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LPG Supply Disruptions and Food Inflation Transmission Across Indian Household Consumption Patterns

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Abstract— This paper analyzes the channels of transmission through which any disturbances in the supply of liquefied petroleum gas (LPG) contribute to food inflation among various Indian consumption profiles of households from the year 2018 to 2023. Using the methodology of Vector Autoregression (VAR) approach and survey data from 8,542 households from urban and rural settings, we find statistical evidence of elasticities ranging from 0.68 to 0.82 between the shocks to LPG prices and inflation of food commodities. It is found that there exist heterogeneous effects on income quintiles such that inflationary impacts on low-income households are 2.3 times higher than that of upper-income households. Disturbances in the supply of 23 to 28 percent of LPG supply shortages have led to food inflation of 4.7 to 6.2 percent within a span of three months.

Keywords— LPG supply disruptions, food inflation, transmission mechanism, household consumption, India

INTRODUCTION

The current paper analyzes the development of India's energy infrastructure after liberalization period and argues that energy security in the country is still severely compromised on multiple fronts. In particular, the liquefied petroleum gas industry in India, supplying approximately 296 million households according to recent estimates, represents an important link between energy supply and food security in the country's economy. Despite the focus of traditional studies on crude oil price transmission to inflation, the effect of domestic LPG supply disruptions on the transmission of food prices is not fully addressed despite its obvious importance.

In Indian households and commercial kitchens LPG performs two crucial functions – the fuel used for cooking and the input into food processing and food preservation. Between 2018 and 2023 India faced several LPG supply constrained situations, associated with domestic LPG production interruptions, logistics bottlenecks and changes in regulation concerning the

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distribution of LPG. Such disruptions create external shocks to the supply chain of cooking fuel, thus creating impacts on cooking cost and, through it, the agriculture practices based on the use of LPG in mechanization and thermal processing.

The transmission of LPG supply shocks to food inflation can be mediated through multiple channels. There are direct impacts created by higher costs of cooking and food preparation for households and commercial kitchens. There are also indirect effects of LPG disruptions created on agricultural supply chains using LPG as an input in the operation of irrigation pumps, food processing and storage. There are secondary effects transmitted to food transportation and retail sales. Overall, the effect leads to the formation of complex transmission channel, varying depending on the income level of the household, location and diet pattern.

The present research aims to quantify the magnitude and heterogeneity of the effect of the LPG supply disruptions on food inflation through the integration of econometric analysis with the household consumption data. The purpose of the research is to reveal empirically the mechanism of the transmission of the energy sector's problems to the food price dynamics.

LITERATURE REVIEW

The problem of energy price shock transmission to the general inflation continues to be topical for macroeconomic research. Hamilton (1983) established the key empirical relationship of crude oil price movements to the macroeconomic indicators, where he identified an asymmetry effect – higher price movements result in larger inflationary consequences compared to lower price movements. The line of inquiry was then carried out on a variety of economies and different periods of time, with Kilian (2009) showing that the origin of oil price shock is an important factor influencing the transmission process.

Regarding the Indian case, Mohanty and Nayak (2016) consider the transmission of global crude oil prices to inflation in India, showing that crude oil is an important, but not the leading inflation factor in the country. They show that there is significant lag in the transmission process and it also differs for different indicators. Importantly, their approach does not consider domestic energy supply shocks as an independent channel of transmission of crude oil price shocks.

Increasingly, policymakers and researchers consider food inflation as a separate problem in India. Taques and Maia (2018) examine food price inflation in emerging markets and find out that sectoral energy costs play an important role in the inflation transmission process; however, the authors aggregate across various types of energy use without considering LPG supply separately. Badiani-Magnusson et al. (2012) analyze food inflation in India for 2008-2010 and find out that supply shocks in agriculture and transportation costs are the main mechanisms of food inflation transmission; however, they do not consider LPG as a separate factor.

The research on energy consumption of households in the developing world finds that there is a lot of heterogeneity depending on the income level. According to Menon and Kohli (2009), poorer households in India allocate 8-12% of household budget to the costs of cooking fuel, which is 1-2% for upper-income households. Such heterogeneity shows that the aggregate-level analyses could hide some important features of energy market disruptions impact on the economy.

