Exploring the dynamics of inflation in India: a comprenhensive empirical analysis (1981-2021)

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ABSTRACT: This study explores the dynamic relationships among key macroeconomic variables influencing inflation in India from 1981 to 2021. Utilizing a comprehensive empirical approach, the research employs the Autoregressive Distributive Lag (ARDL) model to analyse both short-term and long-term effects of variables such as money supply (M3), GDP growth rate, international oil prices, exchange rates, current account balance, and lending interest rates on inflation. The methodology includes stationarity tests to ensure the robustness of the time series data, followed by cointegration tests to confirm the long-run relationships among the variables. Additionally, the Quantile ARDL model examines these variables' impact across different inflation distribution quantiles, providing a more nuanced understanding of their effects. The findings highlight significant positive and negative relationships between these variables and inflation, depending on their lag periods. Notably, the results reveal that money supply and international oil prices play critical roles in shaping inflationary trends, with both direct and lagged effects. The study also identifies that GDP growth generally negatively influences inflation, suggesting that higher economic growth may not necessarily lead to inflationary pressures in the Indian context. The mixed effects of exchange rates on inflation further underscore the complexity of managing inflation in a volatile global environment. This research provides valuable insights for policymakers, emphasizing the need for a balanced approach that includes flexible monetary policy, effective exchange rate management, and strategies to reduce dependency on imported goods to mitigate external shocks. These findings offer a comprehensive understanding of the determinants of inflation in India, contributing to

formulating evidence-based policies for economic stability and growth.

INTRODUCTION

Achieving price stability is essential to the nation's ability to grow steadily and create jobs (Bernanke, 2013a). An acceptable and appropriate rate of inflation is also a prerequisite for favorable economic growth (Bernanke, 2013b). India has historically seen modest inflation (Ball et al., 2016). For the six decades between 1950–1951 and 2012–2013, the Wholesale Price Index (WPI) indicated an average annual inflation rate of almost 6.7% (Tiwari & Shahbaz, 2013). The average annual inflation rate was much lower before the global financial crisis, from 2000–2001 to 2007–2008, at about 5.2% (Mohanty & John, 2015a). However, in 2010–2011 and 2011–2012, headline inflation increased by about 10%; in 2012–2013, it began to drop somewhat (Mohanty & John, 2015b). Following the global economic crisis, India had high and low inflation rates for months, posing the most significant inflationary uncertainty (Mohanty & John, 2015c). India has primarily dodged the disastrous impacts of inflation on the global economy because of its cautious fiscal policies (Akinbobola, 2012). The study shows that, like most developing economies, the money supply and national income are the two main factors influencing India's rate of inflation (Bhattacharya, 1974; Pattnaik & Samantaraya, 2006). Aside from these two, a major driving factor affecting it is the price of crude oil internationally since India imports more than 85% of its domestic fuel needs (Government of India, 2023). An inverse effect of money supply on price level is that inflation may not be due to aggregate demand pressure but rather due to hiccups in the supply chain of goods from the domestic and foreign supply outlets (Blanchard, 1989). However, monetarists solely believed that the source of inflation is fundamentally derived from the growth rate of the money supply and that a rapid increase in money supply leads to a rapid rise in inflation (Friedman, 1995). According to the quantity theory of money, there is a direct relationship between money supply and inflation, which is evident from Fisher's equation of exchange.

$$MV = PT$$

where,
M = The total quantity of money.

V = Velocity of circulation of money

P = Price

T = Transactions performed using money.

In the case of oil prices, it may have both positive and negative influences on inflation. Michael Sarel (1996) used panel data from 87 countries during the period 1970-90 and found that inflation does not significantly affect growth, or it may even show a margin-

ally positive effect. Fisher (1993) examines the relationship between inflation and economic development by using both panel data and cross-sectional data that include both developed and developing countries, and this study suggests a negative relationship. The lending rate of interest and the current account balance are two of the most significant variables affecting inflation, among others. A key measure of a country's economic health is its current account balance, which shows the gap between savings and investment in the economy (Khan & Knight, 1983a). Via changes in import prices or the exchange rate, a current account deficit or surplus can majorly impact inflationary pressures (Khan & Knight, 1983b). An essential tool of monetary policy, the lending rate of interest directly affects investment, consumer spending, and borrowing costs—all of which are essential elements of the inflation dynamics (Tayor, 1993a). Economic theory has a well-established link between interest rates and inflation, with central banks frequently using lending rates as a lever to manage inflation (Taylor, 1993b). To reduce excessive demand and control inflation, the central bank would typically raise interest rates by the Taylor Rule in response to a higher inflation rate. Before adopting inflation targeting in 2016, which marked a significant shift in the nation's monetary policy framework toward maintaining inflation within a specified range, the Reserve Bank of India (RBI) had historically relied on interest rate adjustments to control inflation (Patra & Kapur, 2010a).

The inherent volatility of the global oil price, GDP, Money Supply (M3), Current account balance, lending interest rate, and Exchange rate makes it necessary to investigate how these variables affect the inflation rate in developing nations like India. This study examines factors other than supply shocks' effects on inflation. Thus, this study attempted to analyse the effects of the six variables global oil price, GDP, M3, Current account balance, lending interest rate, and Exchange rate on India's inflation rate. The first section of the study comprehensively addresses the literature review, identifies the research gap, and delineates the study's objectives. Subsequently, the following sections elaborate on the materials and methodology employed in the research. The third section, titled "Results and Discussion," presents the empirical findings and provides a critical analysis of the results. Finally, the concluding section of the study synthesizes the key insights and discusses the policy implications derived from the research outcomes.

SURVEY OF EXISTING LITERATURE AND RESEARCH GAP

Much research was conducted to discover the factors that influence inflation. The relationship between money supply and inflation has been a focal point in economic research, with several studies affirming the positive correlation between the two. Domaç & Elbirt (1998) investigated the causes of inflation in Albania, pinpointing money growth as a significant factor and employing co-integration and error-correction models to underscore the positive relationship between money supply and inflation. This foundational analysis set the stage for further investigations across different countries and periods. Amedeo Strano (2009) extended this line of inquiry through regression analysis, while

Anuradha Patnaik (2010) utilized cointegration vector error correction mechanisms, both confirming the enduring impact of money supply on inflation across various nations. A meaningful way to assess the effectiveness of core money growth metrics for inflation forecasting is by looking at their capacity to predict future patterns in inflation (Carstensen, 2007a). Collectively, these studies solidify the understanding that an increase in money supply is closely linked to rising inflation rates, offering crucial insights for policymakers aiming to stabilize economic conditions through effective monetary regulation (Carstensen, 2007b).

