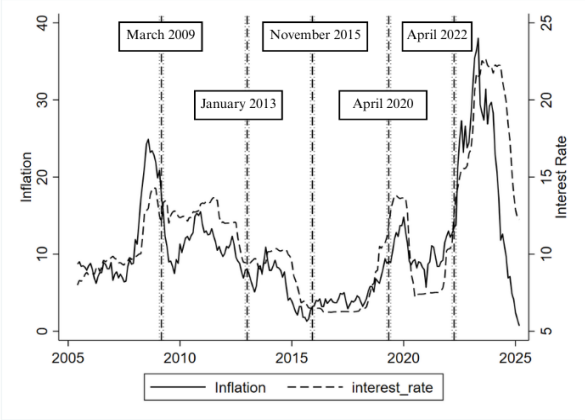


Fig. 5 represents the structural breaks in the classical Fisher model.

Table 7A summarizes the regime-wise Granger causality results between interest rates and inflation across the identified structural breaks in Tables 6A and 6B. The first three and the last one regime results indicate the unidirectional causality from inflation to interest rate, which implies the existence of only the classical Fisher effect dynamic. While in the fourth and fifth regimes, there is bidirectional causality between inflation and interest rate, which implies the existence of classical Fisher and neo-Fisher effect dynamics. Furthermore, in the case of the fourth regime, the causality is statistically strong, while in the fifth regime, it is relatively weak. These results are consistent in the case of the neo-Fisher Model and are presented in Table 7B.

Table 7A Granger causality tests result for the classical Fisher model

Regime	$i \rightarrow \pi$ (Neo-Fisher)	$\pi \rightarrow i$ (Classical Fisher)	Decision
1st	4.309	20.561***	Unidirectional – Classical Fisher holds
2nd	3.493	13.949**	Unidirectional – Classical Fisher holds
3rd	1.309	34.469***	Unidirectional – Classical Fisher holds
4th	22.247***	13.845***	Bidirectional Causality – Both Fisher and Neo-Fisher channels exist and are statistically significant
5th	7.2812*	6.304*	Bidirectional (weak) – Both directions are significant at 10%
6th	5.8227	10.038***	Unidirectional – Classical Fisher holds

Note. For each regime, we have used 1-3 lags. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

Table 7B Granger causality tests result for the neo-Fisher model

Regime	$i \rightarrow \pi$ (Neo-Fisher)	$\pi \rightarrow i$ (Classical Fisher)	Decision
1st	6.1468	33.568***	Unidirectional – Classical Fisher holds
2nd	1.8431	9.4729**	Unidirectional – Classical Fisher holds
3rd	2.2209	36.972***	Unidirectional – Classical Fisher holds

4th	20.819***	13.186***	Bidirectional Causality – Both Fisher and Neo-Fisher channels exist and are statistically significant
5th	7.2812*	6.304*	Bidirectional (weak) – Both directions are significant at 10%
6th	5.8227	10.038***	Unidirectional – Classical Fisher holds

Note. For each regime, we have used 1-3 lags. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

Table 9A represents the empirical results of MTAR for the classical Fisher framework across different regimes, including the complete sample. For the full sample, co-integration exists between inflation and interest rate, and the rate of the pass-through is complete, but it is an asymmetric adjustment, indicating that upward rigidity in adjustments, i.e., interest rates adjust more slowly when inflation is rising than when it is falling. In the case of regimes, there is co-integration in all, except the first one, but it is incomplete pass through in the first three regimes and followed by a weak classical Fisher effect, while it is complete in the remaining regimes and followed by the strong classical Fisher effect. However, the adjustments are symmetric in each regime. Lastly, the value of the threshold varies across each regime.

Table 9B represents the empirical results of MTAR for the Neo-Fisher model across different regimes, including the complete sample. For the full sample, the pass-through is complete with asymmetric adjustment, indicating downward rigidity inflation responds more slowly when interest rates fall than when they rise. Co-integration also exists across all regimes, and it is the complete rate of pass-through, except for the third regime. Furthermore, the adjustment from the long-run mean is symmetric except in the fifth regime, and there is upward rigidity. Lastly, the value of the threshold varies across each regime.

Table 9A MTAR model summary table for the classical Fisher model

Regime	Co-integration ($\rho_1 = \rho_2 = 0$)	Rate of Pass-through	Asymmetry Adjustment ($\rho_1 = \rho_2$)	Adjustment Rigidity ($\lvert\rho_1\rvert \neq \lvert\rho_2\rvert$)	Hypothesis Supported	MTAR Threshold
Full Sample	Yes ($p = 0.009$)	Complete	Asymmetric($p = 0.027$)	Upward	Strong Fisher	0.611
1st	No ($p = 0.179$)	Incomplete	Symmetric($p = 0.220$)	Both strong	Weak Fisher	0.028
2nd	Yes ($p = 0.090$)	Incomplete	Symmetric($p = 0.175$)	Both strong	Weak Fisher	0.180
3rd	Yes ($p = 0.012$)	Incomplete	Symmetric($p = 0.117$)	Both strong	Weak Fisher	-0.749
4th	Yes ($p = 0.003$)	Complete	Symmetric ($p = 0.109$)	Both strong	Strong Fisher	-0.083
5th	Yes ($p = 0.016$)	Complete	Symmetric ($p = 0.131$)	Both strong	Strong Fisher	-1.183
6th	Yes ($p = 0.071$)	Complete	Symmetric ($p = 0.131$)	Both strong	Strong Fisher	1.192

