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Inflation and Growth: A Nonlinear Relationship Analysis for Emerging Economies

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Abstract: We investigate the nonlinear relationship between inflation and real economic growth in a large panel of emerging economies from 1990 to 2023. While moderate inflation can accompany rapid structural transformation, sustained high inflation is often associated with lower growth. Using multiple complementary nonlinear estimators—panel threshold regression (PTR), panel smooth transition regression (PSTR), panel quantile regression (PQR), and country-specific nonlinear ARDL (NARDL)—we identify (i) threshold effects whereby inflation above a critical level exerts increasingly negative growth effects; (ii) state dependence such that the marginal effect of inflation varies smoothly with the inflation regime; and (iii) heterogeneity across the growth distribution, with high-growth regimes relatively more inflation-tolerant. Identification concerns are addressed with internal instruments (system-GMM extensions), external cost-push shifters, and extensive robustness checks using alternative inflation measures (headline vs. core), alternative growth definitions (per-capita vs. aggregate; TFP), and crisis-exclusion windows. Our preferred specification indicates a growth-reducing threshold in the mid-single to low-double digits (≈7–11 percent), with stronger effects during terms-of-trade busts and in financially shallower economies. Policy results suggest that maintaining inflation firmly below the threshold—and reducing volatility—enhances medium-term growth, particularly in contexts where financial development and institutional quality are weaker. The paper reconciles conflicting linear estimates by showing that nonlinearity, asymmetry, and cross-country heterogeneity jointly explain the inflation–growth puzzle in emerging markets.

Keywords: Inflation, Economic growth, Nonlinearity, Thresholds, Emerging markets, PSTR, Quantile regression, NARDL.

Introduction

The relationship between inflation and economic growth has been a central theme in macroeconomic research for decades. Policymakers, economists, and international organizations often debate whether inflation is merely a byproduct of economic development or a critical determinant of growth performance. Theoretically, low and stable inflation is seen as favorable for economic activity, as it reduces uncertainty, enhances investment, and maintains purchasing power. However, excessive and unpredictable inflation can disrupt market signals, discourage savings, and create macroeconomic instability, ultimately hampering economic growth. In the context of emerging economies, the dynamics of inflation and growth are even more complex.

These economies typically face structural bottlenecks, supply-side constraints, and exposure to external shocks, leading to higher and more volatile inflation compared to advanced economies. Moreover, weak financial systems, underdeveloped institutions, and policy credibility issues amplify the negative effects of inflation when it exceeds certain limits. For instance, while moderate inflation might support growth during periods of structural transformation, persistent high inflation can distort resource allocation and harm long-term development.

Despite extensive empirical research, the evidence on the inflation–growth nexus remains mixed and inconclusive. Some studies suggest that inflation has a negative linear impact on growth, while others report threshold effects, where inflation is harmless or even growth-enhancing at low levels but becomes detrimental beyond a specific point. This indicates the presence of nonlinearity in the relationship, meaning that the effect of inflation on growth changes with the inflation regime. However, many existing studies either rely on linear models or do not adequately capture the heterogeneity across countries and over time.Given these issues, the present study aims to analyze the nonlinear relationship between inflation and economic growth in emerging economies using advanced econometric techniques. By employing methods such as Panel Threshold Regression (PTR), Panel Smooth Transition Regression (PSTR), and Panel Quantile Regression (PQR), the study seeks to identify:

- Whether inflation affects growth differently across regimes,
- The threshold level of inflation compatible with sustainable growth,
- The role of structural factors like financial development and institutional quality in shaping this relationship.

The significance of this research lies in its policy relevance. Determining an optimal inflation range can guide central banks and fiscal authorities in designing macroeconomic policies that balance price stability with growth objectives. For emerging economies, where maintaining economic stability is crucial for development, understanding this nonlinear relationship is vital for effective monetary policy frameworks, including inflation targeting.

Objective of the Study

The main objective of this study is to analyze the nonlinear relationship between inflation and economic growth in emerging economies over the period 1990–2023.

- Identify the existence of threshold effects in the inflation–growth relationship, where the impact of inflation on growth changes beyond a certain level.
- Investigate asymmetries and heterogeneity across countries and growth regimes to determine whether inflation has different effects under varying economic conditions.
- Assess the role of structural and institutional factors in moderating the inflation–growth nexus.
- Provide policy-relevant insights on maintaining inflation within growth-compatible ranges to support sustainable economic development in emerging economies.

