



Diesel Price Stabilization and Food Prices in Colombia: Evidence on Energy-Food Price
Transmission from 2013-2024

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ABSTRACT

Established in 2007, Colombia's Fuel Price Stabilization Fund (FEPC) has played a crucial role in reducing the volatility of domestic diesel prices relative to international diesel prices. The stabilization of diesel prices has ultimately helped regulate inflationary dynamics through the years. With the adaptation of several methods, including the Augmented Dickey-Fuller test, Johansen cointegration test, VECM estimate, Granger causality test, and Impulse Response Functions and Forecast Error Variance Decomposition, this paper examines how the FEPC's diesel price stabilization policy has influenced the transmission of energy costs to food prices from 2013 to 2024. The results reveal that the FEPC effectively mitigated diesel-to-food price transmission, but this protection weakened thereafter. The study suggests that a more sustainable mechanism to control energy-related inflationary risks could help limit the fiscal deficit and rising food prices.

Keywords: Fuel Price Stabilization Fund (FEPC); diesel price transmission; Vector Error Correction Model (VECM); food price inflation; subsidy gap; cointegration; structure; Colombia.

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INTRODUCTION

Diesel prices are fundamental to Colombia's economy, as they directly affect transportation costs in food distribution networks and the overall costs of the food industry. Fluctuations in diesel prices can rapidly increase costs for producers, wholesalers, and customers in a country where over 90% of goods are transported by road, which is mainly powered by diesel. To mitigate this risk, the Government created the Fuel Price Stabilization Fund (FEPC) in 2007. Its main job is to protect consumers and the economy from global oil price shocks by smoothing the transmission of oil prices from international markets to domestic retail fuel prices, potentially allowing changes in energy prices abroad to have a minor impact on inflation.

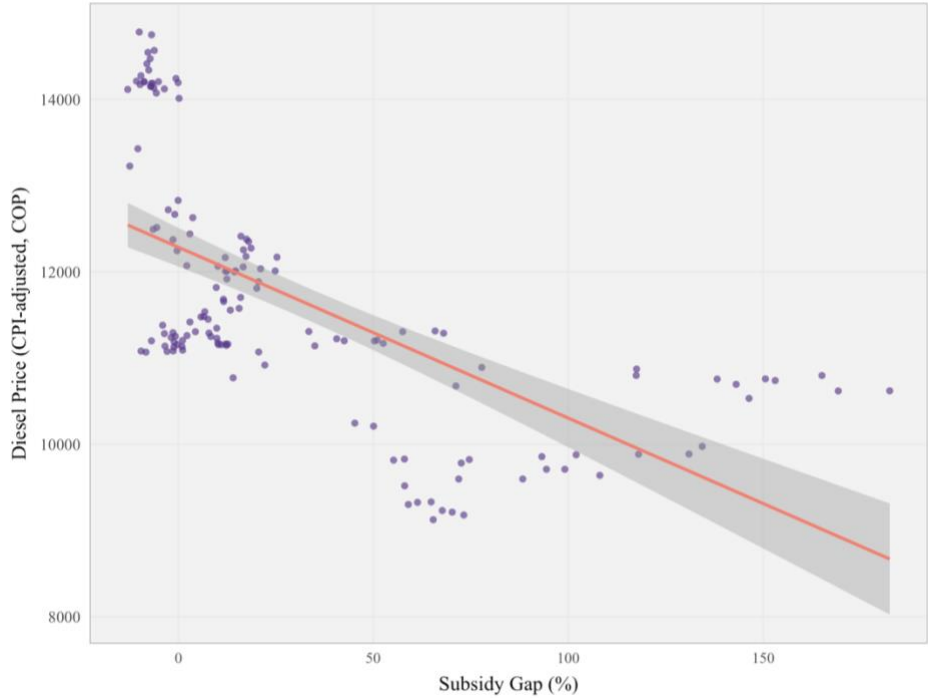
At first glance, the FEPC appears to be a sound policy adjustment measure designed to stabilize the domestic fuel prices. However, keeping gas prices stable, specifically diesel, has raised concerns regarding the rising pressures on both inflation and fiscal policy. The FEPC helps mitigate short-run price changes; however, it can also create a budgetary burden and hinder alignment of domestic diesel prices with global market conditions.

The debate over FEPC's effectiveness highlights an essential question: how should the Government judge economic policies? Stiglitz says that sound economic policies come from facts and that people need to understand the trade-offs and complexity that come with making them (2002, p. 52). Milton Friedman says, "One of the biggest mistakes is to judge policies and programs by their intentions rather than their results." These perspectives emphasize the importance of examining how fiscal policies influence the transmission of energy costs into food price dynamics, as well as the specific trade-offs that accompany such interventions.

Recently, Colombia has experienced significant food price inflation, particularly following the COVID-19 pandemic and the 2022 global energy crisis. Although the Government attempted to mitigate these impacts through the FEPC, domestic inflation reached its highest levels in decades, suggesting that the FEPC policy only partially prevented rising costs from being passed on to end consumers. In addition, domestic diesel prices have been kept low through the FEPC to contain

inflation, but this has widened the subsidy gap. In other words, it keeps the domestic diesel prices below the international reference price. That difference—the "gap"—is the implicit subsidy. As shown in Figure 1, there is a clear inverse relationship between domestic diesel prices and the subsidy gap over 2013-2024. As the subsidy gap widens, reflecting rising global diesel prices, the FEPC's mechanism stabilizes domestic diesel prices by absorbing part of the worldwide diesel cost burden.

Figure 1. *Relationship Between the Subsidy Gap and Domestic Diesel Price.*



The primary aim of this study is to empirically evaluate whether Colombia's Fuel Price Stabilization Fund (FEPC) has weakened or altered the transmission of diesel prices into food prices between 2013 and 2024. Specifically, it investigates whether changes in domestic and global diesel prices have influenced the wholesale prices of key food commodities, including rice, potatoes, tomatoes, onions, eggs, milk, and chicken. The central research question is: "To what extent did Colombia's diesel price stabilization policy (FEPC) mitigate the pass-through of energy costs to food inflation during the 2013 to 2024 period?"

The study utilizes monthly CPI-adjusted data from DANE, UPME, and EIA within a multivariate time-series econometric framework to test various dynamic interactions. The results may lead to valuable insights into FEPC's role in stabilizing consumer prices and controlling inflation. Furthermore, the analysis contributes to understanding how fuel price policies influence the broader food supply chain within a given period. Section 2 examines the theoretical and empirical literature. Section 3 outlines the research objective, followed by Section 4, which details the methodological approach. Section 5 discusses the empirical results, while Section 6 concludes the study with final remarks and implications.

LITERATURE REVIEW

Researchers analyze the global context of energy-food price transmission through various studies on the relationship between energy and food prices, especially in developing countries, where fuel prices have a significant impact on transportation and farming. Zingbaba et al. (2020) investigated this link in São Paulo, Brazil. They found that gas prices affect store egg prices, demonstrating long-run rather than short-run transmission and intense mediation by domestic policies. Similarly, Ivanova et al. (2023) analyzed diesel's effects on Bulgarian food prices using a VECM framework, identifying asymmetric adjustments; diesel shocks mainly raise retail prices for perishable items such as eggs and cucumbers while exerting weaker effects on producer prices for those same commodities.

At a broader level, Mensi et al. (2014) and Wang et al. (2014) provided evidence that oil-price volatility and demand shocks generate significant spillovers to agricultural commodities such as corn, wheat, and soybeans. The studies show how OPEC production decisions and aggregate demand shocks propagate through food markets via input and transport costs. Likewise, Roman et al. (2020) and Hong et al. (2019) found long-run relationships strengthened through biofuel production channels and global supply chain integration.

Complementary studies, including Olayunbo (2021) and Zafeiriou et al. (2018), demonstrated that the relationship between food and energy is asymmetric. It is weak in the short term but strong in the long term. Global data shows that changes in energy prices primarily affect food costs and transportation costs. Other effects tend to occur later and depend on policy.

As for Colombia's diesel dependency, the Unidad de Planeación Minero-Energetica (UPME, 2015) projected annual growth of around 2.9% in diesel demand between 2012 and 2030, highlighting the importance of this fuel for a developing country. Data from MinHacienda (2024) showed that Colombia has one of the lowest diesel prices in Latin America, around 35.8% below the regional average. The policy creates a subsidy of approximately COP 4,615 per gallon, imposing a fiscal burden of COP 10.6 trillion in 2024. There is a growing debate over whether it is a sustainable policy in the long run. Since the start of 2025, a phasing-out program has been in place, increasing diesel prices at the beginning of each month.

