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Retail Gasoline Price Pass-Through to Monthly Inflation Before and After the COVID-19 Pandemic

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Abstract:

This paper examines the influence of U.S. gasoline price fluctuations on the CPI before and after the pandemic, focusing on the short period and long run pass-through of gasoline prices to the inflation. Using an ARDL-UECM model to analyze 182 sets of monthly data from 2010 to 2025, this study aims to estimate gasoline prices' short-term impact on CPI and their long-term equilibrium. Subsequently, by setting step dummy variables, it compares the COVID-19 pandemic's effect on this pass-through effect and whether structural changes occurred. Three core conclusions emerge: First, a significant and statistically robust long-term pass-through exists from gasoline price fluctuations to CPI. A 1% increase in gasoline prices raises the CPI by 0.37%. Second, the error correction model indicates there are temporary deviations from long run equilibrium in temporary phenomena that will be corrected at a rate of 1.48% per month. Finally, the study finds that the pandemic shock caused a structural increase in the price level, shifting the long-run equilibrium of the CPI upward by 13.0% post-pandemic. This suggests that the pandemic's impact did not stop at short-term effects but brought about broader long-term changes.

Keywords: Gasoline Price; Inflation, ARDL; Pass-Through.

1. Introduction

In recent years, retail gasoline prices have experienced significant volatility due to the COVID-19 pandemic, corresponding policy adjustments, as well as other factors such as problems caused by supply chain. This volatility, closely monitored by gasoline consumers, translates into impacts on the CPI. Research indicates that for countries with low petroleum dependency, domestic inflation is directly influenced by fluctuations in oil prices. Conversely, for highly petroleum-dependent nations, the impact of oil price changes on inflation manifests through their effect on exporters' production costs [1]. Research findings indicate that energy price shocks and aggregate supply factors are the primary drivers behind the shift in euro area inflation since the post-pandemic recovery

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[2]. Compared to other upstream indicators like crude oil, changes in retail gasoline prices occur more frequently, are more directly observable, and transmit more rapidly. The research demonstrates that using crude oil prices as an indicator underestimates inflation passthrough, whereas retail fuel prices reveal a stronger transmission effect [3]. And compared to existing research, there is a lack of study analyzing whether the oil price-CPI transmission mechanism underwent systemic changes before and after the pandemic or constructing relevant predictive models. Combining these reasons, this paper will use gasoline prices and CPI indicators as its core focus, incorporating other control variables to build a predictive model and analyze its predictive reliability and value. Firstly, this study aims to quantify the impact of gasoline prices on the CPI. It approaches this from two perspectives: the dynamic effects that happened in a short period and the estimated long run equilibrium. Secondly, it seeks to measure the speed and magnitude of gasoline price pass-through effects. Finally, the empirical results will be analyzed to test whether these dynamic relationships underwent structural changes under the pandemic shock.

2. Data and Empirical Model

In this section of the study, the sources and rationale for selecting the relevant variables will first be introduced. Then, the empirical model will be presented. Finally, descriptive statistics for the data used will be provided.

2.1 Variable Introduction

All data in this paper are sourced from the FRED database, uniformly utilizing unadjusted monthly data (Not Seasonally Adjusted, NSA) spanning the period from July 1, 2010, to July 1, 2025, comprising a total of 182 observations [4]. This approach ensures consistent data standards while maximizing coverage of the complete sample range encompassing the post-pandemic era and periods of heightened geopolitical risks. In the empirical analysis, we transform the raw data into logarithmic form to better observe rates of change.

2.1.1 Dependent Variable

This paper selects the natural logarithm of the consumer price index data in the US (CPIAUCSL in FRED) as the CPI indicator (denoted as lcpi) [5]. This index sets the average price level for 1982-1984 at 100. For example, an index of 130 indicates a price level 30% higher than the base period. To align with unadjusted gasoline prices, this paper also employs the unadjusted CPI.

2.1.2 Independent Variable

This paper selects the natural logarithm of the average gasoline price (lgasoline), represented by the average price of unleaded regular gasoline in U.S. cities, in dollars per gallon (FRED code: APU000074714) [6]. It predicts this variable will be positive, as rising gasoline prices directly increase residents' living costs, particularly in transportation and commuting.

