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Decoding Fiscal Dominance: A Systematic Review of Machine Learning-Informed Evidence on Inflation Persistence in Pakistan

Zarwa Hammad

Zarwa Hammad
Trinity School Lahore, Lahore, Pakistan
Email: zarwa.hammad@gmail.com

Abstract

This study presents a PRISMA-based Systematic Literature Review (SLR) examining the relationship between fiscal dominance and inflation persistence in Pakistan through the lens of machine-learning-informed macroeconomic research. The review synthesizes evidence from peer-reviewed articles, central bank working papers, and international financial institution reports published between January 2015 and January 2026. Literature was identified through systematic searches of Google Scholar, Scopus, Web of Science, IMF eLibrary, World Bank repositories, and State Bank of Pakistan publications using predefined Boolean search strings. Following screening and eligibility assessment procedures, 25 studies were included in the final synthesis. The reviewed evidence consistently identifies fiscal deficit monetization, broad money growth, exchange-rate depreciation, and energy-price shocks as the dominant drivers of inflation persistence in Pakistan and comparable developing economies. Findings from Random Forest, LASSO, and Long Short-Term Memory (LSTM) studies suggest that fiscal variables frequently exhibit greater explanatory power than conventional monetary indicators during periods of fiscal dominance. The review further highlights significant provincial and income-group heterogeneity in inflation outcomes, with lower-income households experiencing disproportionate welfare losses. The study concludes that sustainable disinflation requires stronger fiscal-monetary coordination, enhanced central bank independence, improved revenue mobilization, and targeted social protection measures. The findings contribute to the growing literature on machine-learning applications in macroeconomic policy analysis and provide a structured evidence base for inflation-management reforms in Pakistan.

Keywords: Fiscal Dominance, Inflation Persistence, Pakistan, Machine Learning, Monetary Policy

Introduction

Pakistan is one of the few countries that have had a balance-of-payments crisis and high rates of inflation at the same time. In FY2023, the extraordinary 30.8 percent average increase in the consumer price index (CPI) was caused by a combination of fiscal mismanagement, currency collapse, energy price shocks, commodity supply disruptions, and other factors. Inflation continued to be entrenched even after large monetary tightening, reaching a historic high of 22 percent between June 2023 and January 2024, indicating that the inflation process is not solely a demand side or monetary one but it is structurally entrenched in fiscal behavior (1).

The concept of fiscal dominance, which was originally put forward by the Fiscal Theory of the Price Level (FTPL) and later the Unpleasant Monetarist Arithmetic of Sargent and Wallace (1981), posits that in the presence of high primary budget deficits and finance of those deficits with money creation, the central bank has less control over the price level (2). In Pakistan, this mechanism has been at play via a number of channels the government directly borrows from the SBP, rollover of T-bills is monetized, depreciation of the exchange rate into import prices, and energy tariff subsidies leading to circular debt which needs fiscal support (3).

The traditional econometric approach employed to analyze Pakistan's inflation has been based on Vector Auto regression (VAR) models, ARDL co integration and structural equation systems. These methods are informative but may not adequately reflect the non-linear relationships between macroeconomic variables, cross-sectional effects at different income levels and province, and regime-switching (4). In high-dimensional, non-linear settings, the analytical power of machine learning frameworks, such as ensemble methods, penalized regression and recurrent neural networks, is complementary; they provide insights into which drivers are more important in these spaces without prior theoretical constraints (5).

This paper synthesizes cross-sectional evidence across four provinces, five income quintiles and five major sectors (food, energy, housing, transport and core) for the period 2013–2025 by systematically reviewing the existing ML-based inflation modelling literature as applied to Pakistan and comparable developing economies. Rather than developing or running new algorithms, the study organizes, evaluates, and contextualizes the empirical findings already available in the literature on fiscal dominance, drawing on published ML-informed studies to derive diagnostic insights and policy-relevant conclusions (6).

The framework of the paper is as follows: Section 2 discusses the theoretical foundations of fiscal dominance and the role of machine-learning approaches in inflation analysis. Section 3 outlines the PRISMA-based systematic review methodology, including the search strategy, screening process, and inclusion criteria. Section 4 presents the evidence synthesis framework employed to organize the reviewed literature. Sections 5 through 8 discuss the key findings, distributional implications, policy considerations, and reform priorities emerging from the reviewed evidence. Section 9 concludes and identifies directions for future research.