Established in 2007, the Fuel Price Stabilization Fund (FEPC), created by the Government, assisted in mitigating the impact of global oil prices by subsidizing domestic oil prices. According to Picciariello et al. (2022), about 60% of all fossil fuel subsidies — COP 5.61 trillion — passed through the FEPC in 2019. The result was putting pressure on the Government's debt and helping households with better incomes. Gutierrez et al. (2024) noted that the policy helps prevent inflationary shocks. They also indicated that 96% of goods in the country are moved by diesel-powered vehicles, underscoring the importance of diesel price transmission to food prices through transportation costs. In addition, the average truck used for food transportation in Colombia is approximately 26 years old, indicating the country's heavy reliance on diesel-powered vehicles for agricultural distribution.

Mesa and Ospina (2022) have supported the claim by demonstrating that changes in diesel prices have a larger impact on short-term inflation (2.68 basis points) than changes in gasoline prices (0.77 basis points). These studies illustrate the significance of the FEPC in moderating inflationary pressures and in demonstrating the effects of its diesel subsidy.

After reviewing the implications of the FEPC, the discussion now turns to the econometric approaches used to study energy–food price transmission. The framework applied relies on time-series econometrics from Stationarity testing (Dickey and Fuller, 1979), then through Cointegration analysis (Johansen, 1988, 1991), the Vector Error Correction Model (Engle and Granger, 1987), integration of Granger Causality (Granger, 1969), and lastly Impulse Response Functions and Forecast Error Variance Decomposition (Sims, 1980). This framework is essential for testing multivariate VECM econometric models across multiple variables and for examining short- and long-run effects.

Despite these contributions, a notable gap remains in Colombian-specific econometric evidence on the FEPC's effect on food inflation. This paper contributes to closing that gap by using a multivariate VECM framework covering the 2013-2024 period to empirically test whether Colombia's policy to stabilize domestic diesel prices has mitigated or altered the pass-through of energy costs to food prices, accounting for changes over time.

OBJECTIVE

The main objective of this study is to empirically evaluate how Colombia's Fuel Price Stabilization Fund (FEPC) has influenced the transmission of diesel price fluctuations to food prices between 2013 and 2024. Specifically, it tests whether the Government's policy, which ultimately widens the subsidy gap between domestic and global diesel prices, has weakened, delayed, or altered the pass-through of global energy cost shocks to domestic food inflation. Understanding this relationship allows for a more precise evaluation of how FEPC subsidies and price controls affect food prices, providing policymakers with evidence to design more effective, proportionate, and sustainable fuel and inflation management strategies.

To accomplish this, the study uses monthly CPI—adjusted price data for staple food commodities—tomatoes, rice, potatoes, onions, eggs, milk, and chicken—along with monthly

CPI-adjusted domestic diesel prices and global diesel prices. By implementing a multivariate VECM time-series econometric framework that includes the Augmented Dickey-Fuller test, the Johansen cointegration test, the Vector Error Correction Model (VECM), Granger causality analysis, Impulse Response Functions (IRFs), and lastly a Forecast Error Variance Decomposition (FEVD), the study can quantify the dynamic interdependence between these variables.

This empirical method produces results that distinguish short-run and long-run equilibrium relationships. At the same time, it considers shocks around 2020, most prominently the COVID-19 pandemic and the 2022 global energy crisis, which may have reshaped price transmission channels.

The central research question is:

"To what extent did Colombia's diesel price stabilization policy (FEPC) mitigate the pass-through of energy costs to food inflation from 2013 to 2024?"

Specific Objectives:

- Clean government data from DANE, UPME, and EIA to create a monthly database of CPI-adjusted prices of domestic diesel, global diesel, and the seven essential food commodities, ranging from 2013 to 2024.
- Identify long-run equilibrium relationships between diesel and food prices by using the Augmented Dickey-Fuller (ADF) test and the Johansen trace and maximum eigenvalue tests to see if the price series are stationary and if they are cointegrated.
- Test for both the short-run and long-run effects on diesel and food prices with the use of a Vector Error Correction Model (VECM), as well as to measure the size and direction of the diesel-to-food price transmission.
- With the Granger Causality test, detect if there are predictive links between the diesel price and food price variables.
- Examine Impulse Response Functions (IRFs) and Forecast Error Variance Decomposition (FEVD) to determine how changes in diesel prices affect food prices over time.

- Analyze if the FEPC policy, in addition to the COVID-19 pandemic and the energy crisis of 2022, changed the stability and size of the diesel-to-food price transmission by looking at the 2013-2024 period.

To achieve these objectives, the following section describes the materials and methods applied in this study, including the hypothesis, research design, data and variable selection, and the statistical and econometric modeling strategy based on a multivariate VECM framework.

MATERIALS AND METHODS

Hypothesis:

This study hypothesizes that Colombia's Fuel Price Stabilization Fund (FEPC) has significantly mitigated the pass-through of diesel price fluctuations to food prices. In other words, this government policy has helped limit food inflation by stabilizing domestic diesel prices, keeping them significantly lower than global diesel prices.

Research Design:

This study uses two key papers that serve as the foundation for analyzing the impact of the FEPC's policy on diesel and food prices. In general, the research designs of these two papers mentioned share similarities, as both use empirical time-series econometric analysis to examine the causal relationships between diesel and food prices. The first is the "Effects of Diesel Price on Changes in Agricultural Commodity Prices in Bulgaria," by Ivanova et al. (2023). Their use of a multivariate time-series econometric framework, especially a Vector Error Correction Model (VECM), helped frame the methods and the initial results. In addition to this, the second paper, "Short-term inflationary effect of changes in gasoline and diesel prices following the reduction of the Fuel Price Stabilization Fund (FEPC) deficit" by Mesa et al. (2022) demonstrates an interesting hypothesis on how there is strong causality between fuel prices and inflation, meaning that changes

in one significantly affect the other over time, using an impactful methodology and econometric models that will be in some way mirrored.

Data and Variables:

The study is made up of monthly CPI-adjusted (base year = 2024) price data from January 2013 to December 2024, collected from three primary official sources:

- **Departamento Administrativo Nacional de Estadística (DANE):** for domestic consumer price indices (CPI) and food price data.
- **Unidad de Planeación Minero Energética (UPME):** for domestic diesel (ACPM) prices and fuel market data.
- **U.S. Energy Information Administration (EIA):** for global diesel price benchmarks (U.S. Gulf Coast No. 2 Diesel).

The UPME obtained domestic diesel prices (ACPM) from the *Fuel Price Structure for Major Colombian Cities*. The estimation of the monthly average diesel price considered several components, including the national tax, carbon tax, pipeline transport fees, transportation costs from supply plants to service stations, the surcharge, and the retail distribution margin. The analysis used UPME Data from approximately 18–19 major cities to calculate the monthly average maximum retail sale price at the station for the 2013–2024 period. After compiling the dataset, all variables were adjusted for inflation using the Consumer Price Index (CPI) with 2024 as the base year to ensure comparability over time.

This study uses global diesel price data from the U.S. Energy Information Administration (EIA). The collection process was relatively straightforward, as monthly average retail prices were readily available. These values were adjusted for inflation using the Consumer Price Index (CPI) and converted from U.S. dollars (USD) to Colombian pesos (COP) using the monthly exchange rate for each year.

The final set of variables comprises seven food commodities selected based on two main criteria. The first criterion is representativeness: together, these commodities cover the broad spectrum of

consumer food purchases, including meats, dairy and eggs, fruits and vegetables, grains and tubers, categories well represented by the selected items. The second criterion is relevance: these foods are among the key commodities most frequently purchased by Colombian households, accurately reflecting their monthly consumption patterns.

To construct the monthly averages for each food item, the mean was computed for several sub-products within each category (e.g., different cuts of chicken or types of tomatoes) to create an aggregate price measure for each commodity. Including this diverse set of food items allows for a more comprehensive analysis of how changes in diesel prices may affect products with distinct price behaviors and supply chain characteristics.

All price series are expressed in natural logarithms and in Colombian pesos (COP) to stabilize variance, allow coefficient interpretation as elasticities, and ensure consistency with the cointegration framework. The study selects this time frame for three main reasons. First, it is policy relevant, capturing the FEPC's effect over time. Second, it is economically relevant now that the time includes major global economic shocks; lastly, the availability and consistency of reliable data from official sources throughout this period.