2.1.3 Control Variables

This paper selects the natural logarithm of the Nominal Broad U.S. Dollar Index (lusd) as a control variable [7]. The Nominal Broad U.S. Dollar Index reflects the impact of the dollar's price on tradable goods, thereby influencing the CPI. When the dollar appreciates, the prices of dollar-denominated imported goods decline; when the dollar depreciates, the opposite occurs. Therefore, this paper expects the U.S. Dollar Index to exhibit a negative correlation with the CPI. This paper also incorporates a dummy variable (pandemic) to analyze changes before and after the pandemic, implemented as a step dummy variable. It is set to 0 prior to March 2020 and 1 thereafter. This variable aims to detect whether the pandemic shock produced permanent effects. The study predicts a positive coefficient for this variable, indicating that the global economy will enter a new normal with relatively higher price levels following the shock.

2.2 Empirical Models

This paper's goal is to analyze short-term dynamics and long-term equilibrium within gasoline prices and the nominal broad-based U.S. dollar index on the Consumer Price Index. Thus, this paper employs an Autoregressive Distributed Lag (ARDL) model. This model extends the autoregressive framework by incorporating lagged terms of the explanatory variables [8]. This method can simultaneously estimate short-term and long-term relationships, as well as dynamic cointegration, within a consistent framework. We first conduct stationarity tests (ADF and Phillips–Perron) on the time series, then employ an ARDL model to characterize the different effects of the exogenous variables in long-term and short-term, thereby examining their dynamic relationship. This aligns with the research objectives of this paper. This paper employs the ardl command by Sebastian Kripfganz and Daniel C. Schneider to build models in STATA. Guided by the Akaike Information Criterion or the Bayesian (Schwarz) Information Criterion, ARDL determines the optimal AR and lag order for the ARDL framework and completes the estimation [9].

2.3 Descriptive Statistics

To describe variable distributions and correlations, this paper integrates data into statistics to illustrate the co-movement of gasoline prices and inflation before and after the pandemic.