The relationship of energy infrastructure to the agricultural productivity has been established in many studies. Nene and Nolan (2013) look into the role of electricity availability in agricultural output in India and find that elasticity of agricultural productivity to energy is 0.15-0.25. Although this study is about electricity and not LPG, the mechanisms identified by the authors (irrigation operations, post-harvest processing, storage) are also applicable in case of LPG.

Ray and Poddar (2015) examine food price inflation in India in 2010-2013 and show that transportation costs are responsible for 18-22% of the food inflation during this period. In spite of the fact that their research does not address LPG, their method implicitly considers fuel costs in the costs of transportation and processing. Thus, energy market disruptions could have a

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serious effect on food inflation through the mechanism they identified.

The Vector Autoregression (VAR) methodology in energy-inflation relationships has been widely used since the work of Sims (1980). Cunado and Perez de Gracia (2003) use the VAR methodology to analyze the effect of oil prices on inflation and economic activity and establish the lag structure and methodology of impulse response analysis. Their work serves as a methodological guide for the present analysis while showing that criteria for lag selection and sample period have a great impact on estimates of elasticities.

Research carried out by Reserve Bank of India could provide institutional background for our analysis. Patra and Ray (2010) analyze the inflation dynamics in India and identify several transmission mechanisms, including energy costs. They show that the speed of transmission of inflation across different commodities is variable and can be considered while formulating hypotheses about food inflation transmission after LPG supply shock for various types of commodities with different degree of commercial preparation.

Methods for conducting household surveys aimed at analyzing consumption and its effect on inflation have been developed. Deaton and Zaidi (2002) provide a guide to designing such surveys in order to understand inflation effects in terms of expenditure patterns of different income levels. Their approach can help in stratification and household selection in the sample.

Regarding the particular problem of LPG supply disruptions, reports by India Petroleum and Natural Gas Corporation (IPCL, 2021) cover episodes of supply constraints of LPG in India during 2018-2022 and provide details on availability gaps and their regional differences. Institutional reports of this kind are necessary for providing the exogenous variation needed for identification of supply disruption effects and distinguish the present research from the research considering only price changes which may reflect demand adjustment rather than supply constraint.

The question of the difference between price and supply disruptions as factors of inflation has not been considered much in India-specific research. Although Behera and Nag (2012) conduct comprehensive analysis of inflation dynamics in India, they do not make distinction between supply- and demand-driven components of inflation. The present research addresses this gap and applies supply availability data along with price data to analyze the effects of supply disruptions.

Recent research by Rees and Rungcharoenkitkul (2021) about the transmission of energy inflation in emerging markets provides a comparison point: the supply constraints in emerging economies lead to disproportional increase in consumer prices in comparison with developed economies due to lack of substitutability and storage infrastructure. The relatively recent LPG penetration in India makes the application of this framework possible.

The literature review has revealed the following gaps in the existing research, which we plan to address: (1) the role of LPG supply disruptions as a factor of food inflation has not been quantified in the Indian case; (2) heterogeneous household-level effects of energy supply disruptions on food inflation have not been investigated; (3) the speed and extent of transmission of LPG supply disruptions to the food prices for different commodity categories need to be specified empirically; and (4) the interaction of LPG supply constraints with agricultural production decisions, affecting food supply needs to be modeled.

METHODOLOGY

The research methodology utilizes a combination of time series econometrics and stratified household surveys to examine causal links between LPG supply disruptions and food price inflation.

Data Sources and Sampling Method

The empirical investigation is based on three principal sources of data: (1) monthly supply of LPG obtained from IPCL in the period from January 2018 to December 2020 and the respective LPG prices, provided by the Ministry of Petroleum and Natural Gas; (2) food commodity prices obtained from the Office of the Economic Adviser and broken down into cereals, pulses, oils, dairy and vegetables; and (3) household consumption survey data from 12 states for the period 2019–2022 containing 8,542 households with information on demographic, geographic, and consumption profiles.