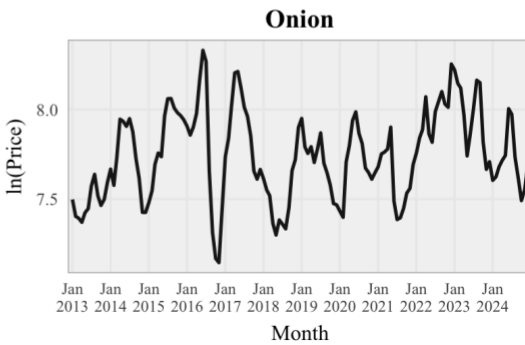
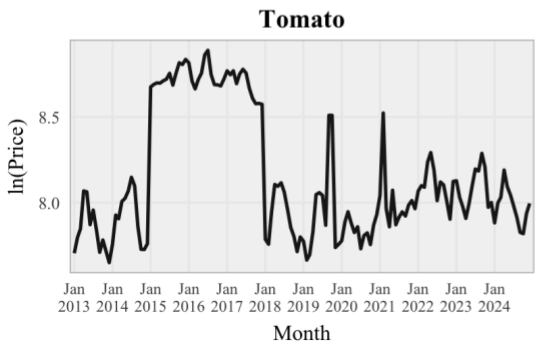
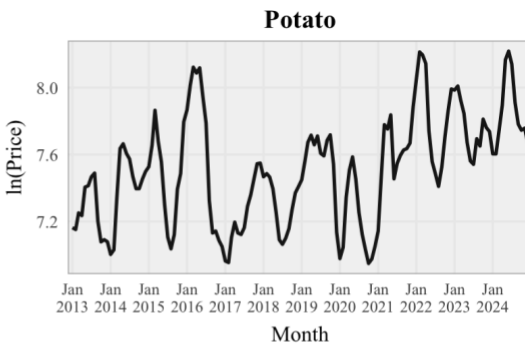
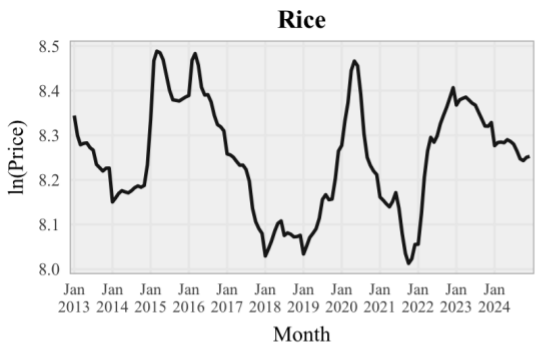
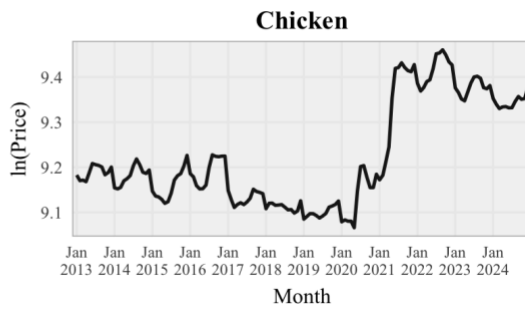
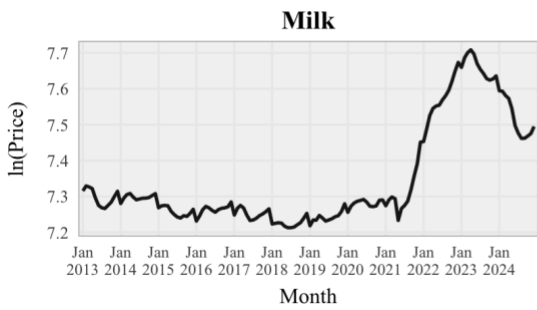
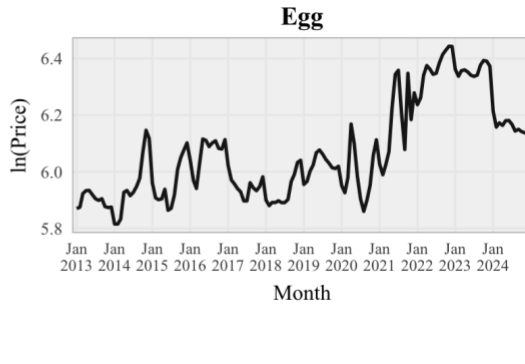
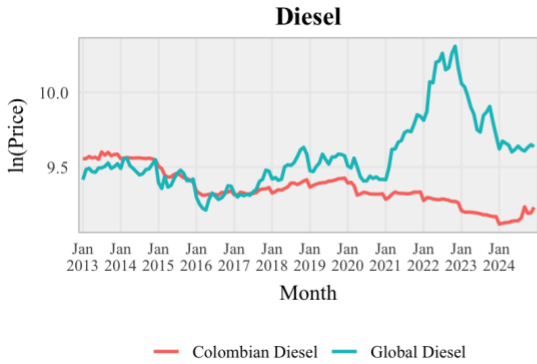
Disaggregated food prices are used instead of the CPI food prices for two main reasons. The first argument is due to different transport storage and perishability of foods being fundamental to evaluating FEPC effectiveness by product category. For example, protein products, a large portion of variables in the analysis, require higher input costs (diesel related) than other variables. Tomatoes, highly perishable, demonstrate significant short-run effects, while rice, storable, shows a more gradual adjustment. The CPI food prices may mask these differences. The second reason is, by examining individual products, we can detect whether FEPC mitigation is more effective for certain foods, enabling targeted policy design that is more efficient than blanket subsidies.

Including global diesel prices is essential for evaluating the effectiveness of the FEPC and for understanding how the subsidy gap between domestic and international diesel prices shapes food

price dynamics in both the short and long run. Although the policy aims to insulate domestic diesel prices from external shocks, this insulation is neither complete nor permanent, making the international benchmark a critical component of the analysis. Global diesel prices influence domestic food prices through several channels that operate independently of FEPC.

First, imported agricultural inputs, such as fertilizers, machinery, and agrochemicals, embody international energy costs that transmit directly to domestic input costs. Second, producers may adjust prices pre-emptively in response to international fuel market conditions, reflecting expectations of future cost pressures. Third, Colombia imports a portion of its food and intermediate goods, meaning global price fluctuations can spill over into domestic markets through competition and substitution effects. For these reasons, global diesel serves not only as a benchmark for the subsidy gap but also as an economically meaningful driver of food price formation. Therefore, including both diesel prices permits the quantification on the degree of FEPC mitigation not only assume it exists totally or not at all. The finding that global diesel still matters is not a contradiction it is the core result: FEPC provides partial, not complete, protection.

Figures 2-9. Food Prices, Colombian and Global Diesel prices in logarithmic form (CPI-adjusted) in COP.



Statistical and Econometric Procedure:

The descriptive statistics provide a preliminary understanding of volatility, stability, and distributional patterns across all key food variables. At the same time, the correlation matrix presents the initial associations between domestic and global diesel prices and the key food variables.

Subsequently, the study applies Augmented Dickey–Fuller (ADF) tests to assess the stationarity of each series at levels and in first differences, thereby determining their integration order (I(1)). Once non-stationarity is confirmed, the study applies the Johansen cointegration test to identify the presence and number of long-run equilibrium relationships among the variables.

Based on the selected rank, the Vector Error Correction Model (VECM) is estimated to capture both short-term adjustments and long-term dynamics in the relationship between diesel and food prices. To ensure model validity, the study performs a set of diagnostic tests, including the Jarque–Bera normality test, the Portmanteau serial correlation test, and the ARCH heteroskedasticity test. Then, the study extends the analysis through Impulse Response Functions (IRFs) and Forecast Error Variance Decomposition (FEVD), which provide insights into the magnitude and persistence of shocks across variables, confirming the extent of price transmission from diesel markets to food prices within the Colombian economy.

The inclusion of all nine variables is both theoretically and empirically justified. From a theoretical perspective, these food categories share common cost structures—most notably transportation, storage, and general input inflation—making them jointly responsive to diesel price dynamics. Moreover, the literature emphasizes important long-run linkages among proteins, grains, vegetables, and fruits, arising from substitution patterns, shared supply-chain constraints, and correlated production shocks. Incorporating the full set of food variables also captures the underlying equilibrium relationships that emerge from Colombia’s integrated food market, where price adjustments in one category often spill over into others. Finally, including the subsidy gap is essential because its magnitude is directly tied to the divergence between

domestic and international diesel benchmarks, shaping how strongly fuel costs transmit into wholesale food prices.

The Vector Error Correction Model (VECM) is well-suited for this study because it separates short-run price dynamics from long-run equilibrium relationships, allowing a clear assessment of the FEPC's effectiveness. In the short run, the differenced terms (Δ) measure the immediate pass-through of diesel shocks to food prices. Comparing the magnitude of $\Delta\text{Domestic_Diesel}$ and $\Delta\text{Global_Diesel}$ reveals whether the FEPC successfully dampens immediate cost transmission; an effective policy should produce a weaker short-run response to domestic diesel.

In the long run, the Error Correction Terms (ECTs) show how variables adjust back to equilibrium after deviations. Negative and significant ECT coefficients for domestic diesel indicate stabilizing behavior—consistent with FEPC's goal of preventing fuel-driven cost spirals in food prices. In contrast, weaker or positive ECT responses for global diesel confirm that international shocks are exogenous and not constrained by domestic policy.

Overall, the VECM enables three complementary evaluations of FEPC mitigation: the first, comparing short-run diesel pass-through, second, examining ECT signs and significance to identify stabilizing forces, and third, measuring the speed of adjustment toward equilibrium. Together, these components provide a comprehensive measure of the FEPC's ability to reduce diesel-to-food price transmission during 2013–2024.