Recently, the world has been moving towards renewable energy sources, from traditional means, to combat environmental threats (Baranowski, 2023). However, the need for crude oil cannot be discarded as developing nations heavily depend on it (Yang et al., 2022). The influence of oil prices on inflation has been extensively documented, with significant contributions from studies like those by Berument & Tasci (2002) and Jiménez-Rodrígue & Sánchez (2005), which shed light on the profound effects of oil price movements on inflationary pressures. Also, The Turkish economy underscored how fluctuations in oil prices directly impact inflation, offering critical insights into the volatility of commodity prices and their transmission into the broader economic landscape (Berument & Taşçı, 2002a). The nonlinear dynamics between GDP and oil prices reveal that changes in oil prices do not uniformly affect economies; instead, their impact varies, often exacerbating in the case of increases (Jiménez-Rodríguez & Sánchez, 2005). These studies collectively highlight the intricate relationship between oil prices and inflation, illustrating economies' complexities in mitigating the adverse effects of oil price shocks. This body of work underscores policymakers' need to consider the volatile nature of oil prices in their inflationary control measures, emphasizing the global interconnectedness of commodity markets and economic stability (Berument & Taşçı, 2002b).

The intricate relationship between GDP growth and inflation has been a subject of considerable academic interest, with various studies revealing a complex interplay that challenges conventional economic theories. The significant negative correlation between GDP and oil prices in OECD nations implies a nuanced interaction between economic growth and inflationary forces (Mork et al., 1994), where external shocks like oil price fluctuations can adversely affect economic stability and growth prospects. Furthering this discourse, Prasanna & Gopakumar (2012) observed the direct relationship between inflation and GDP growth. Their research also suggests that elevated inflation rates can undermine economic growth, positing that inflation beyond a certain threshold may hamper economic expansion by eroding purchasing power, increasing uncertainty, and potentially leading to less efficient allocation of resources. The studies serve as a critical reminder of high inflation's repercussions on economic growth, emphasizing the need for a calibrated approach to monetary policy that carefully considers the growth-inflation nexus.

The influence of domestic factors and supply shocks on inflation is significant, with

studies highlighting how agricultural disruptions and external events shape inflationary trends. Mohanty & Klau (2001) found that in the 1980s and 1990s, supply factors, rather than traditional demand pressures, were primary drivers of domestic inflation. This perspective was further supported by Prita D. Mallya (2011), who pinpointed the agricultural sector's dynamics as a key determinant of food inflation in India. Both pieces of research emphasize the crucial impact of supply-side variables on inflation, suggesting that addressing these factors is vital for effective inflation management. This theme underlines the importance of considering domestic and sector-specific conditions in developing strategies to control inflation. The Economic Survey of India (2003-04 and 2007-08) provided insights into the effects of industrial production, agricultural performance, and crude oil prices on inflation and economic growth, underscoring the importance of policy considerations in managing inflationary pressures. Indeed, the transition from traditional factors like monetary and supply shocks to a heightened emphasis on domestic demand represents a significant shift in a nation's inflation scenario. As highlighted by Unsal & Osorio (2013), this change underscores the evolving dynamics within economies, particularly in Asia, where domestic demand has become a more pronounced driver of inflation in the 2000s. Such a shift necessitates evaluating monetary policy and inflation management strategies, moving beyond conventional focuses to include a broader understanding of economic activities and consumer behaviour.

Numerous literary works discuss how supply and demand affect India's inflation rate (Alam & Alam, 2016; Dua & Goel, 2021). However, the combined effects of the money supply, GDP growth rate, and international oil prices on India's inflation rate have not been well-documented. This is especially the case for the years 1981 to 2021, when several shocks, including the financial crisis (Acharya & Richardson, 2009), demonetization (Ganesan & Gajendranayagam, 2017), the LPG reform (Somalkar, 2006), COVID-19 (Dev & Sengupta, 2020), etc. Depending on the state of the economy, both positive and negative effects are associated with the relationship between money supply and inflation (Waingade, 2011). The Quantity Theory of Money supports a traditional perspective that shows a positive relationship between the two (Lucas, 1980). Mishkin (2007) highlights how excessive money supply can result in demand-pull inflation and, in extreme cases, hyperinflation, as seen in Zimbabwe. Christiano et al. (2005) argue that increased money supply may boost output without causing inflation when the economy operates below total capacity. Milton Friedman (1992) points out that slower money velocity can neutralize inflationary pressures. Therefore, while money supply and inflation often have a positive relationship, various factors can alter this dynamic.

In theory, the inflation rate can be influenced by oil prices in two ways: directly and indirectly. Demand side mechanisms underpin direct effect. Since oil products are used to make final goods, a higher proportion of oil products in consumer baskets will result in higher inflation due to oil costs. The indirect effect influences producer pricing by acting on the supply side (Rasche & Tatom, 1977). Since oil is a necessary component of

production, any increase in its price drives up producers' prices, which in turn drives up inflation. Furthermore, purchasing power is reduced by high oil prices.

Consequently, households might demand higher wages, leading to cost-push inflation since businesses would pass this cost through to their selling prices (Blanchard and Gali, 2007). Findings from the earliest study to look into the potential for non-linearities in the 93-country panel's inflation-growth relationship indicate a negative correlation between inflation and growth using panel and cross-section data for a selection of industrialized and developing nations (Fischer, 1993). Michael Sarel (1996) used panel data from 87 countries between 1970 and 1990 to test for a structural break in the relationship between inflation and growth. She found evidence of a significant structural break at an annual inflation rate of 8%, indicating that inflation either has no effect on growth at all or may even show a marginally positive effect below that rate. India's current account experience deteriorated due to its heavy reliance on imports and its exports' lack of competitiveness. The current account is a key indication of a nation's external performance and is often used to predict the future behaviour of an economy (Fayaz & Kaur, 2016). Changes in exchange rates have a significant impact on the overall level of pricing in emerging economies (Dornbuch, 1976). In Zimbabwe, the results verified a unidirectional causal relationship between inflation and the exchange rate, indicating that the exchange rate had a noteworthy influence on inflation (Madesha et al., 2013). The current year's lending interest rate and inflation rate have a positive impact on the lending interest rate for the following year, meaning that the first lags of lending interest rate and inflation rate are positively relevant in setting the level of lending interest rate (Ogero, 2021) A significant link was found between the variables related to interest rates and inflation by certain writers, who used this information as the foundation for adopting monetary and fiscal policies to support a prosperous economy (Khumalo et al., 2017). Another study examining the relationship between lending rates and inflation found that lending rates at commercial banks were impacted by inflation (Dinh, 2020).

OBJECTIVE

The main goal of this study is to shed light on the intricate relationships and dynamics among the variables M3, GDP growth rate, global crude oil price, lending interest rate, exchange rate, current account balance, and India's inflation rate. Through analysing the relationships among these variables, this research study aims to create evidence-based policy frameworks that support economic stability and prosperity in the Indian context.

