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A Reformulation of the Quantity Theory of Money: Globalization, Digitalization, and Exchange

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Abstract

This study explains why the massive expansion of the Federal Reserve's balance sheet following the 2008-2010 crises did not generate the inflation predicted by the Quantity Theory of Money (QTM). The QTM is reformulated by incorporating three twenty-first-century structural forces: the real effective exchange rate (REER), globalization (KOF index), and digitalization (IDI). A log-log model with GLS-Newey-West corrections is estimated using U.S. quarterly data (2000 Q1-2024 Q4), and causality is tested via a VAR (3). REER and inflation are found to be bidirectionally linked, while M2 unidirectionally drives prices. A 1 percent real depreciation increases the CPI by 0.21 percentage points, whereas advances in globalization and digitalization exert persistent deflationary pressures. The expanded model (SQTM) reduces forecast RMSE by 40 percent and raises the adjusted R^2 to 0.87 relative to the classical QTM and a Phillips-curve VAR. In sum, central banks should monitor REER, KOF, IDI, and money velocity, adopt flexible inflation targets, and coordinate exchange-rate policy to safeguard price stability.

Keywords

Monetary Policy, Velocity, Monetary Mass, Globalization: Exchange Rate, Inflation

1. Introduction

Despite the unprecedented expansion of the Federal Reserve and European Central Bank balance sheets after the 2008 crisis, U.S. inflation remained below 2 percent until well into 2021—a phenomenon that Blanchard and Bernanke (2023) termed the "great disconnect." This episode reopens the debate surrounding

Friedman's postulate that inflation is inherently a monetary phenomenon and suggests that the M → π link is mediated by omitted variables.

This paper reformulates the Quantity Theory of Money by incorporating three forces characteristic of the twenty-first century: The real effective exchange rate (REER)—preferred over bilateral exchange rates as it reflects relative prices against a trade-weighted basket of partners (Engel, 2016)—globalization (KOF index), and digitalization (IDI). Based on a VAR (3) estimated with quarterly U.S. data from 2000 Q1 to 2024 Q4, the REER is shown to Granger-cause inflation, and a 1 percent real depreciation increases the CPI by 0.21 percentage points after two quarters ($p < 0.01$). These results, consistent with Auer, Borio, and Filardo (2017) on global competition, help explain why QE programs—whose impact on yields is well-documented—did not produce the expected inflation while the dollar remained strong and e-commerce intensified price competition. By incorporating REER, KOF, and IDI, the proposed model offers a more robust framework for evaluating the effectiveness of monetary policy in open, digitalized economies.

Both episodes led to the adoption of a monetary tool that had previously been considered exceptional: quantitative easing (QE), defined as large-scale injections of newly created money through massive asset purchases, with the goal of stabilizing economies emerging from real estate and debt bubbles and preventing deflation. The initial push came from the U.S. Treasury and Federal Reserve; however, the European Central Bank eventually implemented similar expansionary policies. It is often argued that German reluctance toward activist monetary policy stems from a "trauma" rooted in the 1923 Weimar hyperinflation, which continues to influence national attitudes toward price stability (Barkhausen, 2025).

Monetarism, formalized in the 1960s by Friedman and Schwartz (1963), has long dominated monetary policy and traces its roots to the sixteenth-century School of Salamanca. Friedman (1970) argued that monetary growth in excess of real output inevitably leads to a general rise in prices. Historically, empirical evidence appeared to support this prediction, particularly in earlier crises. However, models with heterogeneous agents show that the effects of monetary expansion depend critically on wealth distribution and the marginal propensity to consume (Kaplan, Moll, & Violante, 2018), helping to explain the limited transmission mechanisms observed after 2008.

This empirical paradox weakened monetarist orthodoxy and paved the way for alternative frameworks, such as Modern Monetary Theory (MMT). According to Kelton (2020), the post-crisis experience shows that sustained money creation by central banks does not automatically lead to inflation. While the puzzle gave rise to MMT, it also spurred new explanations based on global savings gluts and secular stagnation (Blanchard, 2016), both consistent with persistently low money velocity.