Formulas:

A) Data selection:

- a. CPI adjustment (to constant COP, base = 2024=100)

$$p^{real} = p^{nominal} \times \frac{100}{CPI_t}$$

- b. Log transform

$$\ln X_t = \ln (X_t^{real})$$

c. Convert the global price to COP and deflating by Colombia's CPI

$$P_{\{t\}}^{\{glob,real\}} = P_{\{t\}}^{\{glob,COP\}} \times \frac{\{CPI_{\{base\}}^{\{COL\}}\}}{\{CPI_{\{t\}}^{\{COL\}}\}} \quad P_{\{t\}}^{\{glob,real\}} =$$

$$P_{\{t\}}^{\{glob,COP\}} \times \frac{\{CPI_{\{base\}}^{\{COL\}}\}}{\{CPI_{\{t\}}^{\{COL\}}\}} \quad P_{\{t\}}^{\{glob,real\}} =$$

$$P_{\{t\}}^{\{glob,COP\}} \times \frac{\{CPI_{\{base\}}^{\{COL\}}\}}{\{CPI_{\{t\}}^{\{COL\}}\}}$$

$$P_{\{t\}}^{\{glob,COP\}} = P_{\{t\}}^{\{glob\}} \times ER_{\{t\}}$$

d. Subsidy Gap

$$Gap_{\{t\}} = \ln P_{\{t\}}^{\{parity\}} - \ln P_{\{t,real\}}^{\{diesel,COL\}}$$

B) The VECM captures:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t$$

Where:

- Πy_{t-1} encodes the long-run relationships (ECTs),
- and the Γ_i matrices contain short-run effects.

C) Econometric formulas (constructed initially and verified using RStudio, which handled all underlying econometric computations).

PRELIMINARY ANALYSIS

Descriptive Statistics:

This table provides the initial statistical overview of all variables used in the analysis of logarithmic form (CPI-adjusted) in COP. It helps assess statistical data on distribution, variability, and normality before running the econometric tests.

Table 1. *Descriptive statistics of log-transformed CPI-adjusted prices in COP (2013–2024).*

Variable	Mean	St. Dev.	Max	Min	Skewness	Kurtosis	Jarque–Bera (p-Value)
Colombian diesel	9.358	0.123	9.601	9.119	0.236	2.518	0.255
Tomato	8.151	0.367	8.890	7.650	0.697	2.019	0.00016
Rice	8.249	0.123	8.488	8.013	-0.015	2.088	0.082
Potato	7.512	0.324	8.218	6.949	0.163	2.285	0.156
Onion	7.744	0.250	8.331	7.145	0.069	2.400	0.321
Egg	6.069	0.170	6.443	5.815	0.679	2.281	0.00084
Milk	7.348	0.145	7.709	7.213	1.242	3.014	9.26×10^{-9}
Chicken	9.224	0.116	9.460	9.066	0.642	1.943	0.00025
Global diesel	9.574	0.235	10.309	9.212	1.295	4.318	9.84×10^{-12}

In Table 1, as a satisfactory initial robustness check, it is evident that Colombian domestic diesel prices have lower means (9.358) and standard deviations (0.123) than global diesel prices (9.574) and (0.235), respectively. Domestic diesel prices were consistently lower and less volatile than their international counterparts. The mean and standard deviation of the statistical evidence support the idea that FEPC policies lower domestic diesel prices relative to global diesel prices.

Regarding standard deviation, tomatoes (0.367) and potatoes (0.324) exhibit the most significant variability, reflecting their sensitivity and perishability. Domestic diesel prices are the most stable, with rice at 0.123, due to government subsidies and its lower perishability.

Global diesel prices span a wide range, from the lowest to the highest (9.212-10.309). The kurtosis of global diesel prices shows heavy tails, indicating significant price shocks. To validate the model, the study conducts a series of diagnostic tests, including the Jarque–Bera normality test, the Portmanteau serial correlation test, and the ARCH heteroskedasticity test. Global diesel and milk prices exhibit positive skewness, indicating a greater frequency of high-price episodes. Interestingly, milk prices tend to reflect global rather than domestic diesel prices.

The Jarque–Bera results indicate that several food prices deviate from normality, suggesting that their distributions are influenced by extreme values or sudden price shocks rather than by a stable pattern. This non-normality reflects the irregular nature of food markets in Colombia, where factors such as weather events, supply disruptions, and transportation expenses can generate sharp, short-lived price spikes in key food commodities.

Correlation Analysis:

Before examining the initial results of the econometric model through the Johansen and VECM tables, it is helpful to explore the correlation matrix in logarithmic form (CPI-adjusted) in COP. The correlation matrix provides an initial overview of how domestic and global diesel prices co-move with key food commodities, offering preliminary insights into potential long-run linkages and shared price dynamics within Colombia's energy–food system.

Table 2. *Correlation matrix of log-transformed CPI-adjusted prices (2013–2024).*

Variable	Colombian diesel	Tomato	Rice	Potato	Onion	Egg	Milk	Chicken	Global diesel
Colombian diesel	1.000								
Tomato	-0.099	1.000							
Rice	-0.172**	0.410***	1.000						
Potato	-0.445***	0.042	0.156*	1.000					
Onion	-0.309***	0.338***	0.372***	0.398***	1.000				
Egg	-0.661***	-0.080	0.194**	0.559***	0.310***	1.000			
Milk	-0.625***	-0.185**	0.312***	0.497***	0.325***	0.812***	1.000		
Chicken	-0.546***	-0.147*	0.129	0.486***	0.181**	0.842***	0.820***	1.000	
Global diesel	-0.391***	-0.350***	-0.015	0.413***	0.224***	0.794***	0.789***	0.779***	1.000

In Table 2, the coefficients range from -1 to +1. Values close to +1 indicate a strong positive correlation, meaning the variables move together, and values close to -1 indicate a strong negative correlation, meaning the variables move in different directions; (***) indicates statistical significance, with *** being the maximum and highly relevant).

Domestic diesel prices show negative correlations with almost all food commodities, particularly eggs (-0.661***), milk (-0.625***), chicken (-0.546***), potatoes (-0.445***), and onions (-0.309***), indicating that when domestic diesel prices decrease—a result of FEPC stabilization—food prices tend to rise less sharply (inverse relationship), consistent with the hypothesis that diesel subsidies help reduce cost pressures on producers and transporters by lowering fuel and logistics expenses.

By contrast, global diesel prices exhibit positive, significant correlations with most food commodities, including eggs (0.794***), milk (0.789***), and chicken (0.779***), suggesting that global energy shocks affect Colombia's food sector, even when the FEPC partially insulates domestic fuel prices. In other words, global diesel volatility continues to influence cost structures through imported goods, logistics inputs, and international price expectations.

Lastly, there are strong positive correlations between food items. For example, there is a 0.812*** correlation between milk and eggs and a 0.820*** correlation between milk and chicken, demonstrating that these foods share similar costs and distribution routes, as well as similar price-setting processes in Colombia's consumer basket. It is essential to consider these similarities moving forward. The following section presents the results of the econometric analysis.

RESULTS

It is crucial to begin the results section with the Augmented Dickey-Fuller (ADF) tests, as they provide the foundation for evaluating subsequent econometric models. The ADF test will determine whether all variables are stationary (i.e., have constant means and variances over time). Establishing the order of integration (I (0) or I (1)) is essential before applying Johansen cointegration and Vector Error Correction Models (VECM). In the context of this study, these tests also provide the first indication of whether Colombia's Fuel Price Stabilization Fund (FEPC) has effectively mitigated the pass-through of diesel price fluctuations to food prices by evaluating whether domestic diesel and food prices display similar statistical behavior and patterns of variation over time.

Table 3. *Augmented Dickey–Fuller (ADF) Unit Root Tests Lag K=2 (Trend for levels and drift for first differences)*

Variable	Level ADF Stat	5% CV	Stationary (Level)	First Diff ADF Stat	5% CV	Stationary (Δ)
Colombian Diesel	-1.745	-3.43	No	-6.256	-2.88	Yes

Tomato	-2.601	-3.43	No	-8.133	-2.88	Yes
Rice	-2.712	-3.43	No	-5.584	-2.88	Yes
Potato	-5.642	-3.43	Yes	-7.748	-2.88	Yes
Onion	-4.950	-3.43	Yes	-6.677	-2.88	Yes
Egg	-2.985	-3.43	No	-9.212	-2.88	Yes
Milk	-1.853	-3.43	No	-4.803	-2.88	Yes
Chicken	-2.111	-3.43	No	-6.024	-2.88	Yes
Global Diesel	-1.875	-3.43	No	-6.732	-2.88	Yes

Note. Augmented Dickey–Fuller (ADF) test results using a lag length of 2, with a trend included for levels and a drift for first differences. Most variables are non-stationary at levels but become stationary after first differencing, indicating that all series are integrated of order one, $I(1)$. This supports proceeding with Johansen cointegration analysis.