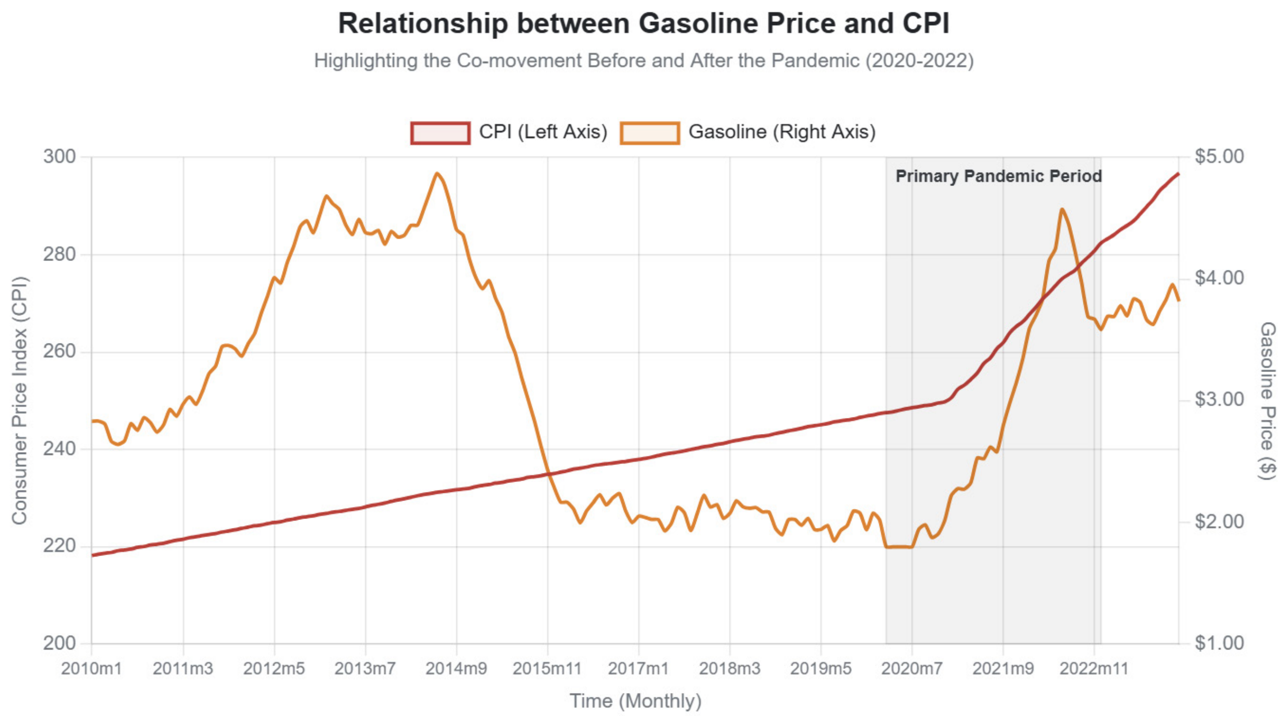

Fig. 1 Gasoline prices and inflation before and after the pandemic

As shown in Fig. 1, both gasoline prices and the CPI experienced significant volatility during the pandemic period, with their rapid increases exhibiting strong synchrony. This corroborates the paper's argument that oil price fluctuations may be one of the primary drivers of CPI volatility.

3. Empirical part

3.1 Model description

This paper employs the ARDL model proposed by Pesaran, Shin, and Smith [10] and conducts analysis using the following UECM equation:

$$\Delta lcpi? = c^0 + \lambda lcpi?^{-1} + \theta^1 lgasoline?^{-1} + \theta^2 lusd?^{-1} + \theta^3 pandemic?$$
$$+\gamma^1 \Delta lgasoline? + \gamma^2 \Delta lusd? + \epsilon?\#(1)$$

In the equation above, Δ is the first-difference operator. $lcpi$, $lgasoline$, and $lusd$ are natural logarithms of the CPI, gasoline price, and U.S. Dollar Index, respectively. The variable pandemic is the dummy variable for the COVID-19 era. The coefficient λ is the speed of adjustment. If λ is negative, it will provide proof of a stable long-term relationship. The coefficients $\theta?$, $\theta?$, and $\theta?$ are the long-term multipliers from which the elasticities are derived. For instance, the long-run elasticity of gasoline price is calculated as $(-\theta?/\lambda)$. The coefficients $\gamma?$ and $\gamma?$ capture the contemporaneous short-run effects of the explanatory variables on the CPI. The c^0 Stationarity Test and Cointegration Test. At the outset of the empirical section, this paper first conducted tests on the data time series. The author employed Augmented Dickey-Fuller (ADF) tests to determine the order of the variables. Results indicate that $lcpi$, $lgasoline$, and $lusd$ are non-stationary at the level but become stationary after first-difference transformation [11]. This allows us to proceed with the cointegration test. Subsequently, it applied for the ADRL test, with the results presented in Table 1. Test results are shown in the table below.

3.2 Stationarity Test and Cointegration Test

At the outset of the empirical section, this paper first conducted tests on the data time series. The author employed Augmented Dickey-Fuller (ADF) tests [11] to determine the order of the variables. Results indicate that lcpi, lgasoline, and lusd are non-stationary at the level but become stationary after first-difference transformation. This allows us to proceed with the cointegration test. Subsequently, we applied for the ARDL test, with the results presented in Table 1. Test results are shown in the table below.

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Table 1. ARDL test results

Test	10% I(0)	10% I(1)	5% I(0)	5% I(1)	1% I(0)	1% I(1)	p-value I(0)	p-value I(1)
F	2.699	3.790	3.211	4.397	4.338	5.707	0.003	0.021
t	−2.533	−3.383	−2.840	−3.719	−3.438	−4.355	0.233	0.542
Test	10% I(0)	10% I(1)	5% I(0)	5% I(1)	1% I(0)	1% I(1)	p-value I(0)	p-value I(1)

The test result also gets the value of F statistics which are 5.105. On the table above we can see that 5.105 exceeds 4.338, indicating the existence of a cointegrating relationship. This also demonstrates the presence of a long-run equilibrium relationship among the variables.

3.3 Regression results and Interpretation

Following the aforementioned tests, the author performed regression analysis on UECM, with the results shown in Table 2.