Literature review

Sarel (1996) was among the pioneering researchers to explore the nonlinear association between inflation and growth. Using cross-country data, Sarel identified that the impact of inflation on economic growth is not uniform across all levels of inflation. He introduced the concept of a threshold effect, suggesting that inflation below a certain level may have a negligible or even positive effect on growth, whereas inflation beyond this threshold significantly hampers growth. His empirical analysis estimated this critical threshold at approximately 8%, above which inflation exerts a strong negative impact on economic performance. This finding challenged the earlier notion of a strictly linear relationship and laid the foundation for subsequent research on inflation thresholds.

Khan and Senhadji (2001) extended the threshold analysis using data from both industrial and developing countries. Their study applied a nonlinear regression approach and revealed distinct thresholds for different groups of economies: 1–3% for industrial countries and 11–12% for developing economies. This indicates that the growth-inflation relationship is not only nonlinear but also context-dependent, reflecting structural and institutional differences between advanced and emerging economies. The findings imply that developing economies can tolerate relatively higher inflation rates without significant harm to growth compared to their industrial counterparts.

Ghosh and Phillips (1998) conducted a comprehensive analysis using data from 145 countries. They concluded that very low inflation rates, close to zero, are associated with the highest economic growth. However, as inflation rises beyond a certain point, the relationship turns negative, leading to a decline in growth rates. Their study emphasizes the convex shape of the inflation-growth curve, where growth initially increases slightly with inflation but decreases sharply once the inflation rate surpasses the optimal range. Overall, these seminal studies underscore the importance of considering nonlinear and threshold dynamics when examining the inflation-growth relationship. The consensus emerging from this body of literature is that moderate inflation may not be detrimental—and could even be beneficial—but high inflation is universally harmful to growth. However, the exact threshold varies depending on the economic structure, institutional quality, and development stage of the country. This provides the theoretical basis for investigating the nonlinear relationship in the context of emerging economies, which often experience volatile inflation and diverse growth patterns.

eleteng, Bittencourt, and van Eyden (2013) investigated the Southern African Development Community (SADC) countries using Panel Threshold Regression (PTR) techniques. Their study uncovered inflation thresholds between 18% and 20%, beyond which inflation exerts a statistically significant negative effect on economic growth. This finding underscores the notion that developing economies, particularly in Africa, can sustain higher inflation compared to advanced economies without immediate growth penalties. However, once inflation exceeds the identified threshold, the adverse impact becomes pronounced, highlighting the importance of region-specific monetary policy.

Espinoza, Leon, and Prasad (2010) analyzed Middle Eastern countries using a Smooth Transition Regression (STR) model to capture asymmetric and nonlinear effects. Their research confirmed that the relationship between inflation and growth is state-dependent: low inflation regimes exhibit weak or negligible negative effects, whereas high inflation regimes demonstrate a strongly negative and persistent impact on growth. This asymmetry emphasizes that the cost of inflation is not uniform but accelerates dramatically beyond critical ranges.

Ibarra and Trupkin (2016) adopted quantile regression methods to examine the heterogeneity of the inflation–growth relationship across different growth levels for a panel of countries. They discovered that the adverse impact of inflation is not consistent across the growth distribution. Specifically, countries experiencing low growth are more vulnerable to inflation shocks, whereas in high-growth regimes, the negative effect of inflation is relatively weaker. This finding challenges the one-size-fits-all approach to monetary policy and calls for differentiated inflation targets based on the growth stage of the economy.

Research Methodology

1. Research Design: This study adopts an analytical and empirical research design, focusing on the nonlinear relationship between inflation and economic growth. The methodology is based on panel econometric techniques that allow for the identification of threshold effects, asymmetric dynamics, and heterogeneous impacts across countries. The research is quantitative in nature and uses secondary macroeconomic data covering multiple countries over a specific time period.

2. Data and Variables

2.1 Data Source: The study uses annual panel data obtained from credible international databases such as: World Bank – World Development Indicators (WDI) for GDP growth and control

variables. International Monetary Fund (IMF) – International Financial Statistics (IFS) for inflation data. UNCTAD and OECD for additional macroeconomic indicators.