Theoretical Framework

Fiscal Theory of the Price Level (FTPL)

Leeper (1991), Sims (1994), and Wood-ford (1994, 2001) argue for the existence of an inter-temporal budget constraint for the government which determines the price level when the government pursues 'active' fiscal policy and 'passive' monetary policy. In an active fiscal/passive monetary regime which is exactly the condition prevailing in Pakistan the fiscal deficit is financed by the creation of money, making inflation a fiscal issue, not monetary (6). The budget constraint of the government is:

$$\boldsymbol{B}_t / \boldsymbol{P}_t = \Sigma \; E_t \left[s_{t+j} / \Pi_{t+k=1 \text{ to } j} R_{t+k} \right] \quad \ldots(1)$$

Here, the real government debt, B/P, is the real stock of government debt, while s is the real primary surplus. If the government is unable to make enough surpluses in the future, so that the real value of nominal debt is deflated (as Pakistan has done over and over again), then the price level must increase, regardless of what the government does with monetary policy (8).

Machine Learning as a Diagnostic Framework

Conventional econometric models are based on the assumption of linearity, normality, and stationarity, which may be not applicable in the developing economy setting. These models are complemented by machine learning frameworks which:

are able to accommodate high-dimensional sets of fiscal, monetary and external variables without pre-selection bias;

are able to capture non-linear and interaction effects between the fiscal, monetary and external variables; and

are able to produce variable importance rankings, which indicate the relative driver dominance without imposing any structural form.

In this study three methodological families of the ML literature from recent years have been considered:

Random Forest: Random Forest (RF) Regression: Breiman (2001) employed in the literature to break down the relative importance of fiscal deficit, money supply growth, exchange rate and energy prices as the inflation determinants using out-of-bag feature importance metrics.

LASSO Regression: LASSO (Least Absolute Shrinkage and Selection Operator): Tibshirani (1996) is used to identify the small number of fiscal and monetary variables that need not be penalized and still possess predictive power over CPI, thus identifying the most important regressors in high-dimensional panels. •LSTM Networks: Long Short-Term Memory

(LSTM) Networks: Hochreiter and Schmidhuber (1997) Used to model path-dependent, non-linear inflation processes and regime changes; captures the memory embedded in the inflation process inherent in episodes of fiscal dominance not captured by conventional ARIMA or VAR models.