MATERIAL, MODEL AND METHODS
MATERIAL

This study conducts a thorough empirical analysis of India's inflation rate by utilizing secondary annual time series data from 1981 to 2021. Inflation, a key economic indica-

tor, is often used to evaluate the health and stability of an economy. In India, inflation has been traditionally measured using both the Consumer Price Index (CPI) and the Wholesale Price Index (WPI). However, economists Rafee & Hidhayathulla (2015) argue that the CPI is a more accurate and reliable measure as it better captures the cost of living for the average consumer. Therefore, this study adopts the CPI as the inflation rate (IR) measure. The data for IR, expressed in percentage terms, is sourced from the World Bank database, which is renowned for its reliability and comprehensive coverage of global economic statistics. This makes the World Bank database an ideal source for researchers and policymakers.

The study incorporates several independent variables hypothesised to influence India's inflation rate. The first is the growth rate of money supply (M3), representing the total amount of money available in the economy, including cash, deposits, and other liquid assets. The relationship between money supply and inflation is a central concept in monetary economics, with changes in the money supply often linked to inflationary pressures. M3 data is sourced from the World Bank, ensuring consistency with IR data and robustness in the analysis. Another significant independent variable in the study is the growth rate of Gross Domestic Product (GDP). GDP growth reflects the overall economic activity within a country and is a primary indicator of economic performance. There is often a strong correlation between GDP growth and inflation, as rapid economic expansion can lead to increased demand for goods and services, driving up prices. The GDP growth data is obtained from Macrotrends, an online platform that provides detailed historical data and forecasts for various economic indicators. Macrotrends is selected for its comprehensive dataset and ease of access to long-term economic data, making it suitable for this study's requirements. The study also considers the international oil price (IOP) as an independent variable. Oil prices are critical in determining inflation, particularly for a country like India, which relies heavily on imported oil. Fluctuations in oil prices can significantly affect the economy, influencing transportation and production costs and, ultimately, consumer prices. The IOP data, sourced from the World Bank database, was initially expressed in price per barrel but converted to price per litre for this analysis. The exchange rate (ER), expressed in rupees per dollar, is another independent variable. Exchange rate movements impact inflation by affecting the cost of imports and exports. For instance, a depreciating rupee can make imports more expensive, leading to higher inflation. The ER data is also sourced from the World Bank, ensuring consistency with other variables.

Additionally, the study examines the current account balance (CAB) as an independent variable. The CAB, expressed in billions, reflects the difference between a country's savings and investments. A deficit in the current account can signal an economy's reliance on foreign capital, which may affect inflation, particularly if it leads to exchange rate volatility. The CAB data is sourced from the World Bank database, offering reliable and consistent data for analysis. Finally, the lending interest rate (r) is included as an inde-

pendent variable. Central banks use the lending rate as a critical tool to control inflation. Higher interest rates typically reduce consumer spending and borrowing, lowering inflationary pressures. The lending rate data is sourced from the World Bank.

This study heavily relies on the World Bank database due to its reputation for reliability and comprehensive coverage of global economic indicators. This consistency in data sourcing ensures that the variables used are comparable and trustworthy, providing a robust foundation for analyzing the complex relationships between these economic indicators and the inflation rate in India.

THE MODEL

In this research context, the inflation rate serves as the dependent variable. In contrast, the independent variables include international oil prices, GDP growth rate, money supply growth rate (M3), exchange rate, current account balance, and lending interest rate.

Inflation Rate = f (Growth Rate of Money Supply, GDP growth rate, International Oil Price, Current account balance, Exchange rate, Lending interest rate)

$$(IR)_t = \alpha + \beta_1 (M3)_t + \beta_2 (gdp)_t + \beta_3 (IOP)_t + \beta_4 (CAB)_t + \beta_5 (ER)_t + \beta_6 (r)_t + u_t \quad \ldots\ldots (i)$$

where α, β_1, β_2, β_3, β_4, β_5, β_6 are the coefficients, u_t is the disturbance term & 't' is the time period.

The following table displays the predicted signs of the concerned variables of the model

VARIABLE	VARIABLE DESCRIPTION	EXPECTED SIGN
IR	Inflation rate	
M3	Money supply growth rate	(+/-)
IOP	International oil price (annual data)	(+/-)
GDP	GDP growth rate	(+/-)
CAB	Current account balance	(+/-)
ER	Exchange rate	(+/-)
r	Lending rate of interest	(+/-)

Table 1. Expected Sign of the Coefficients

Those expected signs are taken from various literary sources.

MODEL SELECTION— STATIONARITY TEST
INTEGRATION ORDER TESTING

To avoid spurious estimation, checking the stationarity test for time series variables is necessary (Gujarati & Porter, 2009). The Augmented Dickey-Fuller test is used to confirm the stationarity of the variables. Unit root test results are represented in Table 2.

Variable	Order of Stationarity
M3	I(1)
GDP	I(0)
IOP	I(1)
IR	I(1)
CAB	I(1)
ER	I(1)
r	I(1)

Table 2. Unit Root Test

It confirms that GDP is stationary at level I(0) and other variables are stationary at first level integration i.e. I(1). Thus, none of the variables are I(2). So, using the ARDL approach is more appropriate for this empirical study.

TEST FOR COINTEGRATION

To confirm the long-run relationship among the variables of a model requires a cointegration test. ARDL long run and Bounds tests are mostly used to examine long-term relationships between variables (Atkins & Coe, 2002).

ARDL (4,4,4,4,1,0,4)		
F-statistic	7.74	
Critical value bound test of F-statistic at		
10%	5%	1%
I(0)= 1.75 I(1)= 2.87	I(0)= 2.04 I(1)= 3.24	I(0)= 2.66 I(1)= 4.05

Table 3. ARDL long run and Bounds tests

From this, we can see that the F-statistic value is higher than the limit at 10%, 5%, and 1% significance level. So, we can say no long-term relationship exists (Odhiambo, 2009).

EMPIRICAL MODEL

We suggest employing the Autoregressive Distributive Lag Model (ARDL) for the stationarity test and Bound test result. Our empirical model will be:

$$(IR)_t = \alpha + \sum_{i=1}^{4} \phi_i (IR)_{t-i} + \sum_{j=0}^{4} \beta_{1j} (M3)_{t-j} + \sum_{k=0}^{4} \beta_{2k} (gdp)_{t-k} + \sum_{l=0}^{4} \beta_{3l} (IOP)_{t-l} +$$
$$\sum_{m=0}^{4} \beta_{4m} (CAB)_{t-m} + \sum_{n=o}^{4} \beta_{5n} (ER)_{t-n} + \sum_{o=0}^{4} \beta_{6o} (r)_{t-o} + u_t \ldots\ldots\ldots (ii)$$