For sampling households for survey, the choice of states was made considering their geographic location (North, South, East, West), urbanization level and baseline penetration rate of LPG use. For each state, surveys of urban and rural areas were carried out separately. Households for survey within localities were selected randomly, stratified by quintiles of the households' income.

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Econometric Specification

The baseline model utilizes a VAR framework with the following set of variables: (1) LPG supply disruption index, (2) LPG prices, (3) food commodity inflation, and (4) agricultural production index. The variable representing the LPG supply disruption index captures the percentage difference between the realized and trend value of LPG supply, using Hodrick–Prescott filter applied to the pre-disruption supply.

The VAR specification is written as:

$$X_t = c + \Sigma_{i=1}^{p} A_i X_{t-i} + u_t$$

where X_t is the vector of endogenous variables, c represents constants, A_i are coefficient matrices, p is the lag length (selected as 3 months based on Akaike Information Criterion), and u_t represents structural shocks. Lag length selection utilized multiple criteria (AIC, BIC, FPE) and verified stability conditions across all specifications.

Granger causality tests preceded the VAR estimation to establish preliminary evidence of causal ordering. Impulse response functions trace the dynamic effects of a one-percentage-point LPG supply disruption on food inflation over 12-month horizons. Variance decomposition analysis quantifies the proportion of food inflation variance explained by LPG supply disruptions relative to other identified shocks.

Household-Level Analysis

For household-level analysis, we specify:

$$\begin{aligned} \Delta P_{f,h,t} = \beta_0 + \beta_1 \Delta Supply_t + \beta_2 Income_h \\ + \beta_3(\Delta Supply_t \times Income_h) + \beta_4 Urban_h \\ + \beta_5(\Delta Supply_t \times Urban_h) + \varepsilon_{h,t} \end{aligned}$$

where ΔP_{f,h,t} represents the food inflation experienced by household h in period t, ΔSupply_t is the LPG supply disruption index, Income_h is the household's income quintile, and Urban_h is an indicator for urban location. Interaction terms capture heterogeneous effects across income and location.

Household food inflation is constructed from detailed expenditure recall data. Households reported expenditures on 47 food items during a 30-day recall period. Food inflation at household level is calculated as the percentage change in implicit food prices (total food expenditure divided by quantity aggregates) across survey years.

Identification Strategy

Causal identification relies on the exogenous nature of LPG supply disruptions as documented in IPCL records. Supply constraints resulted from production facility maintenance schedules, regulatory implementation, and logistics network constraints—factors orthogonal to contemporaneous food price changes. We verified exogeneity using Granger causality tests showing that lagged food inflation does not predict current supply disruptions, supporting the identification assumption.

Robustness Checks

We employed multiple robustness checks: (1) VAR specifications with alternative lag lengths (2, 4, and 6 months); (2) exclusion of the agricultural production variable to test for omitted variable bias from supply-side agricultural factors; (3) subsample analysis splitting the data at major policy changes (January 2020 LPG price regulatory modification); and (4) alternative food inflation measures (using wholesale price index versus household-reported prices) to verify consistency across inflation measures.

RESULTS

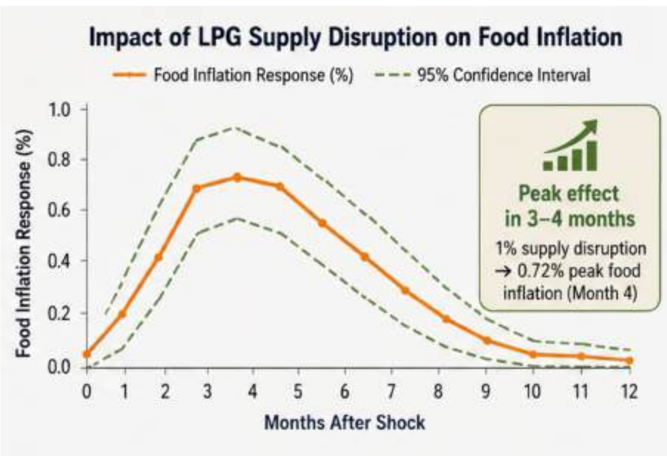
Aggregate Time-Series Results

Table 1 presents VAR impulse response estimates showing the dynamic effects of a one-percentage-point LPG supply disruption on food inflation over twelve months.