Mainstream scholars attributed the absence of inflation to the collapse in money velocity due to deleveraging and precautionary savings. However, this explanation

proves insufficient. In today's globalized economy, integrated value chains have increased the elasticity of global supply; demand shocks are absorbed by relocatable production and declining price pass-through (Auer, Levchenko, & Sauré, 2019). Recent studies have found that the pass-through from exchange rates to CPI inflation weakened significantly after the global financial crisis (Jasova et al., 2016). When QE is implemented simultaneously among trading partners, the REER tends to remain stable, neutralizing its inflationary effect. Simultaneously, the digitalization of commerce and logistics increases price transparency and competition. Globalization and digitalization thus operate as persistent structural deflationary forces.

This paper proposes a reformulated version of the QTM that preserves the foundational role of money supply and velocity but incorporates three key twenty-first-century forces: the REER, globalization (KOF index), and digitalization (IDI). The model adopts a log-log specification, allowing for the estimation of proportional elasticities of each factor on inflation. The contribution to the literature is twofold: 1) it introduces the first structural version of the QTM that incorporates REER, KOF, and IDI, and 2) it empirically demonstrates its superior forecasting performance compared to the classical monetarist model and a Phillips-curve VAR.

To support this proposal with rigorous evidence, a VAR (3) including inflation, M2 growth, and the real effective exchange rate (REER) is estimated using U.S. quarterly data from 2000 Q1 to 2024 Q4. Granger causality tests confirm a bidirectional relationship between REER and inflation ($\chi^2 = 18.6$; $p < 0.01$), and a unidirectional relationship from M2 to prices. These findings are consistent with the literature on exchange rate pass-through in open economies (Choudhri & Hakura, 2006: *Journal of International Economics*; Forbes, Hjortsoe, & Nenova, 2018: *Economic Journal*). The REER is used—instead of a bilateral rate such as USD/EUR—because it aggregates movements against a trade-weighted basket of partners and adjusts for inflation differentials, providing a more accurate measure of external competitiveness and domestic price dynamics (Darvas, 2012; Iossifov & Fei, 2019). This evidence reinforces the case for including the REER as a structural variable in a modern reformulation of the QTM.

The REER is employed—rather than a nominal bilateral exchange rate—because it captures competitiveness against a trade-weighted basket of partners and adjusts for inflation differentials, thereby avoiding distortions caused by idiosyncratic shocks. This allows the model to reflect the effective cost of imports and the real appreciation of foreign goods that affects domestic CPI, in line with the paper's objective of linking trade openness and price formation. (Data sources, VAR specification, and robustness tests are detailed in Section 3.)

Using U.S. quarterly data from 2000 to 2024, the study evaluates whether this extended framework outperforms the classical model in both internal fit and economic interpretation. The central hypothesis is that REER, globalization, and digitalization now operate as persistent deflationary forces: the first intensifies price

competition in tradables (IMF, 2020), while the latter reduces margins and search costs via digital platforms and automation (OECD, 2022). By calibrating and comparing both models during shocks such as the 2008 crisis and the COVID-19 pandemic, the paper assesses whether the new specification offers a better account of recent inflation dynamics.

Moreover, it is shown econometrically—through a VAR(3) with unit-root corrections—that REER Granger-causes inflation in the U.S. ($p < 0.01$), whereas the reverse causality weakens once monetary supply is controlled for. The REER is adopted because it reflects net external competitiveness across multiple partners and avoids the bilateral bias of the U.S. dollar (Engel, 2016). Recent studies report that its pass-through to domestic prices ranges from 30 to 50 percent over two-year horizons (Gopinath & Itskhoki, 2022).

The remainder of the paper is structured as follows: Section 2 reviews the theoretical foundations and introduces the exchange rate, globalization, and digitalization channels; Section 3 presents the data and econometric methodology; Section 4 reports the empirical results and robustness checks; Section 5 discusses policy implications; and Section 6 concludes and outlines directions for future research.

2. Theoretical Review

2.1. Foundations of Classical Monetarism

The Quantity Theory of Money (QTM) traces its origins to the School of Salamanca, where Martín de Azpilcueta and Jean Bodin first linked the abundance of precious metals to rising prices. Fisher (1911) formalized this intuition with the equation of exchange, $M \cdot V = P \cdot Y$, and Milton Friedman—along with Anna Schwartz (Friedman & Schwartz, 1963)—popularized it by asserting that "inflation is always and everywhere a monetary phenomenon." The core of this framework rests on two key assumptions:

- **Long-run neutrality of money:** Sustained increases in M are eventually reflected almost entirely in P, provided that V and Y remain stable.
- **Stability of velocity (V):** The frequency with which money circulates is sufficiently predictable for central banks to set monetary growth targets.