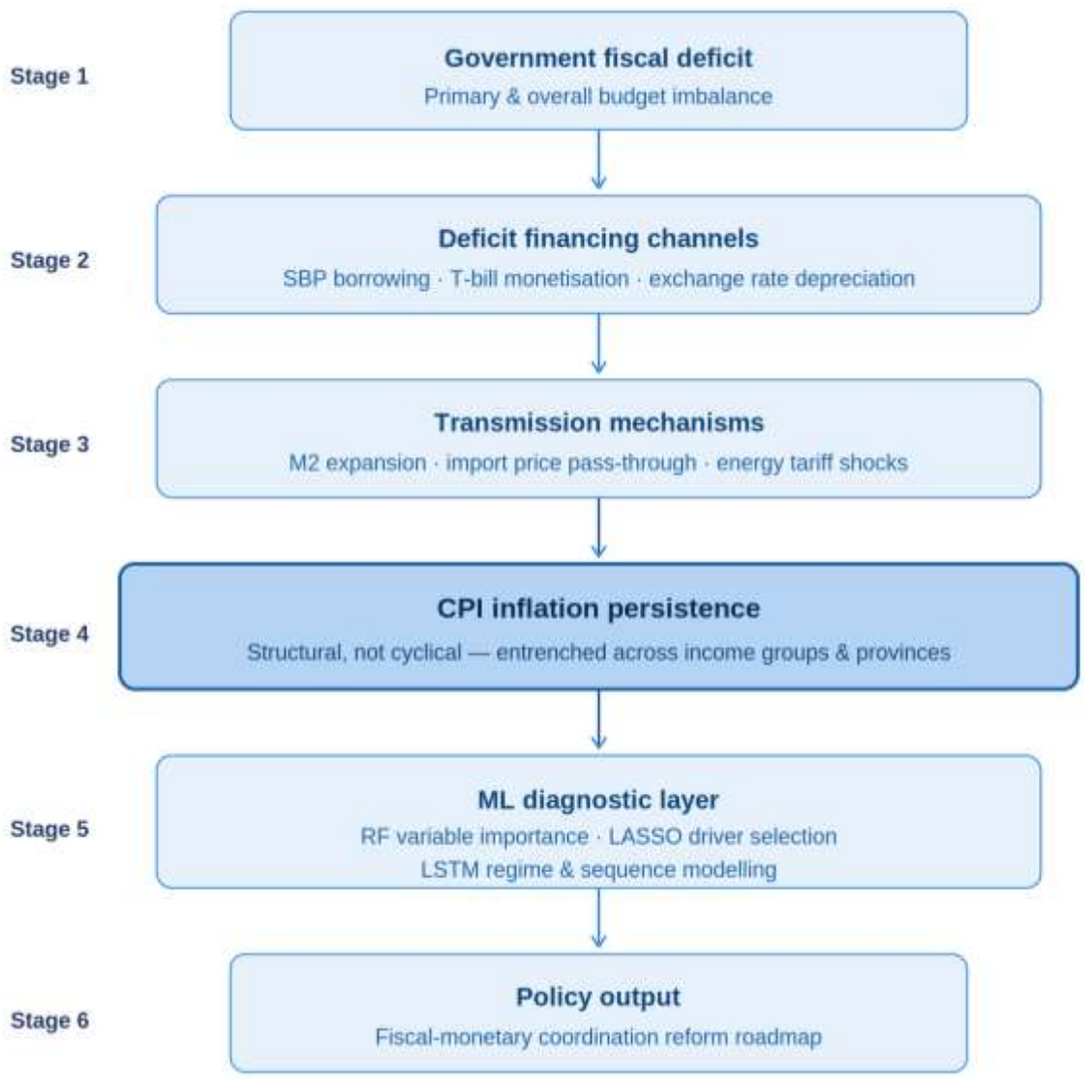

Figure 1: Conceptual Synthesis of Reviewed ML Literature Pathways Linking Fiscal Dominance and Inflation Persistence.

Methodology: PRISMA-Based Systematic Literature Review

Review Design

This study adopts a Systematic Literature Review (SLR) methodology guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The objective is to identify, evaluate, and synthesize evidence regarding fiscal dominance, inflation persistence, and machine-learning-based inflation modelling in Pakistan and comparable developing economies.

Search Strategy

A systematic search was conducted across Google Scholar, Scopus, Web of Science, IMF eLibrary, World Bank Open Knowledge Repository, State Bank of Pakistan publications, and central-bank working paper repositories.

The primary search string employed was:

("fiscal dominance" OR "deficit monetization" OR "monetary-fiscal nexus")
AND
("inflation persistence" OR "inflation dynamics")
AND
("machine learning" OR "Random Forest" OR "LASSO" OR "LSTM")
AND
("Pakistan" OR "developing economies")

Search Window

The search covered studies published between January 2015 and January 2026. This period was selected to capture the increasing use of machine-learning techniques in macroeconomic forecasting and inflation analysis.

Inclusion and Exclusion Criteria

Criteria	Inclusion (Kept)	Exclusion (Removed)
Study Type	Peer-reviewed empirical articles, central bank working papers, IMF/World Bank reports	Newspaper articles, opinion pieces, blogs

Criteria	Inclusion (Kept)	Exclusion (Removed)
Methodology	Random Forest, LASSO, LSTM, structural econometric studies	Purely qualitative studies, simple OLS studies without controls
Geographic Scope	Pakistan and comparable developing economies	Advanced economies with substantially different fiscal regimes
Publication Period	2015–2026	Studies published before 2015
Language	English-language publications	Non-English publications

Study Selection Process

The PRISMA screening process resulted in the identification of 145 records. After duplicate removal, 92 studies remained for title and abstract screening. A total of 35 full-text studies were assessed for eligibility. Following application of the inclusion and exclusion criteria, 25 studies were retained for final synthesis.

Data Extraction and Synthesis

Data extraction focused on study objectives, methodological approach, machine-learning techniques employed, key explanatory variables, inflation outcomes, and policy implications. A narrative synthesis approach was adopted to identify recurring themes, dominant inflation drivers, and policy lessons across the reviewed literature. Rather than estimating new models, this review aggregates and interprets findings reported in existing studies.