Where,

$(IR)_t$ is the dependent variable at time t, α is the constant term, ϕ_i are the coefficients for the lagged values of the dependent variable, $(IR)_{t-i}$ is the lagged values of the dependent variable, are the coefficients for M3(money supply), are the values of money supply, are the coefficients for the values of gdp (gross domestic product), are the values of GDP, are the coefficients for the values of IOP(international oil price), are the values for IOP, are the coefficients for the values of CAB (current account balance), are the values of CAB, are the coefficients for the values of ER(exchange rate), are the values of ER, are the coefficients for the values of r (interest rate), are the values of the interest rate, u_t is the error term at time t.
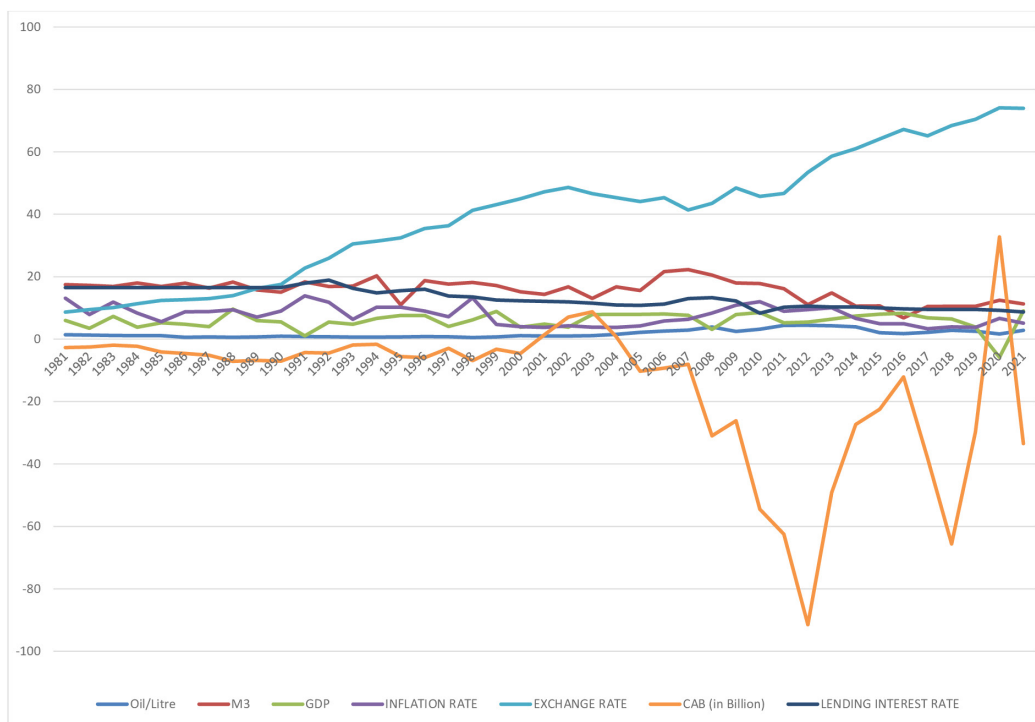
RESULTS AND DISCUSSIONS

Figure 1. Trends in Macroeconomic Variables and Inflation Rate (1981-2021)

Crude oil is one of the most important resources in the world, and demand for its products is rising daily (Gong et al., 2021a). Global consumption increased at a slower rate after 1980, but it remained stagnant from 1973 to 1979. (Adelman, 2002a). Vibrant swings and growing unpredictability have characterized the global economic environment, increasing international capital's speculative activity and leading to abrupt global oil price

swings (Gong et al., 2021b).   Understanding the implications of these changes on the macroeconomy is vital for ensuring economic stability and security. Such price volatility greatly impacts economic security and the stability of the oil supply, which in turn affects the sustainable development of the economy (Gong et al., 2021c). During the 1970s, there have been numerous "oil price changes" (Barsky & Kilian, 2004).

In 1996-1998, warm winters and East Asia recession kept consumption expanding slowly, as non-OPEC supply expanded slightly more, and in Europe and Japan, higher excise taxes, especially on fuel, raised consumer prices and hence depressed demand (Adelman, 2002b).   In early 1999, OPEC began production cuts through agreements with other oil-exporting countries, such as Mexico and Norway, resulting in a significant fall in oil production and a consequent price hike. By the end of 1999, oil prices had more than doubled (Adelman, 2002c).

The beginning of the 2000s was characterized by a significant increase in oil prices (Ledenko et al., 2018a). Thus, in 2008, the price of an oil barrel was over 100 USD. Energy consumption grew until 2007, after the financial crisis in the United States and the economic recession (Dekanić, 2011). After oil prices declined to $70 per barrel at the beginning of 2009, they began to rise again, reaching between $65 and $90 per barrel by the end of 2009 and early 2010. In 2011 and 2012, oil prices exceeded $100 per barrel but fell to $50 per barrel in 2015 (Ledenko et al., 2018b).   The globalisation trend in the petroleum markets has been accelerating. Because of the revolution, the beginning of the 2000s saw a significant increase in oil prices (Ledenko et al., 2018c).   Thus, in 2008, the price of an oil barrel exceeded USD 100. According to Dekanić (2011), energy usage climbed until 2007, following the US financial crisis and economic recession. After dipping below $70 per barrel in early 2009, oil prices began to increase again, reaching $65-$90 per barrel by the end of 2009 and early 2010. Oil prices approached $100 per barrel in 2011 and 2012 before falling to $50 per barrel in 2015 (Ledenko et al., 2018d). Petroleum has become a worldwide commodity as a result of advancements in information technology and increased international trade, and world oil markets are rapidly uniting to establish a global market. (Fan & Xu, 2011). Several significant developments in the international oil market occurred between 2014 and 2016, contributing to the drop in oil prices. Supply issues appear to have been the major force behind the abrupt price collapse in 2014. However, decreasing demand prospects were also a key component, notably in 2015-16. (Stocker et al., 2018a). Changing oil demand conditions, particularly short-run market attitudes and expectations, are key drivers of oil price swings (Lippi & Nobili, 2012; Jacks & Stürmer, 2016). The episode of declining oil prices in 2014-16 demonstrates that big price swings can disrupt the global economy, including deterring investment in both energy and non-energy sectors (Stocker et al., 2018b).

In 2021, as the increasing COVID-19 vaccination rates, loosening the pandemic-related stringent laws, and the recovery of the global economy lead to increased demand for crude oil than supply, and as a result, the oil price dramatically rises (Today in Energy,

2022).

Before the Russian invasion of Ukraine, energy costs were growing due to numerous factors, including the COVID-19 epidemic, supply constraints, and escalating tensions between Russia and Ukraine. During this period, oil prices stayed constant between $80 and $95 per barrel (Nesteruk, 2022). However, oil prices surged above $100 per barrel following the invasion, reaching their highest level in almost 14 years (Hotten, 2022).

Various causes have influenced the constant change in oil prices. Still, the most significant have been the geopolitical and economic crises of oil producers, conflicts, and the massive increase in demand for the world's most populous countries (such as China, India, and Brazil) (Ledenko et al., 2018e).