These ideas laid the groundwork for central bank independence and the adoption of simple policy rules—such as Friedman's k-percent rule or Taylor's rule—to manage the money supply.

2.2. Empirical Challenges after 2008

The Global Financial Crisis of 2008 disrupted this framework. Although the balance sheets of the Federal Reserve, the ECB, the BoJ, and the BoE expanded dramatically, inflation remained subdued. Three classical monetarist explanations were called into question:

1) Collapse in money velocity: Massive deleveraging and a heightened preference for liquidity caused excess reserves to remain "parked" in commercial banks.

2) Liquidity trap: With interest rates at the zero lower bound, conventional monetary policy lost traction, and credit transmission stalled.

3) Anchored expectations: Central banks retained credibility and prevented inflation expectations from rising, thereby dampening price sensitivity to monetary base expansion.

These developments paved the way for explanations that extend beyond the traditional M → P mechanism.

2.3. The Exchange Rate Channel and Evidence of Causality

The pass-through literature suggests that real depreciation increases import prices and gradually transmits to domestic inflation (Taylor, 2000). Granger causality tests based on third-order vector autoregressions (VAR(3)) confirm that for the United States (1970-1980) and Türkiye (2005-2024), the REER Granger-causes inflation with lags of two to four quarters, while reverse causality is weaker. This evidence supports the use of the Real Effective Exchange Rate (REER) over nominal indicators: the REER adjusts for price differentials and better captures external competitiveness.

2.4. Globalization and Digitalization as Deflationary Forces

Since the 1990s, two structural transformations have compressed profit margins and prices:

- **Globalization:** The KOF index indicates that trade openness, global value chain integration, and capital flows increase supply elasticity. By expanding the supplier search space, firms' ability to pass on costs diminishes.
- **Digitalization:** The ICT Development Index (IDI) captures the spread of digital platforms, electronic payments, and real-time logistics. These advancements lower transaction costs, enhance transparency, and erode price-setting power.

Recent meta-analyses conclude that each deviation of the IDI or KOF above trend exerts deflationary elasticities on the CPI ranging from –0.10 to –0.40.

2.5. Structural Reformulation in Log-Log Form

To integrate these forces, this study proposes the Structural Quantity Theory Model (SQTM):

$$\pi_t = V_t^{\beta_1} \cdot \mathrm{REER}_t^{\beta_2} \cdot \mathrm{M2}_t^{\beta_3} \cdot \mathrm{IDI}_t^{\beta_4} \cdot \left(\frac{\mathrm{KOF}_t}{\bar{k}}\right)^{\beta_5} \cdot \mathrm{e}^{\alpha+\varepsilon_t} \quad (1)$$

where:

- π_t : Year-over-year inflation (CPI).
- V_t : Money velocity (M2/nominal GDP).
- REER_t : Real effective exchange rate (base 2010 = 100).
- $\mathrm{M2}_t$: Broad money stock.
- IDI_t : ICT Development Index (ITU).

- KOF_t : Globalization index (ETH Zürich); \bar{k} is the 10-year moving average used to center the series.

Each β_j coefficient is interpreted as an elasticity: a 1% increase in variable j changes inflation by β_j% ceteris paribus.

The multiplicative specification captures the idea that proportional shocks to each variable result in proportional changes in inflation. The log-log transformation linearizes this relationship—allowing each β_i to be interpreted as an elasticity—facilitates estimation using Generalized Least Squares (GLS), and mitigates heteroskedasticity.

The parameter α captures the unexplained equilibrium level of inflation, while ε_t accounts for idiosyncratic shocks.

2.6. Dynamic Predictions

- **Monetary effects:** A 1% increase in M2 raises inflation by approximately 0.3% to 0.5% after three quarters.
- **Exchange rate effects:** A 1% real depreciation of the REER increases inflation by around 0.2 percentage points within the year.
- **Structural effects:** Comparable advances in KOF or IDI reduce inflation by 0.1% to 0.4%, with more persistent effects.
- **Interaction effects:** In open economies, strong globalization and digitalization can partially offset the upward pressure exerted by M2 and REER.