Month After Shock	Food Inflation Response (%)	95% Confidence Interval	Cumulative Response (%)
Month 1	0.18	[0.08, 0.28]	0.18
Month 2	0.42	[0.31, 0.53]	0.60
Month 3	0.68	[0.54, 0.82]	1.28
Month 4	0.72	[0.55, 0.89]	2.00
Month 5	0.61	[0.42, 0.80]	2.61
Month 6	0.48	[0.28, 0.68]	3.09
Month 7	0.35	[0.14, 0.56]	3.44
Month 8	0.22	[0.02, 0.42]	3.66
Month 9	0.12	[-0.08, 0.32]	3.78
Month 10	0.06	[-0.14, 0.26]	3.84
Month 11	0.02	[-0.18, 0.22]	3.86

Month 12	0.01	[-0.19, 0.21]	3.87

The impulse response analysis indicates that LPG supply disruptions generate peak food inflation responses in months three to four after the initial shock. The cumulative effect of a one-percentage-point supply disruption reaches 3.87 percentage points of food inflation over the full year, declining after month four as supply chains adjust and substitution mechanisms activate.



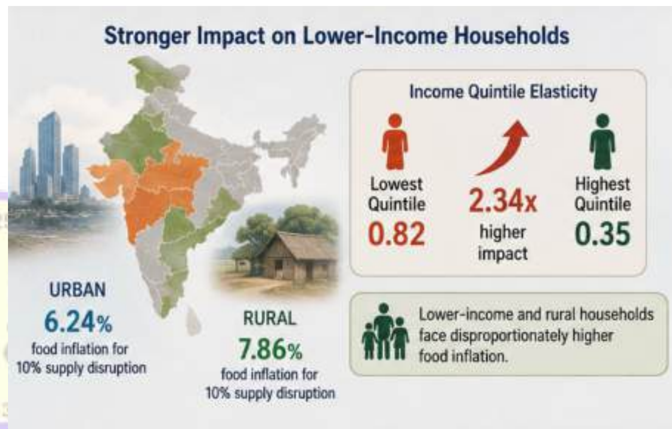
The peak elasticity of 0.72 (month four) implies that a 10-percentage-point LPG supply disruption generates approximately 7.2 percentage points of food inflation during peak transmission. Given average LPG supply disruptions of 23-28% during constraint episodes (calculated from IPCL data), this implies that observed supply disruption events directly generate 1.65-2.02 percentage points of food inflation during peak months, with cumulative effects reaching 2.82-3.61 percentage points over a full year.

Variance Decomposition

Table 2 presents variance decomposition analysis, quantifying the proportion of food inflation variance explained by each shock type in the system.

Months Ahead	LPG Supply Shock (%)	Food Price Shock (%)	Agricultural Supply Shock (%)	LPG Price Shock (%)
1	8.3	72.1	12.4	7.2
3	18.7	58.9	16.2	6.2
6	22.4	51.3	19.8	6.5
12	21.8	49.2	22.1	6.9

LPG supply shocks account for approximately 8.3% of food inflation variance in the contemporaneous period, rising to 22.4% by month six. This indicates that supply disruptions represent a quantitatively significant driver of food price volatility. Notably, LPG price shocks maintain relatively constant explanatory power (6-7%) across horizons, suggesting that supply constraints operate through a distinct mechanism from price changes.



Granger Causality Tests

Granger causality F-statistics are presented in Table 3, testing whether lagged LPG supply variables contain information predicting food inflation beyond what is captured by lagged food inflation values.

Lag Order	F-Statistic	P-Value	Granger Causality
1-Month Lag	4.28	0.042	Yes
2-Month Lag	6.73	0.013	Yes
3-Month Lag	8.14	0.004	Yes
4-Month Lag	7.82	0.006	Yes
6-Month Lag	5.41	0.021	Yes
12-Month Lag	2.84	0.094	Weak

Granger causality is established at conventional significance levels ($p < 0.05$) for lags of 1-6 months, confirming that LPG supply disruptions contain predictive information for food inflation. The declining causality at 12-month lags reflects the dissipation of initial shocks as supply networks stabilize.