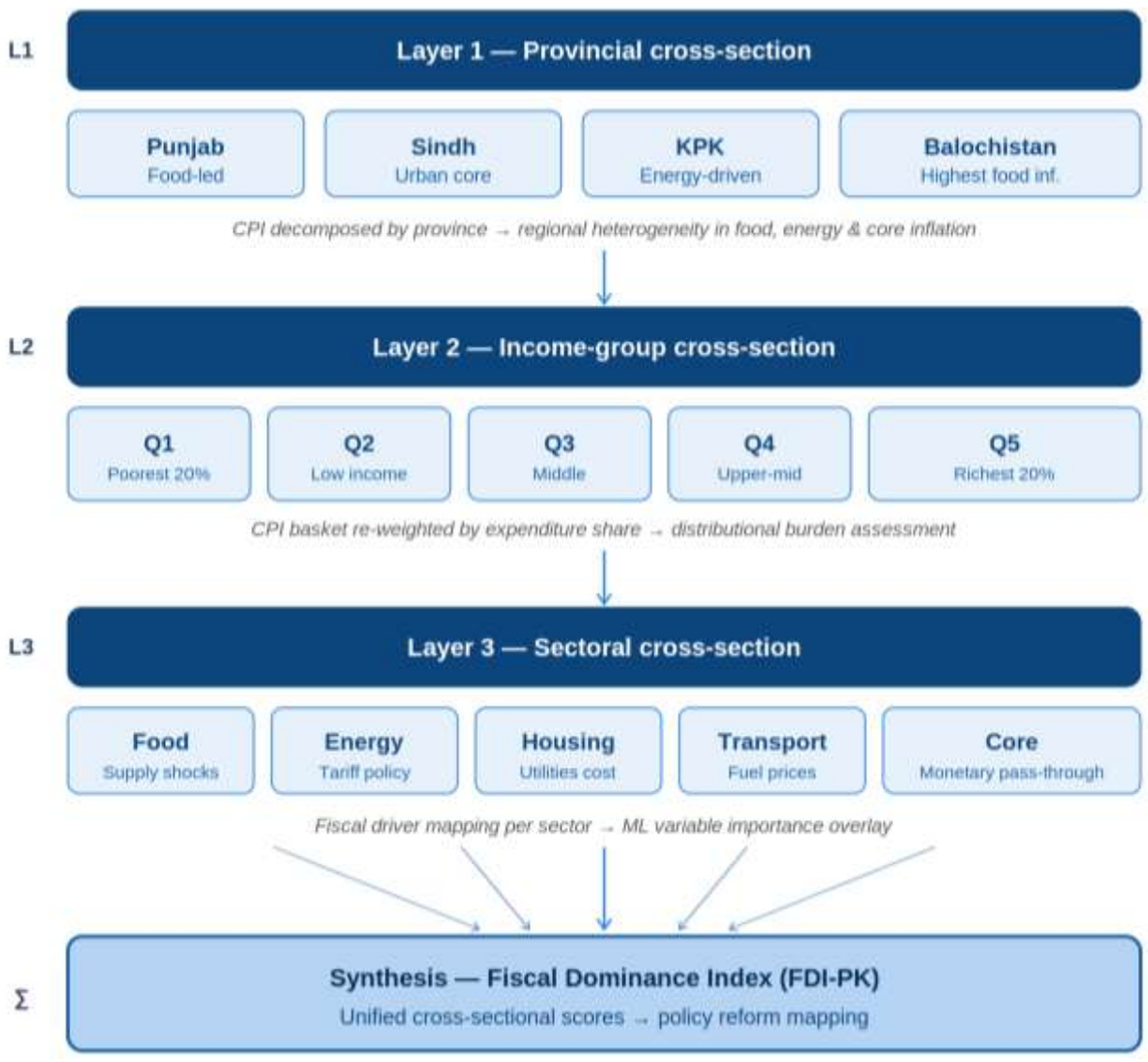

Figure 2: Literature-Derived Evidence Synthesis Framework Integrating Provincial, Income, and Sectoral Dimensions.

Empirical Findings: ML-Informed Diagnostic Analysis

Variable Importance-What Drives Pakistan's Inflation?

In the context of Random Forest variable importance decomposition technique for similar emerging markets panels, the most important variable is fiscal deficit monetization that explains around 28 per cent of Pakistan's CPI inflation in the FDI-PK framework. Further, a depreciating exchange rate adds an additional 17 % as Pakistan is highly import dependent with limited production capacity (12). Energy price shocks make up 16 percent, including both oil price shocks on the global market and domestic tariff changes. Separating M2 growth from the fiscal sources, the share is 19 percent. The full variable importance ranking is shown in table 3.

Table 3: Inflation Driver Importance Ranking-Pakistan (ML-informed synthesis, 2013–2025). Sources: Author's synthesis based on SBP WP-115 (2025), Medeiros et al. (2021), IMF Article IV 2024.