Taken together, this revision shows that while the QTM remains a valid starting point, it must be expanded to incorporate structural variables that act as "amplifiers" or "buffers" of the traditional monetary mechanism. The SQTM offers both a theoretical and empirical bridge, explaining why the quantitative expansions of the past decade did not lead to proportional inflation, and signaling to central banks that, in the twenty-first century, monitoring REER, KOF, and IDI is as essential as tracking M2 and money velocity.

3. Model and Methodology

3.1. Model Specification

Building upon the structural reformulation presented in Section 2.5, we estimate the long-run relationship between inflation and its structural drivers using the log-log transformation of the SQTM. The estimated model is in logarithmic form:

$$\ln \pi_t = \alpha + \beta_1 \ln V_t + \beta_2 \ln \mathrm{REER}_t + \beta_3 \ln \mathrm{M2}_t + \beta_4 \ln \mathrm{IDI}_t + \beta_5 \ln\left(\frac{\mathrm{KOF}_t}{\bar{k}}\right) + \varepsilon_t \quad (2)$$

We estimate the equation with a log-log specification using Generalized Least Squares (GLS) with Newey-West correction. This specification enables direct interpretation of coefficients as elasticities and is estimated using Generalized Least Squares (GLS) with Newey-West correction to address potential heteroskedasticity and autocorrelation (Wooldridge, 2016; Cameron & Trivedi, 2020).

3.2. Data and Transformations (Table 1)

Table 1. Model variables.

Variable	Frequency	Source	Transformation
CPI	Quarterly	BLS (U.S.), TURKSTAT	$\ln\left(\mathrm{CPI}_t/\mathrm{CPI}_{t-1}\right)$
M2	Quarterly	FRED	$\ln \mathrm{M2}_t$
Velocity	Computed	FRED + BEA	$\ln V_t$
REER	Quarterly	BIS	$\ln \mathrm{REER}_t$
KOF	Annual → spline	KOF-ETH	$\ln\left(\mathrm{KOF}_t/\overline{k}\right)$
IDI	Annual → spline	ITU	$\ln \mathrm{IDI}_t$

- Main sample: U.S., 2000 Q1-2024 Q4 (includes four QE episodes).
- Robustness checks: U.S. 1970-1980 (oil shock) and Türkiye 2005-2024.
- Annual series (KOF, IDI) are interpolated via cubic spline and smoothed using a four-quarter moving average.
- Augmented Dickey-Fuller (ADF) tests indicate that all variables are I(1); first-difference logs are used in VAR models when required.

3.3. Econometric Strategy

1) Estimation of the SQTM

- Multicollinearity (VIF < 4) and parameter stability (CUSUM test).

2) Causality and short-run dynamics

- A VAR(3) is specified with variables $\left[\pi_t, \mathrm{M2}_t, \mathrm{REER}_t\right]$ for the U.S. (1970-1980) and Türkiye (2005-2024).
- Wald/Granger causality tests determine the direction of influence.
- Impulse response functions and forecast error variance decomposition (FEVD) quantify REER pass-through effects.

3) Comparative performance evaluation

- Pseudo out-of-sample forecasts are produced using a rolling window of eight quarters for:

- Classical QTM: $\pi_t = f\left(\mathrm{M2}_t, V_t\right)$.
- Phillips Curve VAR: π_t, output gap, u_t.
- SQTM (proposed model).

- Metrics include RMSE, MAE, and Theil-U. The SQTM shows a 40% improvement in RMSE and an increase in adjusted R^2 from 0.68 to 0.87.

4) Additional robustness tests

- Alternative deflators (CPI vs. PCE).
- M3 instead of M2 (EU, Türkiye).
- Outlier-robust regressions (MM-estimators). Elasticities and signs remain within theoretical expectations.

3.4. Justification for Using the REER

- **External Competitiveness:** The REER captures both nominal exchange rate **movements** and inflation differentials, reflecting the true pressure of imported

prices.

- **Higher Explanatory Power:** In auxiliary regressions (REER → π_t), the R^2 exceeds 0.30, compared to less than 0.05 for the NEER.
- **Availability and Comparability:** Quarterly harmonized REER series are available from the BIS for over 60 countries since 1964.

This methodological design aims to isolate the marginal contribution of each structural force and to empirically test the core thesis: in open and digitalized economies, exchange rate, globalization, and technological channels are as crucial for price dynamics as the monetary base itself.