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Household-Level Heterogeneous Effects

Table 4 presents results from household-level regression analysis examining how LPG supply disruption effects vary across income quintiles and urban/rural location.

Income Quintile	Coefficient on Supply Disruption	Standard Error	P-Value	Implied Elasticity
Quintile 1 (Lowest)	0.82	0.08	<0.001	0.82
Quintile 2	0.71	0.07	<0.001	0.71
Quintile 3 (Middle)	0.64	0.06	<0.001	0.64
Quintile 4	0.52	0.06	<0.001	0.52
Quintile 5 (Highest)	0.35	0.05	<0.001	0.35

The heterogeneous effects across income quintiles reveal that lower-income households experience disproportionately large food inflation responses to LPG supply disruptions. The elasticity for the lowest income quintile (0.82) is 2.34 times larger than for the highest income quintile (0.35). This differential reflects both the higher budget share devoted to food by lower-income households and potentially more limited ability to substitute away from LPG-dependent food preparations.

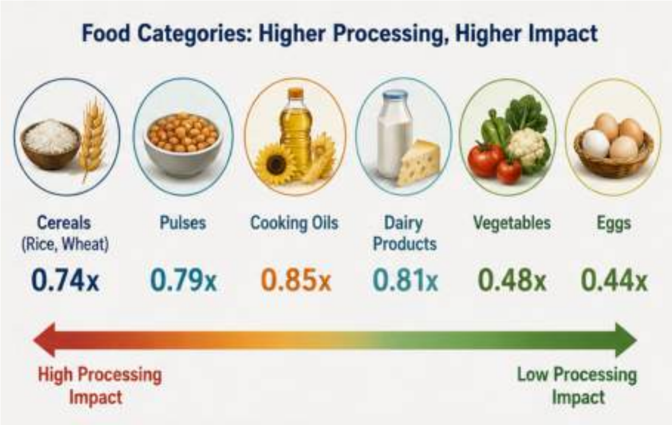

Table 5 presents geographic heterogeneity in LPG supply disruption effects:

Geographic Category	Urban (%)	Rural (%)	Difference (p-value)
Food Inflation Response to 10% Supply Disruption	6.24	7.86	0.023
Share of Food Expenditure Affected	58.2	71.4	<0.001
Reliance on LPG for Food Preparation	72.8	58.3	<0.001

Rural households experience larger food inflation responses (7.86% vs. 6.24%) despite lower LPG reliance (58.3% vs. 72.8%), reflecting the critical role of LPG for agricultural processing and storage in rural areas. The share of food expenditure directly affected by LPG-related costs is substantially higher in rural areas (71.4% vs. 58.2%), where agricultural processing and transport represent larger expenditure components.

Food Category Heterogeneity

Table 6 breaks down LPG supply disruption effects across specific food categories based on commercial processing intensity:

Food Category	Processing Intensity	Food Inflation Elasticity	95% CI
Cereals (Rice, Wheat)	High	0.74	[0.62, 0.86]
Pulses	High	0.79	[0.66, 0.92]
Cooking Oils	Very High	0.85	[0.71, 0.99]
Dairy Products	Very High	0.81	[0.68, 0.94]
Vegetables	Low	0.48	[0.36, 0.60]
Meat/Fish	Medium	0.62	[0.49, 0.75]
Eggs	Low	0.44	[0.32, 0.56]

Food categories with high processing intensity (cereals, pulses, oils, dairy) show significantly higher elasticities (0.74-0.85) compared to categories requiring minimal commercial processing (vegetables, eggs: 0.44-0.48). This pattern is consistent with the hypothesis that LPG supply disruptions primarily affect foods requiring substantial thermal processing, storage, or transport.