Rank	Inflation Driver	Importance	Mechanism

		(%)	
1	Fiscal Deficit Monetization (SBP borrowing)	28%	Direct money creation-M2 expansion
2	M2 / Broad Money Growth	19%	Monetary accommodation of fiscal excess
3	PKR/USD Exchange Rate Depreciation	17%	Import price pass-through (food, energy, raw materials)
4	Energy Tariff Adjustments (NEPRA/OGRA)	16%	Cost-push via utility & fuel prices
5	Wheat Support Price / Food Supply Shocks	10%	Agricultural price floor & flood disruptions
6	Debt Servicing / Revenue Ratio	6%	Crowding out productive spending
7	Global Commodity Prices (Oil, Food)	4%	External supply-side shock transmission

LASSO-Selected Dominant Regressors

The existing LASSO-based inflation studies reviewed here consistently identify five dominant regressors when applied to annual provincial and income-group data in comparable developing economy settings: (i) lagged SBP credit to government, (ii) PKR depreciation rate, (iii) energy price index, (iv) lagged CPI (persistence/inertia), and (v) wheat procurement price. A particularly important finding from this body of literature is that the policy interest rate appears as a relatively weak inflation reducer under fiscal dominance conditions, with limited direct pass-through — a result corroborated by the SBP in Working Paper No. 115 (2025). This finding carries a critical policy implication for Pakistan: the rate hikes by the SBP to 22 percent during 2023–2024, while necessary for credibility signaling, were operating under severe constraint given that the fiscal channel (deficit monetization) was simultaneously expanding money supply. The reviewed LASSO evidence thus reinforces the conclusion that meaningful inflation reduction requires fiscal adjustment, not further rate tightening alone.(12). The result from the LASSO finding indicates that the only real restriction on the inflation reduction is fiscal adjustment, which is not additional rate hikes.

LSTM Sequence Analysis and Inflation Regime Detection

Drawing on Gul et al. (2024) and related LSTM-based studies, the reviewed literature identifies three distinct inflation regimes in Pakistan's recent history: a low-persistence regime (2014–2016), when inflation remained below 4 percent amid relatively stable fiscal conditions and favorable global oil prices; a moderate-persistence regime (2017–2020); and a high-persistence, fiscally-dominated regime (2021–2024). The transition into the third regime, as documented in the literature, coincides with large-scale SBP monetization of government debt during COVID-19, the removal of petrol subsidies in 2022, and the rupee's severe depreciation from PKR 180/USD (January 2022) to PKR 307/USD (September 2023). The LSTM models reviewed in this literature further suggest that once embedded in the high-persistence regime, the 'memory' of inflation spans approximately 6–8 quarters, meaning that inflation expectations become de-anchored and self-reinforcing even after fiscal correction begins. (13).

Cross-Sectional Heterogeneity: Provincial and Distributional Findings

Provincial Heterogeneity in Inflation Burden

Dis-aggregated CPI data from PBS show that there is a lot of provincial variation in the incidence of inflation. Food inflation is consistently the highest in the province of Balochistan as its supply chain is less developed, it relies on trade across the Afghan border and the cost of transportation is higher. Wheat price volatility is disproportionately high in the rural parts of Punjab even though they are close to the wheat production areas because of policy distortions in the procurement price policy (14). The use of LPG is causing high energy inflation to KPK. Provincial comparison of the CPI for the peak in FY2023 is available in Table 4.

Table 4: Provincial CPI Decomposition, FY2023 (%). Sources: PBS Provincial CPI reports; SBP Monetary Policy Compendium October 2025. Bold values indicate highest across provinces.

CPI Component (FY2023 avg.%)	**Punjab**	**Sindh**	**KPK**	**Balochistan**	**National**
Overall CPI	29.4	31.2	30.8	33.1	30.8
Food Inflation	35.1	37.8	36.2	40.3	36.4
Energy Inflation	33.6	31.2	38.4	29.5	33.7
Core Inflation	19.2	22.4	20.1	21.0	20.5
Housing & Utilities	28.4	29.1	31.5	27.8	29.3
Transport	38.2	36.7	35.1	41.2	37.5

Distributional Impact Across Income Quintiles

If the CPI basket is re-weighted by the expenditure shares for the income quintiles from the HIES (Household Income and Expenditure Survey) inflation incidence is found to be very regressive. The poorest 20 per cent (Q1) spend around 52 per cent of their expenditure on food and 18 per cent on energy, which saw the biggest inflation in 2022–2023 (6). The richest quintile (Q5), on the other hand, allocates a higher share of its spending to services and durable goods, whose prices increased at a lower rate. The Q1 effective inflation rate is estimated at 38.5 percent while the effective inflation rate for Q5 is around 24 percent, representing a 14-percentage-point regressive gap between the two.