The fluctuations in India's M3 growth rate from 1981 to 2021 can be attributed to various economic events and policy decisions. As per the annual reports published by the Reserve Bank of India, during the 1980s, India's economic policies contributed to steady growth in the money supply, as the economy was relatively insulated from global markets. The significant dip in 1991-1992 was a result of economic liberalization reforms introduced to address a severe balance of payments crisis, which included the devaluation of the rupee, deregulation, and opening up to foreign investments (Cerra & Saxena, 2002).

The sudden fall in 1995 was due to a combination of factors, including tight monetary policy aimed at controlling inflation, fiscal consolidation efforts, banking sector reforms, and global economic volatility, such as the Mexican peso crisis (Saxena & Cerra, 2000; OECD, 2023). The sharp rise in 2006-2008, followed by a peak, was driven by high economic growth and robust foreign capital inflows, which were later impacted by the global financial crisis (Callen & Chang, 1998; IMF, 2022).

The significant increase in 2009-2010 can be attributed to expansionary monetary policies implemented to stimulate the economy post-crisis, including lowering interest rates and increasing public spending (RBI, 2010). From 2011 to 2013, a decline in the M3 growth rate was observed due to high inflation and economic slowdown, prompting the RBI to tighten monetary policy (Patnaik, 2010).

The sharp decline, followed by a rebound in 2016-2017, was a result of the demonetization initiative, which temporarily reduced the money supply, followed by remonetisation (Kumar, 2017). Finally, the M3 growth rate increase during 2020-2021 was driven by the economic response to the COVID-19 pandemic, with various monetary and fiscal measures implemented by the Indian government and the RBI to support the economy (World Bank, 2022).

The period from 1981 to 1991 for India's GDP trend line is marked by relative stability with minimal fluctuations. From 1981 to 1991, India's average GDP growth rate was approximately 5.5% per year. This period is characterized by relative stability with gradual

economic growth primarily driven by the agricultural sector and limited contributions from industrial and service sectors due to the closed and regulated nature of the economy (Panagariya, 2010)

The period from 1991 to 2002 marked a turning point in India's economic history, characterized by moderate growth following a severe balance of payments crisis. Under Finance Minister Dr Manmohan Singh, the government introduced liberalization, privatization, and globalization reforms, known as the LPG reforms, which led to increased foreign investment, deregulation of industries, and reduced trade barriers (Ahluwalia, 2002; Panagariya, 2005). This integration with the global economy spurred economic growth, with the service sector, particularly IT and software services, emerging as significant GDP contributors (Basu & Maertens, 2007). In 1991, the GDP growth rate was almost 1 % in 2021, but the average growth rate rose to approximately 5.7% per year from 1991 to 2002 due to these reforms.

The period from 2003 to 2008 witnessed accelerated economic growth, as evidenced by the more pronounced upward trend in the GDP line. This phase was characterized by robust economic expansion and increased foreign direct investment (FDI). The IT and service sectors flourished, and there was substantial growth in manufacturing and infrastructure development (Das et al., 2013). Economic policies during this period focused on creating a more business-friendly environment, improving infrastructure, and enhancing financial sector reforms. This period also saw an increase in consumption and investment, both domestic and foreign, contributing to higher GDP growth rates (Chandra, 2009; Panagariya, 2010). According to the World Bank, India's GDP growth rate during this period averaged around 7-9% annually, making it one of the fastest-growing major economies in the world.

The global financial crisis of 2008-2009 led to a noticeable dip in India's GDP growth due to a slowdown in global economic activity, impacting exports and investment flows. However, India's strong domestic demand and conservative banking system mitigated the severity of the crisis. The government implemented fiscal and monetary measures, such as tax cuts, increased public spending, and reduced interest rates, which helped stabilize the economy and supported a quick recovery (The Reserve Bank of India, 2009; Subbarao, 2010).

Following the global financial crisis, India's GDP trend line shows a recovery and steady growth trajectory from 2010 to 2016. This period was marked by resilience and continued economic expansion. The service sector continued to be a major growth driver, and there was a renewed focus on manufacturing with initiatives like "Make in India." Infrastructure development received a significant boost, and there were continued efforts to attract foreign investment (Singh & Sanjeev, 2016). The period also saw the implementation of key economic reforms, including introducing the Goods and Services Tax (GST), aimed at creating a unified national market and improving tax compliance. These

reforms contributed to a more favourable business environment and sustained economic growth (Kumar, 2019). During this period of recovery and steady growth, India's average GDP growth rate was approximately 7.5% per year. This growth was driven by strong performance in the service sector, increased manufacturing activities, and significant infrastructure investments.

From 2017 to 2021, India's GDP growth exhibited volatility due to a mix of domestic and global factors. The implementation of GST and the 2016 demonetization led to short-term disruptions in business operations and economic activities (Baliyan & Rathi, 2018; Sarkar & Karmakar,2021). The 2018 NBFC crisis further strained the economy. Globally, trade tensions and economic slowdowns impacted exports. The COVID-19 pandemic in 2020 caused a sharp GDP contraction, severely disrupting retail, hospitality, and manufacturing sectors. Despite government and RBI relief measures, including fiscal stimulus and liquidity support, challenges in employment, income levels, and investment flows persisted (The Reserve Bank of India, 2021). Thus, a V-shaped recovery was achieved in the Indian economy (Press Information Bureau, 2021). The average GDP growth rate during this period fluctuated, averaging around 4.2% annually.

A nation's exchange rate is An important economic indicator affecting many aspects of the economy, such as foreign investment, international trade, inflation, and general economic stability (McKinnon, 1988). The trajectory of the Indian currency rate between 1981 and 2021 is the result of considerable structural reforms, the country's internal economic policies, and the state of the world economy (Malik et al., 2023a). In the early 1980s, India operated under a fixed exchange rate system, with the US dollar constituting the largest share of the currency basket to which the Indian Rupee was tied (Srinivasan, 2000c; Basu, 2007b). This era was characterized by stringent foreign exchange regulations and restricted foreign trade (Rangarajan, 1999). By the mid-1980s, India faced serious balance of payments issues, necessitating progressive economic liberalization (Srinivasan, 2000d). In response, the government implemented the Liberalized Exchange Rate Management System (LERMS) in 1985, allowing for a partial float of the rupee and a more flexible exchange rate mechanism to attract foreign investment and boost export competitiveness (Srinivasan, 2000e). When India experienced a severe economic crisis in 1991, marked by declining foreign exchange reserves and soaring inflation, it marked a significant turning point in its history (Ozturk, 2006a). In response, the government implemented several economic measures, one of which was a large devaluation of the rupee to deal with the problem (Rossi, 2013a). The rupee lost almost 18% of its value about the US dollar in July 1991; India implemented a dual exchange rate system (Rossi, 2013b). In 1993, India transitioned to a single, market-determined exchange rate system, marking a historic shift from its previous fixed and dual exchange rate regimes (Ozturk, 2006b; Jayachandran, 2013a). This change allowed the exchange rate to be dictated by supply and demand in the foreign exchange market, leading to a weakening rupee due to market pressures and fostering greater integration with the global economy (Jayachan-

dran, 2013b). Strong economic development and a rise in foreign investment during the early 2000s contributed to the exchange rate's relative stability (Jayachandran, 2013c).