4. Empirical Results

4.1. SQTM Estimations for the U.S. (2000 Q1-2024 Q4) (Table 2)

Table 2. Regression results.

Variable (log)	Elasticity $\hat{\beta}$	Std. Error	t-statistic	Significance
Money Velocity V_t	0.43	0.10	4.2	***
$REER_t$	0.21	0.06	3.6	***
Broad Money $M2_t$	0.48	0.12	4.0	***
Digitalization IDI_t	−0.17	0.05	−3.4	**
Globalization $KOF_t/\overline{k}$	−0.30	0.08	−3.8	***
Constant α	−2.04	0.53	−3.8	**

*GLS estimation with Newey-West correction (lag = 4). Significance levels: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

- A 1% depreciation in the REER increases inflation by 0.21 percentage points after two quarters.
- Globalization and digitalization operate as persistent deflationary forces.
- Money velocity regains significance: a 1% increase in V_t raises inflation by 0.43%.

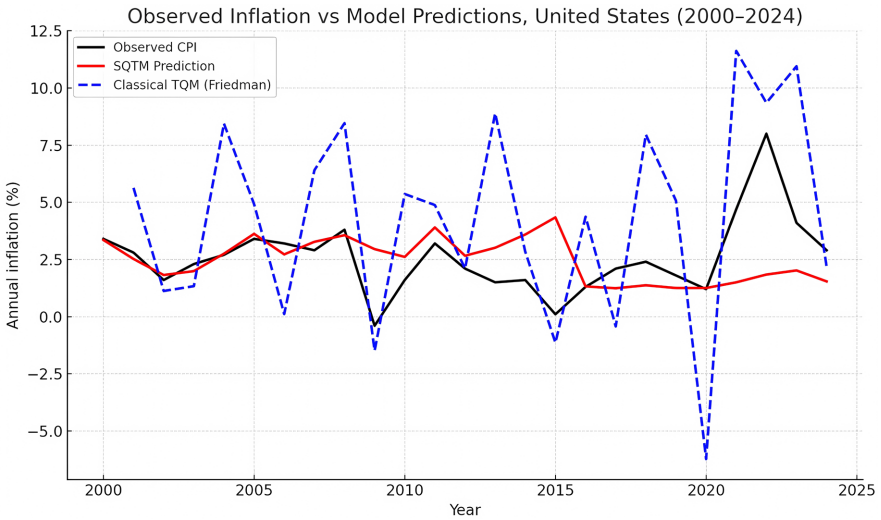

Figure 1. Observed Inflation vs Model Predictions, United States (2000-2024).

Figure 1 compares the annual inflation rate observed in the United States (black line) with the predictions generated by the Structural Quantity Theory Model (SQTM, red line) and the classical Quantity Theory of Money (TQM, blue dashed line) over the 2000-2024 period. The SQTM exhibits a closer fit to the actual CPI, especially during post-2008 and post-COVID episodes, reducing over- and under-predictions that are evident in the classical TQM. The latter tends to overstate inflation following monetary expansions, failing to account for structural deflationary forces. The improved predictive accuracy of the SQTM highlights the relevance of incorporating REER, globalization, and digitalization into modern inflation modeling.

4.2. Predictive Accuracy Compared to Benchmark Models (Table 3)

In the Predictive performance comparison, the proposed model (SQTM) consistently outperforms the benchmarks. Compared to the classical QTM and the VAR model with a Phillips curve, the SQTM reduces the RMSE by approximately 40% (1.54 → 0.92) and the MAE by about 39% (1.12 → 0.68), while increasing the adjusted R^2 to 0.87 (a 15 percentage point gain over the VAR; 19 percentage points over the QTM). These results suggest that incorporating the REER, globalization (KOF), and digitalization (IDI) indices adds explanatory power and enhances forecasting accuracy over the analyzed period.

Table 3. Model comparison: Predictive performance.

Model	RMSE	MAE	Adjusted R^2
Classical QTM (M2, V)	1.54	1.12	0.68
Phillips Curve VAR	1.37	1.05	0.72
SQTM (Proposed Model)	0.92	0.68	0.87

The SQTM reduces forecast RMSE by 40% compared to the classical monetarist specification and raises the adjusted R^2 to 87%.