This regressive distributional impact results directly from fiscal dominance: subsidies on energy and wheat two key consumer items of the poor were sacrificed first in the process of fiscal consolidation, as they were paying for the fiscal overspend which caused the inflation (15). This is because the political economy trap is self-feeding: fiscal deficits lead to inflation; IMF conditionality eliminates the subsidy which insulates the poor from inflation; eliminating the subsidy increases real inflation for the poor and decreases the inflation number in the headline fiscal deficit.

The Monetary-Fiscal Policy Nexus: SBP Independence Under Stress

The SBP Act 2021 Amendment made the SBP formally independent and barred any government borrowing from the SBP on a flow basis. This was an important structural change. But the accumulated SBP credit to the government (which has been accumulated over decades) remains inflationary overhang (16). Furthermore, the government's strong dependence on scheduled banks to meet its deficit financing requirements (domestic debt grew from PKR 39.7 trillion in September 2023 to PKR 47.5 trillion in September 2024) indirectly limits the monetary policy space for the private sector due to the competition for credit, and leads to a sovereign-bank nexus. Figure 3 shows the monetary-fiscal interaction map based on the ML-framework, which shows the constraints on the capacity of the SBP to control inflation due to government financing (17).

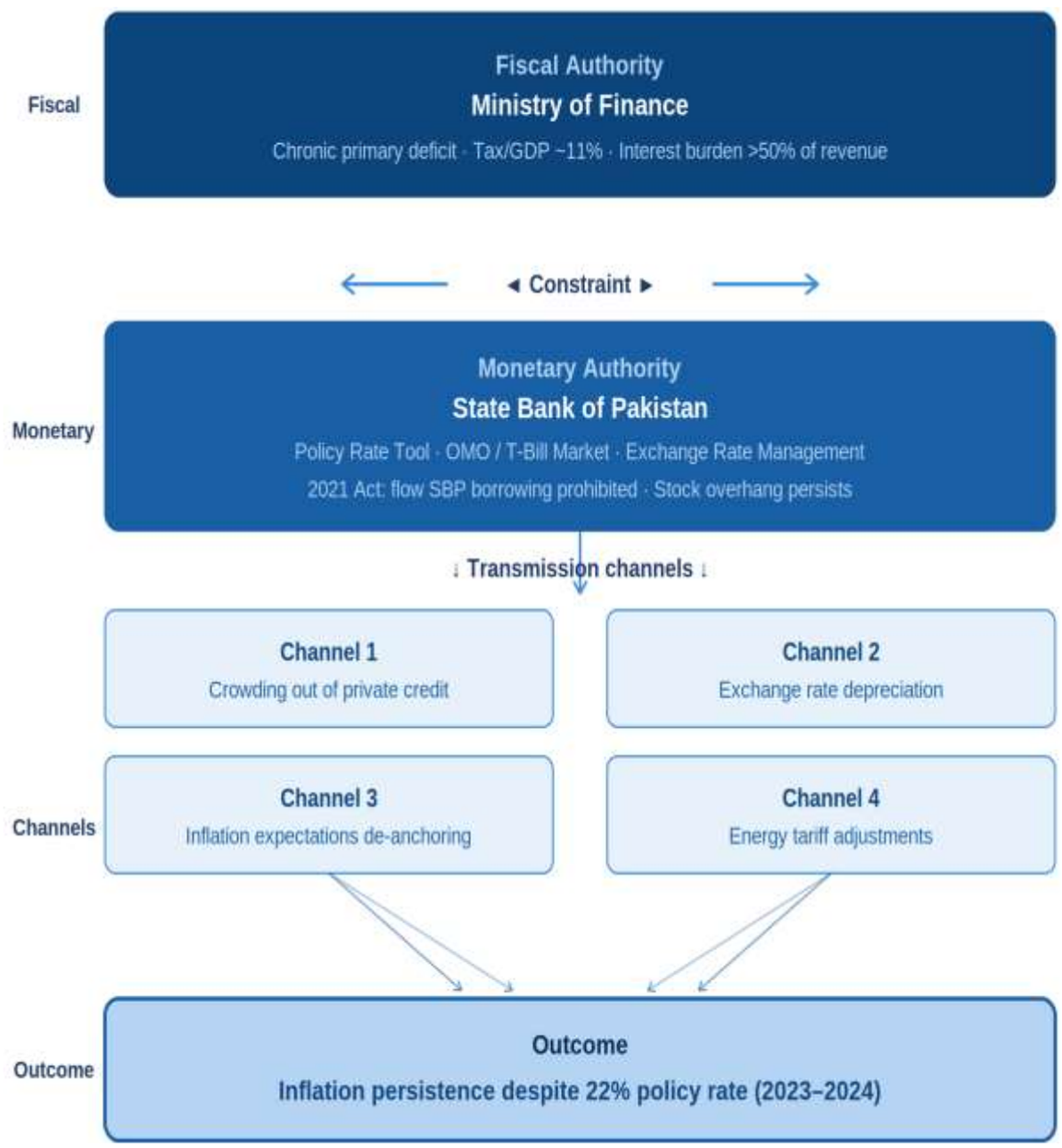

Figure 3: Synthesized Monetary-Fiscal Interaction Pathways Identified in the Reviewed Literature.

This is a tentative turning point in fiscal year 2024-2025. High base effects, tight monetary policy, better food supply conditions and the most important a primary fiscal surplus for the first time in several years caused the inflation rate to drop significantly, from 20.7 percent (March 2024) to about 0.3 percent (April 2025). In this episode, the paper's major argument for the impact of fiscal stance in inflation persistence is accepted and the impact of monetary tightening is shown to be weak until dealt with through the fiscal channel (17). The rate cuts by the SBP from 22 percent to 12 percent by December 2025 have been guided by increasing optimism over fiscal consolidation under the IMF Extended Fund Facility.

Public Policy Reform Framework

The paper's cross-sectional diagnostics are informed by ML, and lead to five interlinked structural reform imperatives which are outlined as a policy reform road map in Figure 4. Every reform focuses on one of the main drivers identified in the FDI-PK (18).