Nonetheless, the rupee saw considerable volatility because of developments in the world economy (Goel, 2014a). For example, the 2008 global financial crisis led to a significant rupee devaluation as investors withdrew from emerging economies (Goel, 2014b). Several domestic and international variables influenced the value of the Indian rupee in 2010 (Goel, 2014c). Exchange rates were impacted by capital flow variations brought about by the US Federal Reserve's and the European Central Bank's quantitative easing policies (Goel, 2014d). The rupee's value was significantly influenced domestically by policy decisions, inflation rates, and current account deficits (Lal et al., 2023). The world economy, including India's, faced unprecedented challenges in 2020 due to the COVID-19 epidemic (Yilanci & Pata, 2023). The severe reduction in GDP, lockdowns, and economic uncertainty all exerted significant pressure on the rupee (Prabheesh & Kumar, 2023a). The economy and exchange rate were, nevertheless, stabilized by fiscal policies and actions taken by the Reserve Bank of India (RBI) (Prabheesh & Kumar, 2023b)

Among the immense issues many rich and emerging countries encounter, the tremendous difficulty in the growing globalized world is maintaining balanced current accounts (Fayaz &Sandeep, 2016a). In the 1980s, India's current account situation gradually deteriorated due to unplumbed shifts in financing, and the oil price shock of 1979 put a major strain on its balance of payments (Fayaz & Sandeep, 2016b). The large current account deficit of the Balance of Payments remained a common characteristic of the Indian economy throughout its history till the early 1990s (Sarkar, 2006). Trade liberalization causes an increase in import demand that exceeds the equivalent growth in exports, resulting in either a persistent increase in the trade imbalance or a permanent fall in GDP (Kraev, 2005).

From 1991-92 to 2001-02, India's current account deficit steadily decreased, and from 2001-02 to 2003-04, it turned to surplus (average of 3.2 percent of GNP). Finally, it turned into a deficit from 2005 forward (Kubendran, 2010). India's current account has continuously been in deficit since 2004–05. The situation drastically deteriorated when the current account deficit (CAD) hit 5 per cent in 2012–13. This was due to multiple structural concerns, including a trade imbalance, increased imports, and subpar export performance, which brought India's external sector to the verge of crisis (Dhar & Rao, 2014). India's current account deficit worsened to 4.8 per cent of GDP in 2012–13, which was one of the main reasons for the rapid increase in inflation and depreciation of the Indian Rupee. The country is continuously impacted by these growing deficits, raising concerns about how these deficits are financed (Sahoo et al., 2016). India's current account experience deteriorated due to its heavy reliance on imports and its exports' lack of competitiveness. The current account is a key indication of a nation's external performance and is often used to predict the future behaviour of an economy (Fayaz & Sandeep, 2016c).

The rate charged for the usage of credit or money, before the rate of inflation throughout the rental period is taken into account is known as the lending interest rate. Stated differently, it incorporates the consequences of both inflation and uncertainty. In other words, the interest rates were not modified to reflect changes in the level of prices that resulted in changes in purchasing power. In actuality, earnings on any investment may cause purchasing power to lose due to inflation. Furthermore, inflation results in a decrease in the principal's purchasing power. There is a close relationship between inflation and interest rates, and one of the most important determinants of interest rates is inflation (Setaiesh et al., 2019).

The loan interest rate is one of the most important tools for managing inflation. Interest rate fluctuations can have an impact on the cost of borrowing, consumer spending, company investment, and currency values, all of which can raise or lower inflationary pressures within the economy. Strategic utilization of this connection by central banks promotes price stability and economic growth. From the graph, we can observe that from 1980-1990 the lending interest rate was stable. From 1990 to 2012, the nature of the fluctuation of the lending rate was greater. Again, from 2012, the rate gradually decreased to 8.7% till 2021, but the fluctuation rate is less than in the previous period.

The trend line shows that from 1981 to 2021, the lending interest rate has been steadily reduced, particularly from the late 1990s onwards, reflecting the country's efforts to expand its economy (Mohan, 2008). By lowering the lending interest rate, the Reserve Bank of India made borrowing more affordable for businesses and consumers, thereby encouraging investment, spending, and overall economic activity (Patra & Kapur, 2010b). This rate reduction, especially after the global financial crisis, helped stimulate business expansion, infrastructure development, and consumer spending, contributing to sustained economic growth (Pandit & Pandit, 2015). The consistent decline in the lending rate aligns with India's strategic focus on fostering economic expansion through increased access to affordable credit (Chavan & Gambacorta, 2019).

In the regression analysis below, the estimated equation explains 94.77% of the total variation in the dependent variable as it is indicated by the R2 value i.e. 0.947713. Additionally, the adjusted R2 evaluates the net gain (i.e. 0.811766). The AIC is used to determine the ideal latency. Having said this, we can consider the model credible and reliable.

The findings demonstrate that the IR_{t-2} lagged inflation rate significantly negatively impacts the current inflation rate (at a 5% level of significance). For exchange rate, ER_{t-2} has a positive significant impact (at a 10% level of significance), ER_{t-3} has a negative significant impact (at a 5% level of significance), and ER_{t-4} has a positive significant impact (at a 5% level of significance). Suppose we see the current account balance (CAB). In that case, we can see that CAB has a negative significant impact on the current inflation rate (at 1% level of significance), but lagged CAB has a positive significant impact on the current inflation rate (at 5% level of significance). Interestingly, we can see that the current

GDP negatively impacts the current inflation rate (at a 10% significance level).

VARIABLES	ESTIMATED COEFFICIENTS	STANDARD ERROR	t- VALUE	p- VALUE
IR_{t-2}	-0.43**	0.19	-2.27	0.04
ER_{t-2}	0.68*	0.38	1.78	0.1
ER_{t-3}	-1.3**	0.43	-3.02	0.01
ER_{t-4}	0.96**	0.40	2.37	0.03
CAB	-0.33***	0.06	-5.69	0.000
CAB_{t-3}	0.12**	0.03	3.65	0.004
gdp	-0.37*	0.19	-1.89	0.08
gdp_{t-3}	-1.17**	0.34	-3.44	0.006
gdp_{t-4}	-0.55**	0.2	-2.73	0.02
r	1.95***	0.4	4.53	0.001
r_{t-1}	-1.14**	0.4	-3.51	0.005
M3	0.71**	0.21	3.3	0.007
IOP	-8.24***	1.5	-5.2	0.000
IOP_{t-2}	3.9**	1.23	3.24	0.008
IOP_{t-4}	-4.14**	1.13	-3.64	0.004
R^2		0.947713		
Adj. R^2		0.811766		
AIC		3.496		
SW		4.672		
DW		2.03		

Note: * implies significant at 10% level, ** implies significant at 5% level, *** implies significant at 1% level.