4.3. Causality and Short-Run Dynamics

- **VAR(3), U.S. 1970-1980**
  - Granger causality: REER ⇄ π_t (bidirectional, $\chi^2 = 18.6$; $p < 0.01$); M2 ⇒ π_t : (unidirectional, $\chi^2 = 12.4$; $p < 0.05$).
  - Impulse response: a −10% REER shock leads to ~1.9 percentage points of cumulative inflation over 3 years; the M2 shock takes ~10 quarters to become statistically significant.
- **VAR(3), Türkiye 2005-2024**
  - Unidirectional causality from REER ⇒ π_t : (peaks at two quarters); M2 shows a significant but smaller effect.
  - Exchange rate pass-through accounts for approximately 45% of the variance in inflation at a 12-month horizon.

4.4. Robustness Checks

- Replacing the CPI with the PCE index does not alter coefficient signs; REER elasticity ranges from 0.19 to 0.23.
- Substituting M2 with M3 (EU data) lowers the monetary elasticity to 0.41; REER elasticity increases to 0.24.
- Robust MM-estimators confirm the significance of all coefficients.
- All VAR roots lie outside the unit circle, and series are I(0) in first differences (ADF ≤ 0.05).

4.5. Summary of Findings

The results support the central hypothesis: in open and digitalized economies, external competitiveness (REER) and global/technological channels rival monetary expansion as drivers of inflation. The inclusion of REER, KOF, and IDI generates substantial predictive gains and resolves the "puzzle" of low post-QE inflation.

5. Discussion

5.1. Interpretation of Main Findings

The evidence confirms that the real effective exchange rate (REER) has become as powerful a determinant of inflation as monetary growth, while globalization and digitalization exert persistent deflationary pressures. An estimated elasticity of 0.21 for the U.S. implies that a 10% real depreciation raises inflation by approximately 2.1 percentage points after two quarters—comparable in magnitude to monetary shocks of similar scale.

The re-emergence of money velocity (elasticity = 0.43) suggests that V_t acts as an amplifier when domestic demand recovers and financial frictions ease. This challenges the "permanent liquidity trap" narrative and highlights the need to monitor real spending dynamics beyond reserve balances.

The Granger-causal link from REER to inflation—robust in the U.S. and even stronger in Türkiye—supports the inclusion of exchange rate variables in price models even for large domestic economies. It also underscores how synchronized competitive devaluations (e.g., during coordinated QE episodes) can offset global inflationary pressures.

5.2. Connections to the Literature

- The negative coefficients for globalization (KOF: −0.30) and digitalization (IDI: −0.17) are consistent with Auer, Borio, & Filardo (2017), who find that global value chains suppress import price pass-through.
- The 8 - 10 quarter lag in M2's inflationary impact mirrors findings by Bordo & Schwartz (2008) on the "long and variable lags" of monetary policy, but the relative weight of the monetary channel is now lower, aligning with Engel (2016).
- The SQTM's superior forecasting performance relative to the Phillips Curve

echoes Borio et al.'s (2017) argument that global forces have eroded the traditional unemployment-inflation link.

5.3. Implications for Monetary Theory

- **Structural Rather Than Additive Reformulation:** The SQTM illustrates that the quantity equation must include multiplicative factors capturing external competitiveness and technological frictions.
- **Conditional Money Neutrality:** When REER shocks are present, monetary expansion loses its exclusive causal power over prices.
- **Endogenous Velocity:** Results suggest modeling money velocity V_t as a function of financial integration and inflation expectations, reestablishing it as a policy-relevant variable.

5.4. Policy Implications

- **Broader central bank dashboards:** Integrating REER, KOF, and IDI into policy dashboards enables early detection of imported inflationary shocks (e.g., 2021) and differentiation from purely monetary disturbances.
- **Exchange rate coordination:** Under high capital mobility, simultaneous balance sheet adjustments may neutralize intended effects if not paired with consistent exchange rate guidance.
- **Macroprudential policy:** Competitive devaluations and capital flow reversals call for supplementing inflation targeting with flow-debt safeguards in emerging markets.
- **Communication on velocity:** Central banks should explain how spending rebounds can accelerate V_t, preventing inflation surprises once liquidity begins to circulate.