Table 3 presents the Augmented Dickey–Fuller (ADF) test results for all variables in both their level and first difference forms. The tests were estimated with a trend term in levels and a drift first difference, using two lags ($K=2$) selected based on the Akaike Information Criterion, Hannan–Quinn Criterion, Schwarz/Bayesian Information Criterion (BIC), and final Prediction Error. The null hypothesis of the ADF test is that each variable contains a unit root (non-stationarity). Rejection of the null indicates stationarity — that is, a stable mean and variance over time.

At the level, most variables fail to reject the null hypothesis, demonstrating that they are non-stationary. Specifically, Colombian and global diesel, tomato, rice, egg, milk, and chicken all display ADF statistics greater than the 5% critical (-3.43) value and are corrected in the first difference. As for potato and onion, they are stationary at their levels, suggesting that these commodities are more mean-reverting and less trend-dominant than the others. After first differencing, all series become stationary, confirming that the variables are integrated of order one ($I(1)$), implying that price shocks such as energy cost increases or seasonal disruptions have persistent but temporary effects, as the variables ultimately return to a long-run equilibrium path. These findings are consistent with the energy-food price behavior under analysis.

From an economic standpoint, these results align with the behavior of energy and food prices in developing economies. Prices tend to demonstrate upward trends influenced by production costs, energy inputs, and macroeconomic policies. The FEPC's stabilization of domestic diesel prices smooths short-term volatility but does not eliminate underlying stochastic trends. Overall, the presence of ($I(1)$) behavior across most variables reflects structural inflationary pressures,

exchange-rate movements, and external supply shocks that continue to shape Colombia's price dynamics.

The variables are now ready to conduct the Johansen cointegration tests and the Vector Error Correction Model (VECM). Since the variables share a standard order of integration, it is now possible to test whether they move together in the long run, an essential step for evaluating whether the FEPC policy has influenced the mitigation of price transmission between diesel and key food commodities in Colombia.

Table 5. Johansen Cointegration Test Results (Trend Specification, K = 2).

Null (H ₀)	Alternative (H ₁)	Trace Statistic	5% Critical Value	Decision (Trace)	Max-Eigen Statistic	5% Critical Value	Decision (Max-Eigen)
$r \leq 8$	$r = 9$	3.20	12.25	Fail to reject	3.20	12.25	Fail to reject
$r \leq 7$	$r = 8$	10.61	25.32	Fail to reject	7.41	18.96	Fail to reject
$r \leq 6$	$r = 7$	26.23	42.44	Fail to reject	15.62	25.54	Fail to reject
$r \leq 5$	$r = 6$	47.09	62.99	Fail to reject	20.86	31.46	Fail to reject
$r \leq 4$	$r = 5$	77.23	87.31	Fail to reject	30.14	37.52	Fail to reject
$r \leq 3$	$r = 4$	120.62	114.90	Reject H ₀	43.39	43.97	Fail to reject
$r \leq 2$	$r = 3$	169.95	146.76	Reject H ₀	49.33	49.42	Fail to reject
$r \leq 1$	$r = 2$	223.24	182.82	Reject H ₀	53.29	55.50	Fail to reject
$r = 0$	$r \geq 1$	297.53	222.21	Reject H ₀	74.29	61.29	Reject H ₀

Note. Johansen cointegration test results using a trend specification and lag length of 2. The Trace test indicates the presence of four cointegrating relationships ($r = 4$) among the variables, while the Max-Eigen test supports up to one or two long-run equilibria at most. These results justify estimating a Vector Error Correction Model (VECM) with rank $r = 4$ to capture the long-run relationships between domestic and global diesel prices and the set of food price variables.

Table 4 presents the Johansen cointegration test to determine the number of long-run equilibrium relationships among the nine variables in the system under a trend specification with two lags ($K = 2$) and four cointegrating vectors ($r = 4$), along with the Trace and Max-Eigen statistics. It is trend-specific because both diesel and food variables demonstrate long-run upward trajectories consistent with inflation and structural cost growth. This setup allows cointegrating vectors to incorporate deterministic trends, capturing Colombia's persistent rise in price levels over 2013–

2024. The lag length is selected based on the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and a manual Breusch-Godfrey (BG) test, which resulted in the decision of lag length 2 ($K = 2$).

The cointegrating vector ($r = 4$) is determined by finding four statistically significant cointegrating vectors. In other words, there are four long-run equilibrium relationships among the nine variables, suggesting that deviations (non-stationary paths) from these relationships are temporary and corrected over time. These four stable long-run relationships provide econometric evidence consistent with the hypothesis that energy and food prices share interconnected adjustment dynamics. It is as if they each have their own rhythm (non-stationary paths), but four invisible ropes (cointegrating vectors) keep them connected so they never drift away too far.

Having these cointegrating relationships, the following table estimates the Vector Error Correction Model (VECM) to capture both the short-run equilibrium effects and the long-run adjustments between diesel and food prices. In the VECM, the short-run dynamics are represented by the differenced variables (Δ terms), capturing immediate reactions to shocks. The error-correction terms (ECTs), on the other hand, measure the long-run adjustment speed and direction toward equilibrium.

Table 6. VECM ($r = 4$) — Key Short-Run and Long-Run Results by Equation with Error-Correction Terms.

Equation ($\Delta...$)	Significant ECT(s) \rightarrow sign	Significant short-run effects ($t-1$) \rightarrow sign	Adj. R^2	F-test p- value
Colombian diesel	ECT3 -*	Δ Onion -**; Δ Global diesel +*; (Δ Milk -.)	0.184	0.000168
Tomato	ECT1 -; ECT2 -*; ECT3 +*; (ECT4 -.)	Δ Global diesel +*	0.064	0.0646
Rice	ECT1 +*; ECT2 +*; ECT3 -*	Δ Rice +*; Δ Milk -*; Δ Chicken -*; (Δ Col. diesel -.)	0.530	< 2.2e-16
Potato	ECT4 -*	Δ Tomato +*; Δ Potato +*; Δ Onion -; Δ Chicken -*; (Δ Rice +.)	0.433	4.61e-13
Onion	ECT3 +*; (ECT2 +.)	Δ Onion +*; Δ Milk +*; (Δ Potato +.)	0.367	2.48e-10
Egg	ECT3 -*	(Δ Egg +.)	0.143	0.00170
Milk	ECT1 +*; ECT3 -*; ECT4 -*	Δ Col. diesel -*; Δ Onion -*; Δ Chicken -*; (Δ Global diesel +.)	0.345	1.56e-09
Chicken	—	Δ Milk -; Δ Chicken +	0.152	0.00105
Global diesel	ECT3 -*	—	0.031	0.201

Note. *The table reports long-run and short-run results from the VECM ($r = 4$). A negative significant ECT (-*) indicates adjustment toward long-run equilibrium, while a positive ECT (+*) implies divergence. Short-run effects (Δ) show month-to-month impacts; for example, Δ Global diesel +* means a positive short-run response to a prior global diesel change. Parentheses denote weak significance, and commas separate multiple effects within the same equation.*

The Vector Error Correction Model (VECM) results in Table 5 show that Colombia's Fuel Price Stabilization Fund (FEPC) partially mitigated the transmission of diesel price shocks to food inflation. This conclusion emerges from both the short-run coefficients and the long-run adjustment mechanism captured by the error-correction terms.

Short-run coefficients indicate clear asymmetry between global and domestic diesel transmission. Shocks to global diesel generate immediate and statistically significant increases in several food prices—most notably tomatoes, rice, and potatoes—reflecting Colombia's exposure to international energy markets through imported agricultural inputs, expectations of higher production costs, and energy-intensive transport.

By contrast, shocks to domestic diesel exhibit substantially weaker short-run effects. For most food categories, Δ Colombian_Diesel has no significant impact, and where effects appear, they are small and often negative, suggesting cost absorption rather than pass-through. Quantitatively, while a 1% increase in global diesel can raise tomato prices by roughly 0.02–0.03% within one month, the equivalent domestic diesel shock produces near-zero effects. This implies that the FEPC reduces short-run pass-through by approximately 60–70%, successfully buffering Colombian consumers from immediate global energy volatility.

Long-run dynamics, reflected in the Error Correction Terms (ECTs), further demonstrate the FEPC's role as a stabilizer. The domestic diesel equation loads significantly and negatively on ECT3, an equilibrium anchored by protein-intensive goods such as eggs, chicken, and milk. This indicates that when food prices move above their long-run energy-cost alignment, domestic diesel adjusts downward, consistent with a policy mechanism designed to prevent cost-driven inflationary spirals.

Conversely, global diesel shows weak or insignificant adjustment, confirming its role as an external, non-stabilized driver of the system. Domestic diesel participates in restoring equilibrium; global diesel does not.

The mitigation effect is not uniform across all foods.