Table 4. Results of the Analysis

Source: Authors' own estimation

Similarly, we can see that lagged GDP negatively impacts the current inflation rate (at a 5% level of significance). However, let's take the lending interest rate (r) case. We can see that it has a positive significant impact on the current inflation rate (at 1% level of significance), but lagged r has a negative significant impact on the current inflation rate (at 5% level of significance). In comparison, M3 positively impacts the current inflation rate (at a 5% level of significance). Lastly, let's look into the international oil price (IOP). We can see that it negatively impacts the current inflation rate (at a 1% level of significance). Still, two periods lagged IOP, which has a significant positive impact on the current inflation rate (at a 5% significance level). In contrast, IOP at four lag has a negative significant impact (at a 5% significance level).

DIAGNOSTIC TEST

To investigate the consistency of the model and the data assumptions, regression diagnostic tests are run as part of the regression analysis. The validity of a selected model can be tested by performing different diagnostic tests such as the Jarque-Bera Normality test, the multicollinearity test, the CUSUM Test, etc. The following are the results of our model's different diagnostic tests.

Diagnostic Test	P value
Normality Test (Jarque- Bera)	0.6337

Table 5. Diagnostic Test Result

Source: Authors' own calculation
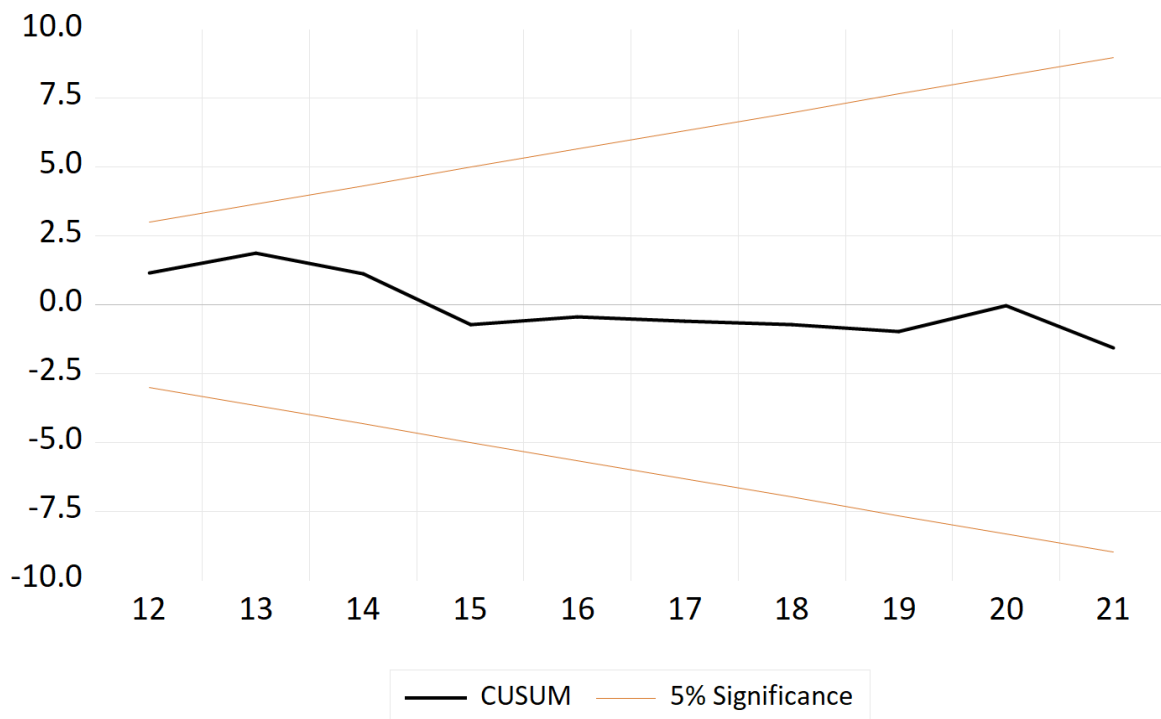
Source: Authors' own estimation
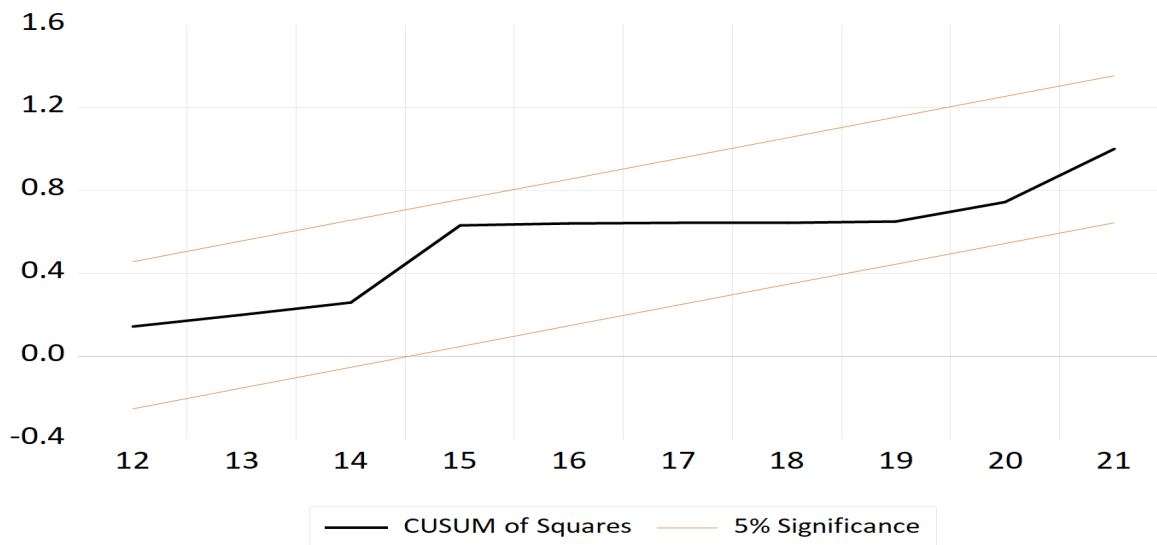
Source: Authors' own estimation

The model is stable at 5 per cent, according to the displayed CUSUM Test result. We can also see that the model is stable at 5 per cent in the CUSUM square test.

Multicollinearity test:

In Ordinary Least Squares (OLS) regression, multicollinearity is a serious problem since it can compromise the accuracy and interpretability of the predicted coefficients (Wooldridge et al., 2016a) when two or more independent variables in the regression model have a high degree of correlation, multicollinearity occurs, which has several significant consequences (Wooldridge et al., 2016b).

The VIF test is used to detect multicollinearity, which verifies that there isn't a case of multicollinearity because all of the variable's VIF values are less than 10. The multicollinearity thumb rule states that if VIF>10, there is severe multicollinearity between the variables (Gujarati, 2021).