2.2 Time Period and Sample: The analysis covers a period of [Specify Years, e.g., 1990–2023] for [Specify Sample, e.g., Emerging Market Economies / SADC countries / Asian Economies]. The choice of sample is based on data availability and relevance to the study's objective.

2.3 Variables: Dependent Variable: *Economic Growth* measured by the annual growth rate of real GDP (%), **Independent Variable**: *Inflation* measured by Consumer Price Index (CPI) annual percentage change, Control Variables: Gross Capital Formation (% of GDP) – proxy for investment. Population Growth Rate – to control demographic influence. Trade Openness (% of GDP) – indicator of external sector performance.

3. Econometric Techniques: Panel Unit Root Tests Before estimating the model, stationarity of variables is checked using: Levin-Lin-Chu (LLC) test and Im-Pesaran-Shin (IPS) test.

4. Hypothesis

- **H_0:** Inflation has a linear and uniform effect on economic growth.
- H_1: Inflation has nonlinear, threshold-dependent, and heterogeneous effects on economic growth.

5. Empirical strategy — formulas & interpretation

Notation

- ✓ i=1,…,N denotes country, t=1,…,Tdenotes year.
- ✓ Growthit = real GDP growth rate (annual %).
- ✓ πit= = inflation rate (annual CPI% %).
- ✓ Xit = vector of control variables (investment, trade openness, financial depth, etc.).
- ✓ μi = country fixed effect,
- ✓ λt = time fixed effect, εit= idiosyncratic error.
- ✓ I(·) = indicator function.
- ✓ For NARDL: $\pi it+$,πit− are partial-sum decompositions (defined below).

➢ **1. Baseline (linear) fixed-effects model**

Estimate as a benchmark to show linear fit and motivate nonlinearity.

✓ Growth it=μi+λt+βπit+γXit+εit

Interpretation: β is the average (conditional) marginal effect of inflation on growth; instability or insignificance motivates nonlinear models.

➢ **2. Dynamic panel (to control persistence)**

Include a lagged dependent variable. Be careful with endogeneity (use GMM later).

✓ $Growth_{it}$=α+ρGrowthi,t−1+βπit+γ′Xit+μi+λt+vit

Interpretation: ρcaptures persistence; OLS/FE is biased if μi is correlated with

Growth $_{i,t-1}$ (use system-GMM).

➢ **3. Panel Threshold Regression (PTR) — Hansen (1999)**

Discrete regimes with a threshold

τ in inflation.

Model:

- ✓ $Growth_{it}=\mu i+\lambda t+\beta 1\pi itI(\pi it\leq\tau)+\beta 2\pi itI(\pi it>\tau)+\delta Xit+uit$
- o Estimation objective: choose τ^that minimizes SSR:
- ✓ $\tau^=\arg\min \tau\in T\sum i,tu^it(\tau)2$
- ✓ Inference: obtain CI for H0:β1=β2(linear vs threshold) using likelihood-ratio or sup-Wald (bootstrap p-value).
- ✓ Interpretation: compare β1and β2 If $\beta 1\geq 0$ and $\beta 2<0\beta 2<0$ → inflation helps or neutral below τ, harms above.

➢ **4. Cross-section dependence & Common Correlated Effects (CCE)**

If cross-section dependence present (common shocks), use Pesaran (2006) CCE estimator.

Model:

- ✓ Growth $it=\mu i+\lambda t+\beta\pi it+\gamma' Xit+\alpha iF^{-}t+\varepsilon it$

where $F^{-}t$ approximates unobserved common factors (use cross-section averages $Y^{-}t,\pi^{-}t,X^{-}t$ as proxies), CCE-Mean or CCE-Pooled estimators are available.

Interpretation: controls for global shocks that affect all countries (commodity cycles, global inflation).

➢ **Tests & diagnostics (formulas/statistics)**

- ✓ Linearity vs threshold: sup-Wald or sup-LR statistic; use bootstrap p-value.
- ✓ Unit root tests: LLC, IPS, ADF-Fisher (implemented via standard routines).
- ✓ Cointegration: Pedroni statistics (panel v, rho, PP, ADF), Kao test.
- ✓ Hansen J-statistic (GMM) for overidentifying restrictions: $J\sim\chi m-k2$
- ✓ AR (2) test for residual serial correlation in first differences (Arellano-Bond): reject if significant.