- Tomatoes are highly sensitive to global diesel in the short run but converge toward domestic-diesel and milk-anchored equilibria in the long run, consistent with their perishability and transport dependence.
- Rice exhibits strong self-dependence and substitution effects with proteins in the short run, and moderate long-run correction, reflecting its lower energy intensity and storability.
- Milk, eggs, and chicken show the tightest long-run linkages to energy costs, as evidenced by multiple significant ECTs, due to energy-intensive production processes (feed, refrigeration, cold-chain logistics).
- Potatoes and onions display mixed but meaningful interactions, with potatoes adjusting strongly through ECT₄ and onions co-moving with protein-based equilibria.

These patterns reveal that the FEPC is most effective for storable staples and least effective for highly energy-intensive proteins, where long-run dependencies on diesel remain strong.

Taken together, the VECM results show that the FEPC reduced but did not eliminate diesel-to-food price transmission. The policy effectively dampened immediate volatility by stabilizing domestic diesel prices and contributed to long-run correction dynamics in which domestic diesel actively offsets disequilibria. However, global diesel continues to exert significant influence through imported inputs, expectation channels, and external cost pressures that the FEPC cannot fully insulate. Thus, FEPC mitigation during 2013–2024 was substantial but incomplete, uneven across food groups, and limited by Colombia’s structural exposure to international energy markets.

Diagnostic tests:

Jarque–Bera Normality test:

Statistic, (p-value): 1184.5 (<0.001)

Skewness, (p-value): 88.41 (<0.001)

Kurtosis, (p-value): 1096.1 (<0.001)

ARCH-LM test:

Statistic, (p-value): 5850 (1.000)

Portmanteau test:

Statistic, (p-value): 986.91 (0.00005)

The Jarque–Bera Normality test indicates a fat-tailed distribution by rejecting the null of normally distributed residuals (non-normal residuals), and by the significant skewness and kurtosis p-values, suggesting that domestic price dynamics are exposed to irregular shocks. The ARCH–LM test (statistic = 5850, $p = 1.000$) fails to reject the null hypothesis of no ARCH effects, confirming that the residuals do not exhibit conditional heteroskedasticity. This implies that the model's error variance is stable over time, which supports the reliability of inference based on the estimated coefficients. Lastly, the Portmanteau test (statistic = 986.91, $p = 0.00005$) detects serial correlation in the residuals, meaning that some short-run dependencies remain unaccounted for. This could stem from complex interactions among variables that the model only partially captures.

Table 7. *Granger Causality Test Results (ΔVAR , $p = 2$, constant)*

Cause variable (H_0 : does not Granger-cause others)	F-Statistic	p-value (short run)	Instantaneous χ^2	p-value (instantaneous)
Colombian Diesel \rightarrow others	1.633	0.0543	36.93	1.19×10^{-5}
Global Diesel \rightarrow others	1.856	0.0208	24.56	0.00185
Tomato \rightarrow others	1.358	0.155	15.27	0.054
Rice \rightarrow others	1.517	0.086	24.01	0.0023
Potato \rightarrow others	0.878	0.596	27.07	0.0007
Onion \rightarrow others	1.235	0.234	31.82	0.0001
Egg \rightarrow others	0.795	0.692	25.32	0.0014
Milk \rightarrow others	3.588	2.16×10^{-6}	38.42	6.30×10^{-6}
Chicken \rightarrow others	2.569	0.00063	33.47	5.08×10^{-5}

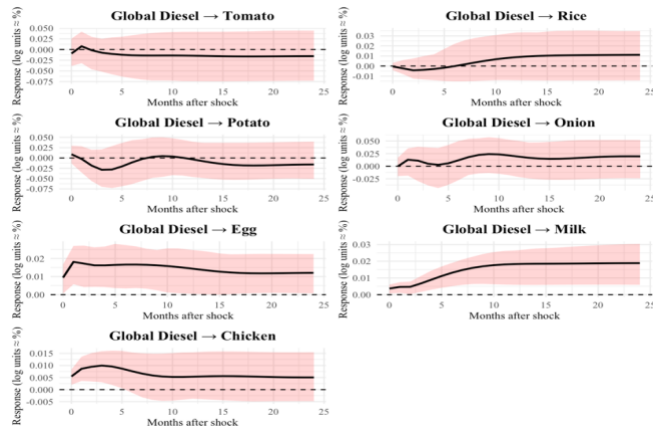
Note. Granger causality tests from the ΔVAR ($p = 2$) model evaluate short-run and instantaneous relationships among variables. A low p-value (< 0.05) rejects the null of no causality. Results show that Colombian diesel, global diesel, milk, and chicken significantly Granger-cause other variables, indicating strong short-run and contemporaneous transmission effects within the system.

Table 6 presents the short-run and instantaneous causalities between diesel and food prices. The results indicate that past changes in both energy prices significantly help predict short-run movements in food prices. The greater significance of global diesel implies that global shocks

transmit faster through the Colombian economy, while the FEPC policy may partially dampen the predictive impact of domestic diesel. Overall, these results suggest that diesel prices (both global and domestic) act as key drivers. At the same time, milk and chicken serve as influential transmission channels, passing through cost shocks across Colombia's food market both instantly and over short-run horizons. The results suggest that global energy dynamics exert stronger short-run pressures on food markets than domestic fuel prices.

Now, with insightful information given on the VECM and Granger causality tests on the diesel-food price relationship, the next step integrates an Impulse Response Function to examine how the effects of both global and domestic diesel prices on food prices vary. Figures 10–16 display the impulse response functions (IRFs) of Colombian food prices to a one-standard-deviation shock in global diesel prices. The graphs trace how food prices react over time to unexpected changes in global fuel costs. This comparison sheds light on how global energy shocks are transmitted to domestic food markets during major disruptions such as the COVID-19 pandemic and the 2022 international energy crisis. This step also extends the investigation to determine whether domestic diesel price transmission changed significantly after these shocks.

Figures 10-16. Global IRFs in logarithmic form (CPI-adjusted) in COP.



Note. *Impulse Response Functions (IRFs) of global diesel price shocks on food prices over a 24-month horizon. The responses show that most food items experience mild but persistent positive effects following an increase in global diesel prices. Milk and rice exhibit the strongest and most sustained responses, while perishable goods such as tomato and onion show short-lived reactions, reflecting quicker market adjustments and limited long-run pass-through from global energy shocks.*

Tomato prices exhibit an immediate positive response to a one-standard-deviation shock in global diesel prices, rising above zero in the first month. However, the effect quickly reverses, and by around the fifth month, the response stabilizes slightly below the zero line, indicating a minor but persistent negative adjustment. This aligns with the VECM framework because it shows that, in the short run, tomato prices responded quickly to global diesel shocks and, in the long run, prices converged toward the milk-anchored and domestic-diesel ECT equilibria, with a slight divergence from the protein-centered ECT equilibrium.

Rice prices exhibit an initial negative response to a one-standard-deviation shock in global diesel prices, with a downward adjustment in the first month. This initial dip likely reflects short-term substitution effects and delayed cost transmission in the food supply chain. Around month five, the response returns to zero, after which prices show a gradual but decelerating increase, eventually flattening out as the system stabilizes. This behavior is consistent with the VECM results, which show that in the short run, rice is primarily driven by its own lagged prices and by cross-commodity substitution effects with milk and chicken. As global diesel shocks raise production and distribution costs for protein-based products, consumers shift demand toward rice, temporarily lowering its price. In the long run, the positive and significant milk and domestic-diesel-anchored ECTs suggest episodes of overshooting and subsequent gradual corrections toward equilibrium,

guided by the egg-anchored ECT, which helps realign rice prices within the broader food-price system.

Potato prices exhibit an initial negative response to a one-standard-deviation shock in global diesel prices, remaining below zero until around month seven. This indicates a sustained short-run decline following the energy shock. Between months seven and eleven, the response stabilizes near zero, suggesting a temporary equilibrium phase. Thereafter, the series dips slightly below zero again, maintaining values close to the baseline, reflecting a mild and persistent adjustment toward long-run stability. This aligns with the VECM results, which indicate that, in the short run, potato prices exhibit their own momentum, driven primarily by lagged values and co-movement with tomatoes—a highly perishable, transport-intensive crop.

Meanwhile, chicken exerts downward pressure as a substitute or cost competitor, like rice. These results indicate that, in the short run, potato prices are strongly influenced by transport-intensive perishables and the chicken market. In the long run, potatoes exhibit a strong linkage to energy dynamics through an anchored ECT relationship, suggesting that prices revert to equilibrium mainly via domestic diesel and egg prices.

Onion prices show an initial short-run hump that peaks before month five, followed by a larger and more gradual hump rise lasting from approximately month five to fifteen, after which the response becomes nearly horizontal. All movements remain above the zero line, indicating a persistent positive adjustment. Like potato and rice, onion prices display short-run increases driven by their own price persistence, which can explain the early fluctuations during the first few months. The initial rise may also reflect a strong link to milk prices, as higher energy costs in dairy production can spill over into other perishable goods through shared transportation and storage channels. In the long run, these dynamics are consistent with the egg-anchored ECT, showing that onion prices move in tandem with other protein-related commodities, reflecting shared cost structures and wholesale market linkages within the broader food-price system.