VARIABLE	VIF
GDP	1.24
M3	1.76
IOP	4.39
CAB	3.41
ER	6.98
r	7.53
Mean VIF	4.22

Table 6. Variance Inflation Factor (VIF) Analysis of Concerned Independent Variables
Source: Authors' own estimation

Quantile Auto Regressive Distributed Lag (ARDL) Model: Quintile ARDL—an advanced version of ARDL is employed here for robustness checking. Through this regression, the relationship among the variables in various quantiles has been analysed as the Quantile ARDL model allows for a simultaneous examination of the long-run relationship with their related short-run movements over a series of quantiles of the dependent variable's conditional distribution. Unlike the standard linear techniques, the Quantile ARDL approach provides greater flexibility and a more comprehensive picture by allowing for an exploration of the short and long-run linkages between the dependent and independent variables (Koenker & Bassett, 1978).

Quantile Process Estimates
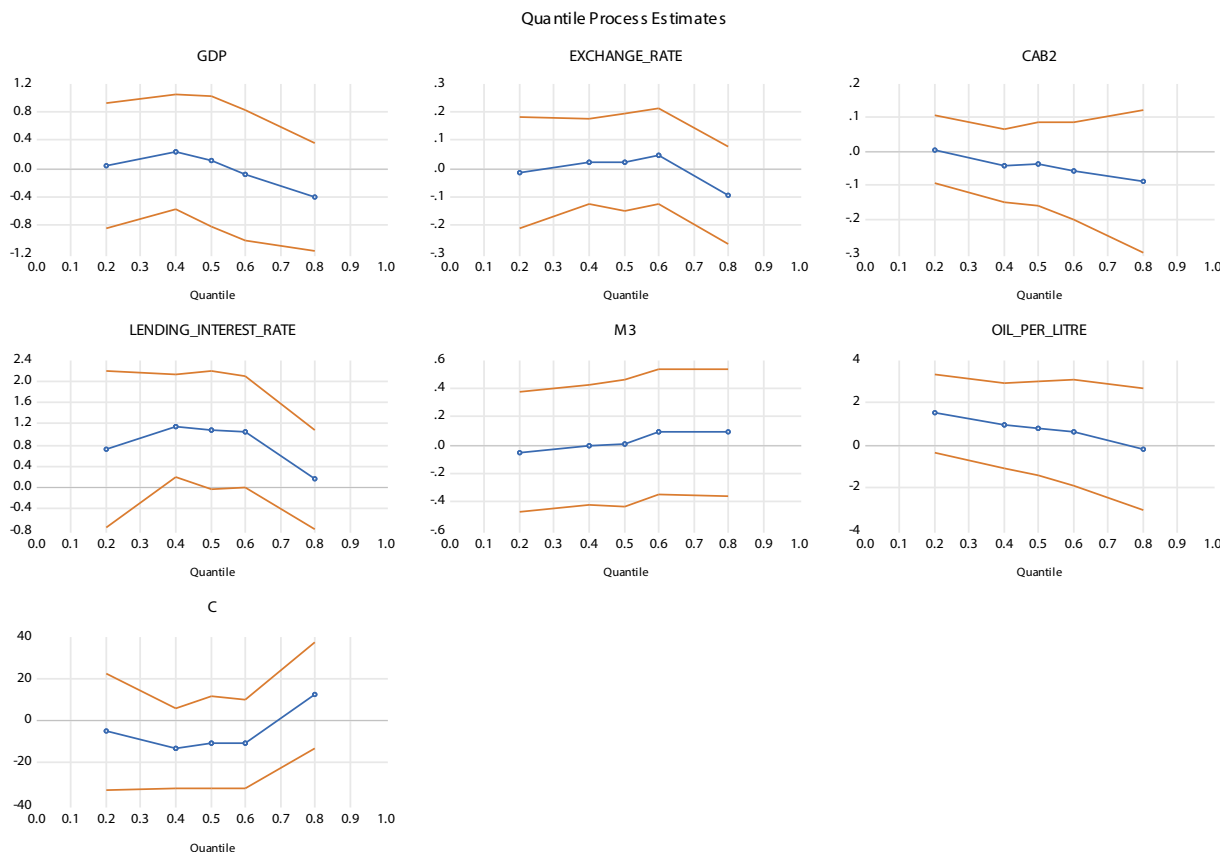
In summary, the quantile ARDL model indicates that GDP has a varying impact on inflation, particularly in lower quantiles, while other variables play a less significant role across different quantiles. Focusing on the quantile regression result, the analysis primarily explores how different macro-economic variables influence inflation at various points in its distribution (quantile)

CONCLUSION AND POLICY IMPLICATION

The study analyses the key determinants of inflation in India from 1981 to 2021, focusing on variables such as money supply (M3), GDP growth rate, international oil prices, exchange rates, current account balance, and lending interest rates. The findings reveal

that both supply-side factors (like international oil prices and money supply) and demand-side factors (such as GDP growth rate and current account balance) play critical roles in influencing inflation rates. The study identifies significant statistical relationships, with several variables showing both positive and negative impacts on inflation, depending on their lag periods.

The results highlight that money supply (M3) and international oil prices statistically affect inflation, indicating their practical importance in shaping inflationary trends in India. The money supply shows a positive relationship with inflation, consistent with monetary theory, suggesting that higher liquidity levels contribute to rising prices. However, international oil prices demonstrate both positive and negative effects on inflation across different lag periods, reflecting the complexities in the transmission mechanism of global price shocks to domestic inflation. The findings suggest that the relationship between oil prices and inflation is not linear and may depend on broader economic conditions and policy responses.

Additionally, the GDP growth rate negatively impacts inflation, indicating that higher economic growth does not necessarily lead to inflationary pressures in the context of India. This finding is crucial for policymakers, suggesting that stimulating economic growth can be a strategy to manage inflation without adverse effects. Conversely, the exchange rate shows mixed effects on inflation, with both positive and negative coefficients at different lags, implying that currency depreciation can have varying impacts depending on the timing and extent of the exchange rate movements.

From a policy perspective, the study underscores the importance of a balanced approach to managing inflation. The Reserve Bank of India (RBI) should adopt a flexible monetary policy that can respond swiftly to changing economic conditions, judiciously using tools like money supply adjustments and interest rate changes. Additionally, managing exchange rates effectively, particularly during periods of global volatility, could help mitigate adverse inflationary impacts. Enhancing supply chain resilience by reducing dependency on imported goods, mainly crude oil, could also buffer the economy against external shocks.

The study's practical significance lies in its detailed examination of the dynamic relationships between inflation and its determinants, providing valuable insights for policymakers. By recognizing the nuanced impacts of various macroeconomic variables on inflation, the study suggests targeted strategies to stabilize prices and foster sustainable economic growth in India. This comprehensive approach is vital for maintaining economic stability in a highly volatile global environment.

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