Note. For each regime, we have used 1-3 lags. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

Table 9B MTAR model summary table for the neo-Fisher model

Regime	Co-integration ($\rho_1 = \rho_2 = 0$)	Rate of Pass-through	Asymmetry Adjustment ($\rho_1 = \rho_2$)	Adjustment Rigidity ($\lvert\rho_1\rvert \neq \lvert\rho_2\rvert$)	Hypothesis Supported	MTAR Threshold
Full Sample	Yes ($p = 0.005$)	Complete	Asymmetric($p = 0.002$)	Downward	Strong Neo-Fisher	0.071
1st	Yes ($p = 0.0137$)	Complete	Symmetric($p = 0.4984$)	Both strong	Strong Neo-Fisher	0.244
2nd	Yes ($p = 0.0361$)	Complete	Symmetric ($p = 0.1712$)	Both strong	Strong Neo-Fisher	-0.406
3rd	Yes ($p = 0.0161$)	Incomplete	Symmetric ($p = 0.2575$)	Both strong	Weak Neo-Fisher	1.122
4th	Yes ($p = 0.000$)	Complete	Symmetric ($p = 0.327$)	Both strong	Strong Neo-Fisher	-0.494
5th	Yes ($p = 0.00$)	Complete	Asymmetric ($p = 0.08$)	Upward	Strong Neo-Fisher	1.441
6th	Yes ($p = 0.039$)	Complete	Symmetric ($p = 0.395$)	Both strong	Strong Neo-Fisher	1.362

Note. For each regime, we have used 1-3 lags. **, **, and * represent the significance level at 1%, 5% and 10%, respectively.

5. Discussion and Conclusion

The empirical analysis shows that Pakistan's experience does not fully conform to the conventional Fisher effect but instead offers support for the Neo-Fisherian perspective. In addressing the classic Fisher effect, our results indicate no strict long-run relationship between nominal interest rates and inflation in Pakistan. In other words, interest rates do not uniformly adjust with inflation over time, and is a contradictory with literature (e.g., Ayub et al., 2014), which found co-integration consistent with a long-run Fisher effect. However, our TVP approach suggests that the linkage has weakened or become unstable, possibly due to structural breaks or changes in monetary policy regimes. These findings are consistent with recent quantile-co-integration evidence that the Fisher effect may only hold under certain conditions, and may not be robust either because of inflation volatility or insistency in policy. Thus, our empirical results indicates that no stable one-for-one Fisher relationship in the long-run.

Contrary, our empirical results strongly confirms the evidence of a Neo-Fisherian effect in Pakistan. Specifically, sustained increases in the policy interest rate appear to be followed by higher inflation in the short to medium run. Our TVP-VAR and Granger-causality tests suggest, when the SBP hikes rates persistently, inflation expectations and actual inflation often rise subsequently. Furthermore, these findings are consistent with Hina (2024), who reports that "the neo-Fisher effect" became significant in Pakistan from around 2015 onwards, overpowering the Fisher effect. In other words, raising rates – especially if viewed as a lasting policy change – has been associated with higher inflation. This is consistent with theoretical work showing that a credible, permanent increase in the nominal rate can raise inflation expectations and thus inflation immediately. In sum, our findings align with the emerging view that low interest rates can be deflationary in some settings, and conversely, high rates can be inflationary if credibility or expectations are pinned by policy.

These results have important implications for Pakistan's macroeconomic debate. They suggest that the conventional wisdom – that raising interest rates is the primary tool to "tame" inflation – may not hold without qualification. Instead, in Pakistan's case, rate hikes alone may have *fuelled* inflationary pressures in recent years. This echoes international experience after the global financial crisis: Williamson (2016) notes that theoretical models predict that raising the nominal rate can actually boost inflation. Likewise, Uribe (2018) finds in U.S. data that a permanent interest-rate increase leads to an immediate rise in inflation. Our Pakistan-specific results confirm that similar dynamics are at work here. In practice, the Neo-Fisherian outcome may arise if markets and households view the central bank's rate increases as permanent or if inflation expectations adjust upward due to tighter policy. Consitent with Tayyar (2019), we note that such an effect tends to require a *disciplined and credible* monetary framework: without central-bank credibility, rate hikes may fail to anchor expectations and instead come across as inflationary shocks. In short, our study implies that Pakistan's central bank cannot assume that conventional interest-rate policy works the same way it does in textbook models; the Neo-Fisher channel may dominate, especially when credibility is low.

Given these findings, policymakers in Pakistan should be cautious about relying solely on aggressive rate hikes to control inflation. If raising the policy rate is in fact associated with higher inflation, then traditional monetary tightening could be counterproductive. Instead, it may be crucial to strengthen central bank credibility and to address structural inflation drivers. For example, maintaining low and stable inflation may require the SBP to explicitly target inflation and build trust in its commitment, rather than frequently oscillating rates. As Tayyar (2019) emphasizes, only in a "disciplined financial environment" can the Neo-Fisher effect be managed for better inflation control. Pakistan's policymakers should therefore focus on medium-term credibility measures alongside traditional tools. Additionally, given the evidence of a changing Fisher relationship, financial authorities might consider alternative stabilization tools (such as macro prudential regulation or forward guidance) rather than aggressive hikes alone.