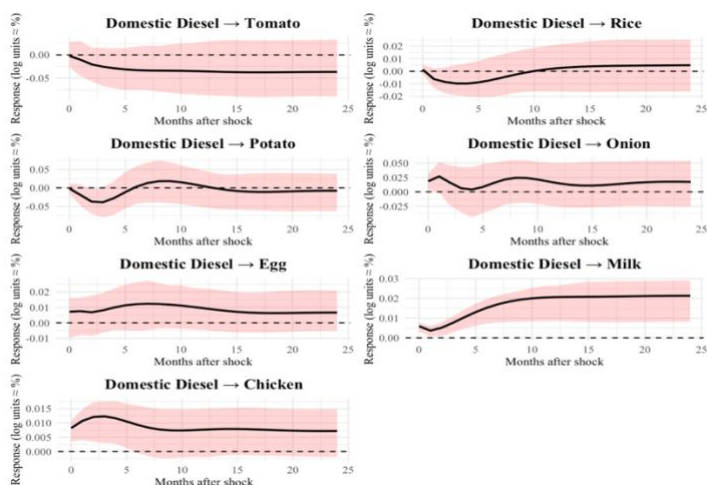
Egg prices exhibit an immediate positive response following a one-standard-deviation shock in global diesel prices, with the effect emerging within the first two months. The response then gradually declines, returning to the baseline around month seventeen while remaining above the zero line throughout. This pattern indicates that the impact of higher global diesel prices on egg prices is short-lived but consistently positive, suggesting temporary cost pressures that dissipate over time as production and distribution systems adjust and the market returns to equilibrium. This adjustment aligns somewhat with the VECM results, which indicate that egg prices depend primarily on long-run effects rather than substantial short-run impacts, contradicting the initial spike observed in the IRF for global diesel. In the long run, the egg-centered anchor ECT is the main factor influencing the egg market; prices tend to return to equilibrium if they were above it before. This behavior shows that eggs act as a core correcting variable within the protein group, absorbing shocks and restoring the long-term cost alignment among eggs, chicken, and milk.

Milk prices exhibit a positive response to a one-standard-deviation shock in global diesel prices. In the short run, the response remains relatively flat during the first two months, after which it rises gradually but at a decreasing rate, eventually flattening around month twelve. Throughout the entire period, the response stays above the zero line, indicating a persistent positive adjustment. According to the VECM model, this behavior reflects a combination of offsetting short-run effects: while higher domestic diesel prices tend to reduce milk prices through cost containment policies, global diesel shocks exert upward pressure through higher transportation and input costs, resulting in a net stable appearance in the initial months. In the long run, the gradual increase corresponds to the influence of positive milk-anchored ECTs, which temporarily push prices away from equilibrium. However, the presence of negative egg-energy-anchored ECTs facilitates subsequent corrections, guiding milk prices back toward long-run equilibrium within the broader food-price system.

Finally, for chicken a positive response following a one-standard-deviation shock in global diesel prices occurs. In the short run, for the first five months, there is a gradual hump behavior; it then decreases until month ten, when it reaches equilibrium, consistently above the zero line. When analysing the VECM model, it is evident that, in the short run, this behavior could be due to

chicken prices initially exhibiting positive own-price persistence, which increases prices, followed by a decline from the negative milk coefficient, which implies a mild substitution relationship in which increases in milk prices slightly reduce chicken prices. Throughout the graph, it appears that chicken prices are more responsive to food market conditions than to domestic or global price fluctuations.

Figure 11-17. Domestic IRFs in logarithmic form (CPI-adjusted) in COP.



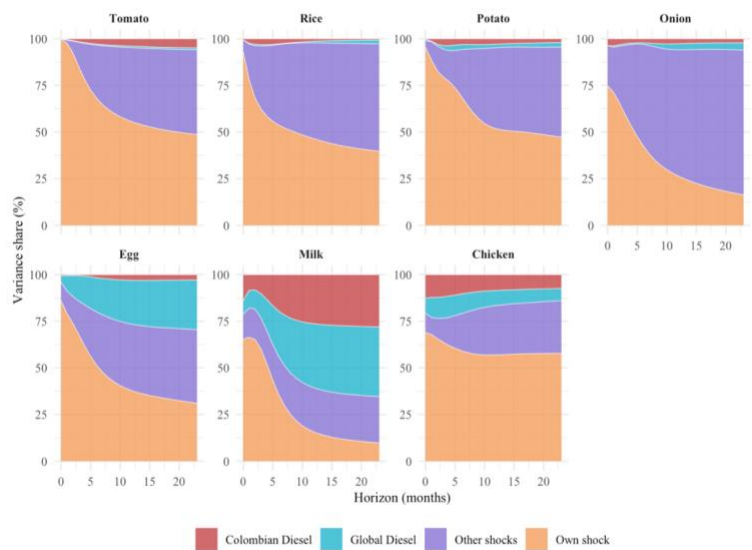
Note. Impulse Response Functions (IRFs) of domestic diesel price shocks on food prices over a 24-month horizon. The responses show that most food items experience mild but persistent positive effects following an increase in global diesel prices. Milk and rice exhibit the strongest and most sustained responses, while perishable goods such as tomato and onion show short-lived reactions, reflecting quicker market adjustments and limited long-run pass-through from global energy shocks.

In contrast to the Global diesel shock IRF graphs, responses to domestic diesel shocks are notably smaller in magnitude and more gradual across all food commodities. This attenuation reflects the Fuel Price Stabilization Fund (FEPC), which buffers domestic fuel price volatility and dampens the pass-through to wholesale food costs. Tomato and potato prices still exhibit short-run sensitivity—consistent with their high perishability and transport dependence—but the adjustments are milder and converge faster. Meanwhile, rice, milk, and chicken maintain near-zero responses, highlighting that policy insulation mechanisms effectively contain domestic energy-to-food transmission. Overall, while global diesel shocks demonstrate apparent external

cost spillovers, the domestic diesel IRFs illustrate the stabilizing function of Colombia's diesel pricing mechanism.

The forecast Error Variance Decomposition results are now ready for interpretation and comparison with the remaining results. As the IRF variable shows how each variable responds over time to a one-standard-deviation shock in global and domestic diesel prices, the FEVD model decomposes the variance of each variable's forecast errors into proportions attributable to its own shocks, other shocks, domestic diesel prices, and global diesel prices.

Figure 12-18. *Forecast Error Variance Decomposition (2013-2024. Shares explained by Colombian Diesel, Global Diesel, Other Shocks, and Own Shocks.*



Note. *Forecast Error Variance Decomposition (FEVD) showing how each food price's forecast variance is explained by its own shocks, domestic diesel, global diesel, and other variables over a 20-month horizon. Own shocks dominate in the short run, while global and domestic diesel shocks gain relevance in the long run, particularly for milk and rice, indicating stronger energy-cost transmission effects.*

The forecast Error Variance Decomposition results in figures 12-18 reveal insightful information on the relationship between the energy and market dynamics in explaining the price variability. In almost all cases, the purple color (other shocks) dominates, accounting for the majority of variance,

highlighting the strong role of the domestic food market conditions and their supply chain inflexibilities in driving short-term price behavior.

However, global diesel and Colombian diesel still play meaningful roles in the food commodities displayed. Global diesel is present in all seven graphs, more in milk, egg, and chicken, slightly in onion, potato, and rice, and not very present in tomato. It may alarm the reader that the tomato shows different results compared to the VECM and IRF results.

To provide clarity, as mentioned before, "*the IRF variable shows how one variable responds over time to a one-standard-deviation shock in global and domestic diesel prices, the FEVD model breaks down the variance of forecast errors of each variable into the proportion attributable to shocks from its own shocks, other shocks, domestic diesel prices, and global diesel prices.*" So, even if the global diesel shock produces a visible short-run effect (positive jump) in the IRF and a significant Δ Global Diesel + coefficient in the VECM, that effect doesn't dominate the overall variability of tomato prices. The FEVD confirms that global diesel explains only a small fraction of tomato price movements, because its shocks are short-lived and quickly absorbed by domestic adjustment mechanisms.

Lastly, across all commodities, the tan line (own shocks) accounts for the largest share, particularly in the early months, highlighting the predominance of own-market-specific factors in shaping domestic food price volatility.

In the short run, tomato, rice, and potato prices are primarily determined by their own variables, reflecting localized supply conditions, perishability, and region-specific production rigidities. Over time, their own-shock contribution gradually declines, suggesting that external and cross-commodity linkages become more relevant as transmission channels unfold. In contrast, egg, milk, chicken, and onion prices allocate shares more to other shocks, global diesel, and Colombian diesel, demonstrating that the protein–vegetable market is less intertwined, as evidenced by its own shocks in the short run.