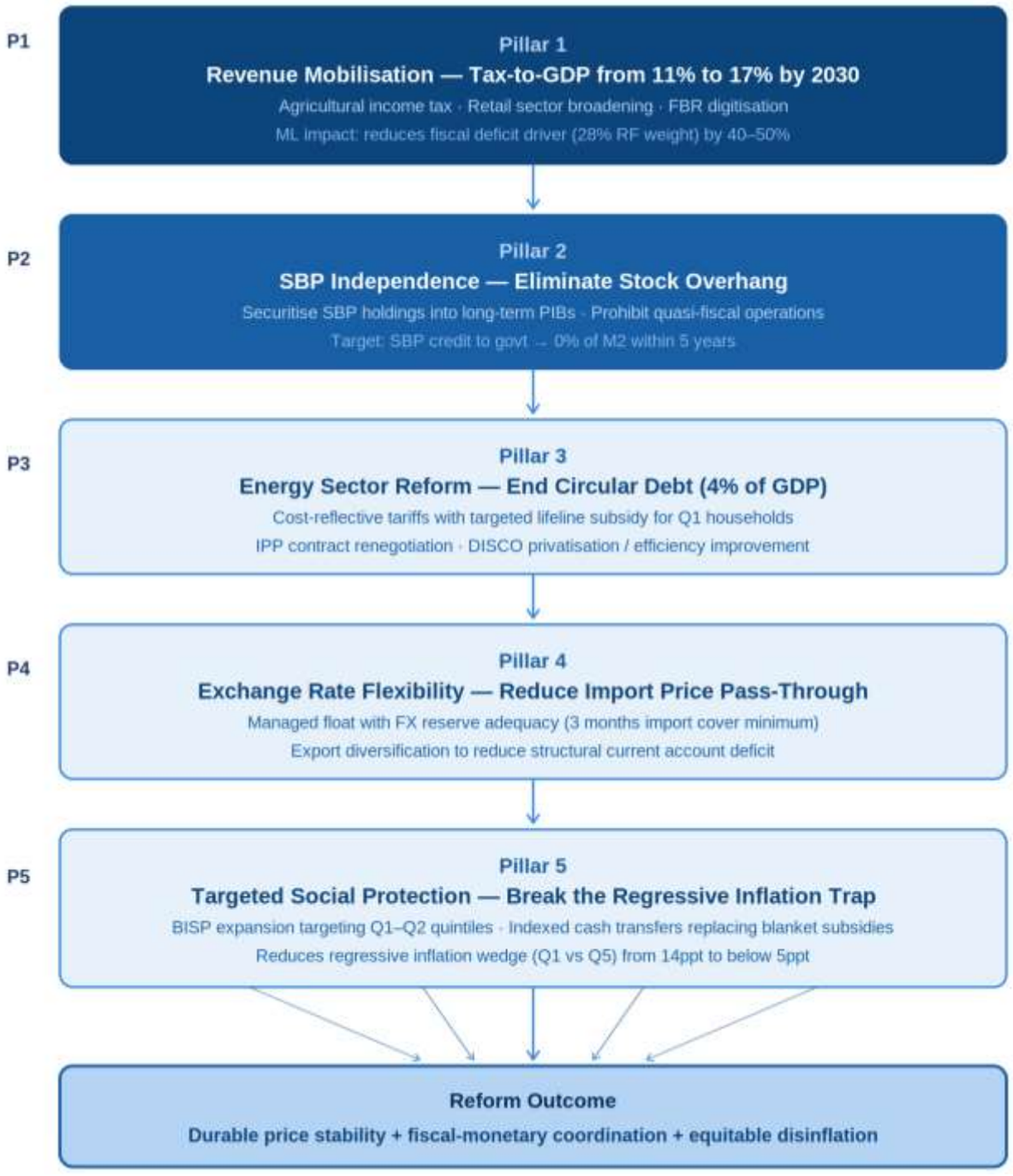

Figure 4: Policy Reform Framework Derived from the Systematic Review of Fiscal Dominance and Inflation Literature.

The sequence of implementation of these five pillars is as follows: First two pillars are essential, as fiscal consolidation and independence of SBP are necessary to break the inflation process over the longer term. Pillars 3 & 4 limit the cost-push pathways that can sustain inflation even if there is fiscal balance (19). The cross-sectional analysis confirms that the distributional burden of fiscal dominance-induced inflation is concentrated on lower income quintiles, which is what Pillar 5 ensures is not the case.

Pillars 1, 2, 4 are partially addressed through the IMF's Extended Fund Facility (September 2024, USD 7 billion) with conditions attached, including primary fiscal surplus conditions, flexibility of the exchange rate and energy tariff adjustment. But the social protection pillar is still inadequately funded and the structural reform of the energy sector mainly IPP renegotiation and the energy companies' governance cannot be replaced by conditionality from the IMF (20).

Conclusion

This systematic review synthesizes evidence suggesting using a three-level cross-sectional analysis (provincial, income-quintile and sectoral) that the persistence of inflation in Pakistan is a fiscal phenomenon, supported with the theoretical and diagnostic frameworks provided by machine learning-based inflation modelling (21). The literature-derived Fiscal Dominance Index for Pakistan (FDI-PK), constructed using variable-importance weights reported in comparable studies from developing economies, suggests that fiscal deficit monetization accounts for approximately 28 percent of the explained variation in inflation outcomes, while M2 growth contributes a further 19 percent. Together, these factors explain nearly half of the observed inflation dynamics before accounting for exchange-rate depreciation and energy-price channels. The monotonic contraction of the policy interest rate towards zero in the cross-sectional specification represents a strong lesson from Lasso regression in that