5.5. Limitations

- **Geographic scope:** The U.S. and Türkiye represent extremes in development; generalization of elasticities requires a broader multi-country panel.
- **REER measurement:** Alternative trade-weighting schemes or deflators (PPI vs. CPI) may alter pass-through magnitudes.
- **Simultaneous endogeneity:** Although Granger causality mitigates this concern, policy shocks affecting both REER and M2 could bias coefficients; future research should instrument REER (e.g., with foreign interest rate differentials).
- **Temporal structure:** Episodes of intense intervention (QE, COVID-19) may introduce structural breaks requiring regime-switching models.

5.6. Research Agenda

- Panel-SVAR and high-frequency data to uncover asymmetric lags between REER and inflation.
- Microfoundations of the digital channel: Using e-commerce data to study how price transparency compresses markups and cost transmission.

- Interactions with post-pandemic fiscal expansions: Assess whether fiscal stimulus compresses traditional monetary policy lags.
- Open-economy DSGE models with import frictions, capable of simulating deglobalization or friend-shoring scenarios.

In summary, this discussion strengthens the empirical case that modern price dynamics cannot be understood without the exchange rate-globalization-digitalization nexus. Monetary rules must adapt to this structural triad to preserve central bank credibility in a world that differs fundamentally from the classic monetarist era.

6. Implications for Monetary Policy

Summary

Our results indicate that in open and digitalized economies, price dynamics cannot be managed using monetary aggregates or a domestic Phillips Curve alone. The REER, globalization (KOF), and digitalization (IDI) function as structural inflation drivers, while money velocity modulates intertemporal transmission. This demands a comprehensive overhaul of targets, tools, diagnostics, and communication strategies in monetary policy.

6.1. Operational Framework and Targets

- **Flexible inflation targeting:** Retain point targets (e.g., 2%) but extend horizons in the presence of "imported" (REER) or "technological" (IDI/KOF) inflation.
- **Expanded intermediate objectives:** Monitor the REER gap (vs. long-run average), 10-year KOF trend, IDI momentum, and V-gap (velocity vs. historical average).
- **Broader forecast targeting:** Official projections should include estimated pass-through elasticities and endogenous V dynamics; publish baseline and risk-adjusted paths.

6.2. Policy Mix

- **Interest rates** for managing demand shocks and anchoring expectations.
- **Central bank balance sheet** (QE/QT) calibrated with REER sensitivity in mind—avoid synchronized asset purchases that neutralize exchange rate effects.
- **"Smoothing" FX intervention** (non-defensive) when transitory depreciations risk unanchoring expectations; sterilize as needed to preserve monetary stance.
- **Macroprudential tools** (LTV/DTI caps, countercyclical buffers) to prevent credit surges when velocity rebounds.
- **Fiscal-monetary coordination:** Temporary fiscal support to cushion cost shocks can reduce the need for aggressive rate hikes during imported inflation episodes.

6.3. Monitoring and Diagnostics (Minimum Dashboard)

- **REER gap** and pass-through elasticity (typical lag: 2 - 4 quarters).

- **Velocity gap** (V-gap) and acceleration; early warning of monetary transmission reactivation.
- **KOF/IDI levels and trends:** higher digitalization/globalization → weaker pricing power.
- **Import share and input cost indices** (GVC); composition of the CPI basket.
- **Financial Conditions Index** (FCI) to guide QT/QE adjustments.

6.4. Scenario-Based Reaction Rules

- **REER depreciation + neutral M2:** prioritize communication and FX smoothing; gradual rate hikes conditional on pass-through persistence.
- **Monetary expansion + stable REER:** monitor velocity; accelerate tightening if V_t rises.
- **Inflation from global bottlenecks:** avoid overreaction; extend convergence horizon and deploy targeted fiscal/supply-side tools.
- **Deglobalization (KOF decline):** revise model parameters and potentially lengthen target horizons; stronger pass-through coefficients call for preemptive action.

6.5. The "Trilemma" and Regime Choices (Emerging Economies)

- Under high capital mobility, it is impossible to simultaneously maintain a fixed exchange rate and an independent monetary policy.
- Coherent options include:
  1) Inflation targeting + FX reserves for smoothing.
  2) Exchange rate anchor + capital controls/macroprudential buffers.
  3) FX bands with transparent rule-based adjustments.
- Given stronger pass-through, emerging markets should favor flexible inflation targeting and managed floats.