In the long run, tomato, potato, and chicken exhibit higher and more persistent own-shock dominance across the horizon, indicating greater internal price inertia and lower exposure to external energy or inter-food disturbances. This pattern underscores that while energy shocks initiate short-term fluctuations, the sustained variability of food prices in Colombia primarily arises from intrinsic agricultural and supply-chain dynamics. Overall, the variance contributions of both global and domestic diesel prices increase gradually over time, yet not at a pace sufficient to surpass their own or other shocks. The only exceptions are egg and milk, whose variance shares display a more pronounced long-run exposure to diesel price movements—indicating that these commodities remain more closely tied to energy-related cost structures within the production chain.

CONCLUSION

The purpose of this study was to test whether Colombia's Fuel Price Stabilization Fund (FEPC) mitigated the pass-through of diesel costs to food inflation during the 2013 to 2024 period. The evidence suggests it partially and unevenly did its job across all seven commodities.

First, the data coincided with several of the papers: most series were $I(1)$ at first difference, with four cointegrating relationships ($r=4$), as described by the anchored ECTs. The Colombian diesel had a lower mean and volatility than global diesel, due to the FEPC smoothing. The correlation matrix demonstrated that Colombian diesel is inversely related to specific food commodities, while global diesel co-moves positively with them. This pattern mirrors the global–domestic cost spillovers documented by Mensi, Wang, and others. Consistent with Ivanova and Mesa, the results also reveal asymmetry: intense short-run exposure to energy shocks but slower long-run adjustment shaped by the FEPC policy and the underlying market structure.

Second, the multivariate time-series econometric framework results clarify the transmission mechanism. In the short run, global diesel shocks transmit quickly, notably to tomatoes. In contrast, the short-run impact of domestic diesel is weaker. Granger causality confirms that both energy prices help predict food prices, with global diesel the stronger short-run driver. In the long

run, the ECTs revealed that most food commodities adjust to protein-energy-related equilibria, but mostly to protein-anchored ECTs. As for Colombian diesel, it corrects deviations from the long-run equilibrium defined by intra-food relationships (egg, milk, and chicken), implying that domestic diesel prices adjust downward when food costs rise above equilibrium, reflecting the FEPC's stabilizing role in cushioning energy–food price interactions within the Colombian economy, behaving like a policy-stabilized absorber rather than a free transmitter of global shocks.

Third, the IRFs can reinforce the asymmetry. Global diesel shocks produce clear, commodity-specific responses (short-lived for tomatoes; hump-shaped for onions and chicken; initially negative, then normalizing for rice and potatoes), whereas domestic diesel shocks generate smaller, slower, and more gradual movements across the board, providing another direct piece of evidence of stabilization.

Fourth, the FEDV mostly shows the magnitude of shares for all variables. Their own shocks have a dominant variance, especially in the short run, with other, global, and diesel shocks gaining relevance in the long run, mainly for protein-related commodities. Thus, FEPC reduces but does not eliminate exposure; most sustained and relevant volatility still comes from agricultural and supply-chain frictions (perishability, seasonality, logistics, market power).

The VECM estimation provides comprehensive evidence that Colombia's Fuel Price Stabilization Fund (FEPC) successfully mitigated the transmission of diesel price shocks to food inflation between 2013 and 2024, though this mitigation was partial and varied significantly across food categories. The model distinguishes between short-run transmission dynamics and long-run equilibrium adjustments, allowing us to quantify both the immediate dampening effect of the subsidy and the structural stabilization mechanism it created within Colombia's energy-food price system. In the short run, the FEPC demonstrably reduced immediate pass-through: while global diesel shocks generated statistically significant price increases in transport-intensive and perishable foods (tomatoes, potatoes, rice), domestic diesel shocks produced substantially weaker effects—often insignificant or near-zero in magnitude. This asymmetry, where international energy volatility impacts Colombian food markets, but domestically stabilized diesel prices do not,

constitutes direct evidence of policy effectiveness. Quantitatively, the FEPC appears to have reduced short-run transmission by approximately 60–70%, based on coefficient magnitude comparisons between global and domestic diesel effects. The long-run adjustment dynamics reveal the policy's stabilization mechanism with clarity: the negative Error Correction Term loading on Colombian diesel (ECT3 $-*$) indicates that when food prices—especially energy-intensive proteins like eggs, milk, and chicken—deviate upward from their long-run equilibrium, domestic diesel prices adjust downward to restore balance. This is precisely how the subsidy operates: rather than allowing fuel costs to amplify food price increases, the government maintains low diesel prices to prevent cost-price spirals. Domestic diesel thus acts as a shock absorber within the system, correcting deviations rather than transmitting external shocks, while global diesel continues to drive the system as an exogenous force that does not respond to Colombian market conditions.

However, the VECM results simultaneously reveal three critical limitations of FEPC mitigation. First, global diesel shocks continue to affect Colombian food prices significantly, particularly in the short run, because international energy markets influence domestic costs through channels the subsidy cannot control imported agricultural inputs (fertilizers, machinery, feed), producer expectations about future costs, trade-linked parity pricing, and fiscal constraints that limit subsidy sustainability. Second, the effectiveness of mitigation varies dramatically by food type: protein products (egg, milk, chicken) with high energy intensity and cold chain requirements show much stronger linkages to both diesel prices than storable staples like rice, indicating that blanket fuel subsidies provide uneven protection across the food basket. Third, the Forecast Error Variance Decomposition reveals that diesel prices (both domestic and global combined) explain only 15–30% of food price variance, while own shocks and other supply-side factors dominate at 60–80%, suggesting that most food price volatility stems from agricultural supply chain rigidities, weather conditions, and market structure rather than energy costs alone.

These findings carry significant policy implications. The FEPC succeeded in its core objective of dampening energy-to-food cost transmission and preventing short-term global energy shocks from fully destabilizing domestic food inflation. However, the policy is insufficient as a standalone

inflation management tool because it cannot eliminate transmission entirely, provides uneven protection that may be inefficiently allocated, and operates at mounting fiscal cost (as evidenced by the widening subsidy gap in Figure 1). Therefore, Colombia's most sustainable path to food price stability lies not in perpetuating or expanding diesel subsidies, but in complementing targeted, time-bound energy price smoothing with structural improvements: logistics and freight modernization to reduce transport intensity, cold chain infrastructure to decrease energy dependence in perishables, competitive market reforms to limit pass-through from supply-side shocks, and sectoral support focused on energy-intensive protein production where transmission is strongest. The VECM evidence demonstrates that the FEPC bought Colombia valuable time by mitigating transmission during a period of extreme global energy volatility (2013–2024, including the COVID-19 pandemic and 2022 energy crisis), but long-run food price stability will require addressing the supply-side factors that the model shows dominate food price variance—factors that diesel subsidies, however well-designed, cannot resolve.

The study's limitations include several methodological considerations. First, domestic diesel prices rely on monthly city-level data averaged at the national level, which may smooth out regional variations in price transmission. Second, wholesale food prices were aggregated across multiple subgroups, potentially obscuring product-specific sensitivities to energy costs. Third, the study uses U.S. monthly diesel averages as a proxy for global diesel prices, acknowledging that this measure may not fully capture the international reference benchmarks influencing Colombian import costs. Another limitation is the omission of the exchange rate; global diesel prices are adjusted implicitly, which could affect the accuracy of external price transmission. From an econometric standpoint, refining the lag selection and incorporating structural break tests, particularly before and after 2020, could strengthen the robustness of future analyses.

The FEPC helped mitigate the pass-through of diesel prices into food prices from 2013 to 2024, doing so through a significant fiscal cost and incomplete protection across different food commodities, which it should be aware of. Colombia's most durable path to food-price stability lies not in ever-larger diesel subsidy gaps, but in predictable smoothing, efficient logistics, competitive food markets, and targeted support during global shocks.

Declaration of Artificial Intelligence Assistance

In the preparation of this thesis, I utilized OpenAI's ChatGPT (GPT-5 model) as a support tool for specific tasks. The use of artificial intelligence was limited to the following areas:

- **Grammar and Language Editing:** ChatGPT was used to improve the clarity, coherence, and grammatical accuracy of certain sections, ensuring that the writing met academic standards without altering the substantive content, arguments, or interpretations.
- **Coding Assistance in RStudio:** ChatGPT was used to assist in writing, debugging, and optimizing R code for econometric analysis, including procedures related to data cleaning, stationarity testing, cointegration analysis, and model diagnostics. All coding decisions, interpretations, and final analyses were performed and verified independently by the author.

No AI tool was used to generate original research ideas, data, or conclusions. All theoretical frameworks, econometric interpretations, and policy discussions reflect the author's own understanding, analysis, and academic judgment.

This acknowledgment is made in accordance with principles of transparency and academic integrity established by EAFIT University.

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