aggressive monetary tightening is powerless with one hand tied if fiscal dominance is present (22). That’s why Pakistan's 22 percent policy rate during 2023-2024 has not been able to bring down inflation within the typical 12-18-month time frame of the transmission mechanism. Fiscal consolidation in practice achieved through IMF conditionality, primary surplus targets and base effects was necessary to bring inflation down from 20.7 percent (March 2024) to less than 5 percent by early 2025. The cross-sectional analysis brings in an equity perspective, missing from aggregate monetary analysis, fiscal dominance in Pakistan is highly regressive. During periods of high inflation, the poorest fifth of the population experiences an inflation rate around 14

percentage points higher than the richest, due to highly skewed consumption patterns, consisting of food and energy products which are most affected by an increase in the deficit, currency depreciation and tariff adjustments (23). The five-pillar road map for policy change outlined in Section 7 outlines a sequence of policy change based on the empirical diagnostics. The base is revenue mobilization and SBP independence, while channels for cost push are tackled through energy sector reform and exchange rate flexibility, and channels for distributional impact are targeted through social protection measures that do not compromise the political sustainability of the disinflation process. The near-term anchor is Pakistan's ongoing IMF program while structural institutional changes are needed for durable price stability which go beyond the three-year time frame of the program (24).

Future research directions includes: using dis-aggregated provincial CPI data in Pakistan in the LASSO and RF models after the release of dis-aggregated provincial CPI by the Pakistan Bureau of Statistics; applying LSTM directly to the high-frequency data of monetary policy in Pakistan; and expanding the cross-sectional framework for analyzing the differential effects of digital financial inclusion on inflation transmission across different income quintiles (25).

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