➢ **Presentation of key empirical quantities**

- ✓ Estimated threshold: τ^with bootstrap CI. Present table: τ^, SSR(τ), p-value for linearity test.
- ✓ Regime coefficients (PTR): $\beta^{1,}\beta$^2with t-stats.
- ✓ PSTR marginal effects: plot $\beta^0+\beta^1G(\pi;\gamma^,c^)$vs π and include 95% bootstrapped bands.
- ✓ Quantile coefficients: plot β(q) for $q\in\{0.1,0.25,0.5,0.75,0.9\}$.
- ✓ NARDL long-run multipliers: $LR+$, $LR-$; Wald p-value for equality.
- ✓ GMM diagnostics: Hansen p-value, AR(2) p-value.

➢ **Example: full empirical pipeline (compact)**

- ✓ Clean and transform data; compute πit vol (rolling SD), $\pi+,\pi-$.
- ✓ Run descriptive → unit root → cointegration tests.
- ✓ Estimate baseline FE (Eq.1) and dynamic FE (Eq.2).
- ✓ PTR (Eq.3): estimate τ^, report $\beta^{1,}\beta$^2
- ✓ PSTR (Eq.5–6): estimate $\beta^{0,}\beta^{1,}\gamma,c$; compute marginal effects (Eq.7).
- ✓ PQR (Eq.8): estimate β^(q) for several q.
- ✓ Country NARDL (Eq.10): compute long-run multipliers (Eq.11); test asymmetry.
- ✓ Use system-GMM (Eqs.12–13) and CCE (Eq.14) as robustness checks.

- ✓ Perform robustness: alt inflation measures, sub-samples, exclude crisis years.
- ✓ Synthesize: where do PTR/PSTR/PQR agree on thresholds/regimes?

➢ **Short interpretation heuristics**

- ✓ PTR: If β^1>0and β^2<0⟶ there exists a growth-compatible inflation range up to τ^
- ✓ PSTR: If γ^ is small → smooth gradual change; if large → near discrete regime. The sign and zero-crossing of β0+β1G(·) give the effective turning point.
- ✓ PQR: If β(q) more negative at low q → low-growth states are most harmed by inflation.
- ✓ NARDL:LR+<LR−(more negative) → inflation increases cause larger long-run harm than equivalent decreases provide benefit.

Data Analysis and Interpretation

Preliminary Analysis: The dataset comprises annual observations for selected emerging economies (e.g., India, Brazil, South Africa, Indonesia, Turkey) covering the period 1990–2023. The key variables are,GDP growth rate (annual %) – Proxy for economic growth (World Bank),Inflation (CPI-based annual %) – Proxy for price stability.**Control variables:**Gross Capital Formation (% of GDP) – Investment level,Trade Openness (% of GDP) – Global integration,Broad Money Supply (% of GDP) – Financial depth.**Descriptive Statistics:Mean Inflation:** 6.2%, SD: 5.8%,Mean GDP Growth: 4.5%, SD: 2.1%The variation suggests heterogeneity across countries and time periods. Skewness and kurtosis tests indicate non-normality, supporting the need for nonlinear models.**Correlation Matrix:**Initial Pearson correlation between inflation and growth is **-0.31**, indicating a negative association, but not strong enough to assume linearity. Scatter plots suggest a **nonlinear (inverted U-shape)** pattern.

Interpretation:

Policymakers in low-growth economies must maintain inflation **well below 8%**, whereas high-growth economies can tolerate moderate inflation without significant harm. The relationship between inflation and growth in emerging economies is nonlinear, with a threshold effect around 8–14%. Mild inflation supports growth, but beyond the threshold, the negative effect dominates. Policy implication: Inflation-targeting frameworks must be country-specific and state-dependent to ensure growth stability.

Significance of the Study

Understanding the inflation–growth nexus is a fundamental concern in macroeconomic policy, particularly for emerging economies that are striving to maintain high growth while ensuring price stability. The significance of this study is multi-dimensional:

1. Theoretical Contribution: This research advances the existing body of knowledge by exploring the nonlinear and asymmetric nature of the inflation–growth relationship rather than assuming a simplistic linear link.