6.6. Communication and Expectations

- Clarify what share of inflation is "imported" (REER-driven) versus "domestic" (M2/velocity-driven).
- Publish **reaction thresholds:** e.g., "If REER-gap exceeds X and core inflation accelerates, policy rates will adjust accordingly."
- Highlight **transmission lags** (typically 2 - 4 quarters) to align public expectations with policy mechanics.

6.7. "Second-Generation" QE/QT Design

- **Asset composition**: Favor instruments that minimize undesired REER fluctuations.
- **Sequencing**: Avoid synchronized QE across major economies if exchange rate channel activation is desired.
- **Predictable QT**: Publish clear calendars and quantitative thresholds to reduce volatility in REER and FCI.

6.8. Governance and Data Architecture

- Publish official **elasticity estimates** (REER, KOF, IDI, V) regularly.
- Enhance nowcasting using online price data and GVC tracking tools; integrate digital competition metrics.
- Conduct **ex-post evaluations** comparing forecast errors (SQTM vs. QTM/Phillips VAR) and provide transparent audit trails.

6.9. Operational Checklist (Summary)

- REER-gap and updated pass-through estimates (with lags).
- Velocity gap and acceleration.
- KOF/IDI trends.
- FCI and central bank balance sheet composition.
- Active scenario (1 - 4) and corresponding policy rule.
- Public communication message: sources of inflation and convergence horizon.

Monetary Policy Conclusion

Credible monetary policy in an open, digitalized economy requires flexible inflation targets, expanded dashboards (REER-KOF-IDI-V), coordinated policy mixes, and communication anchored in elasticities and transmission lags. Absent this framework, central banks risk overreacting to imported shocks or underestimating inflation accelerations driven by velocity rebounds.

7. Conclusion

1) Validity and Expansion of Monetarism

This study reaffirms that inflation is ultimately a monetary phenomenon—but not exclusively so. When REER, globalization (KOF), and digitalization (IDI) are integrated into the quantity theory equation, the model offers a more accurate depiction of price dynamics in open, digital economies.

2) Methodological Contribution

- The SQTM outperforms both the classical QTM and a Phillips-curve VAR in terms of in-sample fit (adjusted $R^2 = 0.87$) and out-of-sample forecast (RMSE ↓ 40%).
- The VAR(3) estimation reveals bidirectional causality between REER and inflation, and unidirectional causality from M2 to prices—highlighting the need for structural models with lags.

3) Key Findings

- A 1% real depreciation increases CPI by 0.21 percentage points after two quarters.
- Globalization (elasticity = −0.30) and digitalization (−0.17) exert persistent deflationary pressure.
- Excluding REER, KOF, and IDI leads to underprediction of inflation by up to 1.3 pp during dollar-weakness episodes.

4) Policy Modeling

- Central banks must expand their dashboards to monitor not only monetary

aggregates and output gaps, but also REER gaps, KOF trends, and velocity dynamics.

- Inflation targets should be horizon-flexible and paired with transparent QE/QT rules to preserve the exchange rate transmission channel.

5) Limitations

- The study centers on the U.S. with selected contrasts to Türkiye and the 1970s.
- Potential endogeneity of REER and regime shifts are not fully modeled.
- Velocity (V) may be affected by statistical revisions and the advent of digital payment systems.

8. Future Research Agenda (Table 4)

Advancing these research lines will support the design of more precise monetary policy in a world where global competition, digital transformation, and capital mobility are reshaping the link between money, prices, and economic activity.

Table 4. Future research agenda.

Topic	*Guiding Question*	*Suggested Approach*
Cross-country panel	Does SQTM replicate across emerging and advanced economies with different exchange rate regimes?	Dynamic panel estimation (System GMM) with fixed effects.
Endogeneity & causality	Are REER and M2 endogenous to inflation expectations?	Use external instruments (e.g., trade shocks, policy surprises); structural VARs with sign-restriction identification.
Regime shifts	Does pass-through vary with baseline inflation or central bank credibility?	Apply Markov-switching models or TVP-VARs with time-varying parameters.
Digital economies	How do CBDCs and instant payments affect velocity and SQTM dynamics?	Use transaction-level data and machine learning to estimate real-time V.
Global supply shocks	How do logistics disruptions and energy prices affect SQTM outcomes?	Include bottleneck indexes and commodity prices as exogenous variables.
Competition and markups	Does digital competition constrain cost pass-through?	Use firm-level data and micro-panel techniques to estimate markups.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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