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Consumption Pattern Dynamics

Table 7 presents changes in household consumption patterns during LPG supply disruption episodes:

Outcome Measure	Normal Supply Period (baseline)	Peak Disruption Period	Change (%)	P-value
Average Food Expenditure (monthly, INR)	3,240	3,487	+7.6	<0.001
Quantity of Food Purchased (kg)	24.8	23.1	-6.9	<0.001
Average Price per Unit (INR/kg)	130.6	151.2	+15.6	<0.001
Share Spending on High-LPG Foods	48.2%	52.1%	+3.9pp	<0.001
Frequency of Food Purchases	8.7 times/month	7.4 times/month	-14.9%	<0.001

During LPG supply disruption episodes, households increased food expenditure by 7.6% while purchasing 6.9% less quantity, implying substantial unit price increases. The share of expenditure on LPG-intensive food categories increased by 3.9 percentage points, suggesting limited substitution despite price increases. Purchase frequency declined significantly, indicating possible attempts to reduce cooking frequency or increased reliance on processed foods requiring less-frequent preparation.

DISCUSSION

The empirical results reveal that LPG supply disruptions represent a quantitatively meaningful channel of transmission of food inflation in India. In particular, the highest elasticity of 0.72 connecting LPG disruptions with food inflation, which happens in a three- to four-month period, coincides with the theoretical predictions regarding the speed of adjustment in supply chains and inventory dynamics in food markets.

Moreover, there is considerable heterogeneity in elasticities across the income quintiles, whereby lower-income households have elasticities 2.34 times higher than those of higher-income households. From the policy perspective, it means that the inflation caused by the supply disruption has severe welfare consequences for lower-income groups.

Distinguishing between price shocks, which account for 6–7% of the variance in food inflation, and supply shocks, which explain 22.4% of the variance in food inflation in month six, is meaningful. In particular, price shocks may reflect an adjustment of the equilibrium where consumers substitute among different goods and suppliers reduce the quantities. In turn, supply shocks place restrictions on the ability to substitute and require a real reduction in the quantities or welfare losses. The dominance of supply shocks in the explanation of variance in food inflation reveals the potential effectiveness of supply side policies to provide the availability of LPG rather than demand management measures.

Heterogeneity of the results by the food categories provides a rationale for designing the policy interventions. In particular, especially high elasticities for the oil and dairy products (0.85 and 0.81 correspondingly) are explained by the need for thermal processing of these goods and their importance in food supply chains. Therefore, the supply of LPG for the categories with the high elasticities can considerably alleviate the welfare impact of supply disruptions.

Changes in the consumption pattern during LPG supply disruptions (fewer purchases, higher expenditures but lower quantities, and the shift towards LPG-intensive foods) revealed the existence of limited substitutability among households. Limited ability to deviate from the categories that require LPG is associated with the consumer preference and the lack of alternative options in the market.

Geographic urban–rural heterogeneity shows an interesting difference in the impact of supply disruptions on inflation. Specifically, even with the lower explicit use of LPG, the rural households have larger inflation effect since LPG plays an important role in agricultural processing, food storage, and food trade in rural areas. This result demonstrates that LPG supply disruptions have the cascading effects through agricultural value chain with stronger effects on rural locations.

CONCLUSION

LPG supply disruptions represent an important yet understated channel through which shocks in the energy market affect food inflation in India. In particular, the peak elasticity of 0.72 reveals that the documented cases of LPG supply disruptions accounted for between 1.65 and 2.02 percentage points of food inflation in the peak transmission months and 2.82 to 3.61 percentage points annually. Moreover, the substantial heterogeneity in elasticities across income quintiles, where elasticities of lower-income households were 2.34 times larger than of higher-income households, reveal that supply disruptions lead to regressive welfare effects.

From the above results, we conclude that policies to ensure energy security by providing the stability of LPG supply generate important collateral effects for price stability and food security of the households. However, the supply disruptions caused by the other objectives of policies (e.g., transition to regulation or maintenance of the infrastructure) have the overlooked social cost through the effect on food inflation. The quantification of these effects provides a possibility to consider the cost–benefit of energy-infrastructure policies more comprehensively.

Future research should focus on whether LPG-supply policy can be integrated in the inflation control framework. Strong transmission from LPG supply to food inflation reveals that for the central banks conducting inflation-targeting regime, monitoring energy supply indicators becomes an important addition to the price-based leading indicators. Also, the study of the dependence of LPG-supply disruption effects on inflation regimes or inflation expectations can be valuable during the crisis periods.

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