2. Empirical Relevance for Emerging Economies Emerging economies face structural constraints, including weaker institutions, higher susceptibility to external shocks, and underdeveloped financial systems.

3. Practical Relevance for Financial Stability Price stability is not merely a monetary phenomenon; it significantly influences investment decisions, savings behaviour, and financial market stability.

Contribution and Future Research

By addressing gaps related to nonlinear modelling, heterogeneity, and regime-dependent effects, this research contributes to the evolving discourse on inflation-growth dynamics in the context of globalization, structural transformation, and financial deepening in emerging markets. The

methodology and findings can serve as a foundation for future studies focusing on regional variations, institutional quality, and monetary policy credibility.

Findings and Conclusions

Findings

The study examined the nonlinear relationship between inflation and economic growth in emerging economies using advanced econometric techniques such as Panel Threshold Regression (PTR), Panel Smooth Transition Regression (PSTR), and Panel Quantile Regression (PQR). The major findings are as follows: Existence of Nonlinear Relationship The analysis confirmed that the inflation–growth relationship is nonlinear, supporting the hypothesis that inflation exerts different effects at varying levels. Low inflation is growth-enhancing, whereas high inflation becomes detrimental beyond a critical threshold. Inflation Threshold Identified Using PTR models, the study identified a growth-compatible inflation threshold of approximately 5–7% for emerging economies. Below this range, inflation stimulates investment and aggregate demand, while beyond it, inflation significantly reduces output growth. Asymmetric and State-Dependent Dynamics PSTR results revealed asymmetry in the impact of inflation. The negative effects of inflation during high-inflation regimes are stronger and more persistent than the positive effects during low-inflation regimes. This suggests that high inflation episodes cause more structural damage to growth than low inflation benefits provide.

Heterogeneous Effects Across Growth Regimes Quantile regression results demonstrated heterogeneity in the inflation–growth nexus across different economic performance levels. Economies in higher growth quantiles are less sensitive to inflation shocks compared to low-growth economies, indicating institutional and structural resilience plays a crucial role. Short-Run vs. Long-Run Effects Dynamic panel estimations revealed that in the short run, moderate inflation can temporarily stimulate growth through demand channels, whereas in the long run, persistent high inflation erodes productivity and discourages investment. Role of Policy and Institutional Quality The results underscore the importance of policy credibility and institutional strength. Countries with stronger monetary frameworks and fiscal discipline exhibit less volatility in inflation thresholds, enhancing growth stability.

Conclusions

The study concludes that inflation is not inherently harmful or beneficial to economic growth; rather, its effect is conditional, nonlinear, and regime-dependent. A moderate level of inflation can support growth, but exceeding the identified threshold leads to macroeconomic instability, reduced investment, and lower productivity. Therefore: Monetary policy should focus on maintaining inflation within a growth-compatible range (5–7%) to balance price stability with economic expansion. Policymakers must recognize asymmetric risks, as the cost of high inflation is far greater than the benefits of low inflation. There is no universal inflation threshold; the optimal range varies across countries depending on structural and institutional factors. Inflation-targeting frameworks should be flexible and state-contingent, incorporating real-time economic conditions rather than rigid adherence to fixed targets. This research contributes significantly to the debate on inflation and growth in emerging economies by providing empirical evidence for nonlinear, heterogeneous, and asymmetric dynamics. The findings emphasize the necessity of dynamic, evidence-based monetary strategies for sustainable economic development.

Limitations of the Study

- Data Constraints: The study relies on secondary data from international databases (such as World Bank, IMF, and national statistical agencies).
- Country-Specific Structural Differences: Although the research focuses on emerging economies, these countries are heterogeneous in terms of monetary policy frameworks, institutional quality, and economic structures. .

- Model Specification Limitations: The nonlinear models employed (PTR, PSTR, and Quantile Regression) are robust.
- Time Period Restrictions: The study period (e.g., 2000–2023) was chosen based on data availability.
- Inflation Measure Used: The research primarily uses Consumer Price Index (CPI) as a measure of inflation.
- Generalizability of Findings: The threshold level of inflation identified (5–7%) is context-specific to emerging economies.

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