Table 2. Regression results

Variable	Coefficient	Std. Error	t	p > |t|	95% Confidence Interval
L.lcpi	−0.0147965	0.0048217	−3.07	0.002	[−0.0243134, −0.0052795]
L.lgasoline	0.0054678	0.0012524	4.37	0.000	[0.0029959, 0.0079398]
L.lusd	0.0132525	0.0038717	3.42	0.001	[0.0056107, 0.0208942]
pandemic	0.0019177	0.0005289	3.63	0.000	[0.0008738, 0.0029615]
D.lgasoline	0.0526039	0.0024187	21.75	0.000	[0.0478300, 0.0573778]
D.lusd	−0.0062685	0.0107185	−0.58	0.559	[−0.0274244, 0.0148874]
Constant	0.0154147	0.0128438	1.20	0.232	[−0.0099360, 0.0407655]

The error correction term lcpi L1's coefficient is -0.0148, test result p=0.002 indicating this result is highly significant. Thus, a cointegration relationship does indeed exist. More precisely, when deviating from the long-run equilibrium, approximately 1.48% of the deviation is corrected in the following month. The coefficient for lgasoline D1 is 0.0526 with t=21.75, indicating a highly significant short-term impact of gasoline prices. A 1% increase in gasoline prices during a given month leads to a 0.053% rise in the CPI for that same month (As shown in Table 3).

Table 3. Model summary

Statistic	Value
Observations (N)	180
F(6, 173)	93.09
Prob > F	0.0000
R-squared	0.7635
Adjusted R-squared	0.7553
Root MSE	0.00168
Statistic	Value

The long-term estimation results obtained via the nlcom command are presented in Table 4. All variables exhibit statistical significance within the 1% confidence interval. The coefficient for long-run gas elasticity is 0.3695, indicating a 1% increase in gasoline prices will cause a 0.37% rise in CPI—a result consistent with our expectations. However, the coefficient for long-run USD elasticity is 0.8957, a positive value. This suggests that a 1% appreciation of the US Dollar Index causes CPI to increase by 0.90%. This contradicts our expectations and may stem from the dollar's enhanced status during the pandemic shock due to heightened risk perceptions. Concurrently, these risks drove price increases, leading to the observed anomaly. This phenomenon likely relates to political factors and the dollar's unique position in the global economy. The coefficient for the long-run pandemic effect variable is 0.1296, indicating that the pandemic shock has shifted the long-run equilibrium of CPI upward by 13%. This also signifies that the pandemic's impact on prices extends beyond short-term effects.

Table 4. Long-term estimation results

Variable	Coefficient	Std. Error	z	P > |z|	95% Confidence Interval
long_run_gas_elasticity	0.3695375	0.0730639	5.06	0.000	[0.2263348, 0.5127401]
long_run_usd_elasticity	0.8956519	0.1344239	6.66	0.000	[0.6321860, 1.1591180]
long_run_pandemic_effect	0.1296046	0.0356986	3.63	0.000	[0.0596367, 0.1995726]

3.4 Limitations

Although this study has yielded significant results, several potential errors and limitations exist. These are summarized as follows: Firstly, the CPI prediction model employed in this study only incorporates variables such as gasoline prices and the U.S. Dollar Index. It excludes potentially significant factors like wage levels that influence CPI, or more specific policy impacts. The research indicates that conflicts over income distribution are a significant source of inflationary pressures [12]. Including these variables could enhance coefficient precision and yield a more practically applicable model. Secondly, to analyze the pandemic's impact, this study introduced a dummy variable named "pandemic." Using a single stepwise dummy variable to represent the pandemic oversimplifies a complex, multifaceted event. The pandemic's impact was not an instantaneous, one-time shock but likely evolved over time. Other inflationary factors emerged during the pandemic's duration, such as war or global economic shifts. Their influence on inflation may create new evidence that causes other research results. Analysis confirms that current evidence is insufficient to overturn the conclusion that the overall inflationary pressures observed in 2021 and 2022 stem primarily from non-energy price shocks [13]. This paper only researches the effect of gasoline price changes without considering other important energy index. Other energy categories like natural gas may have different effects on inflation. This paper demonstrates that when these structural shocks are influenced by natural gas prices, they exhibit nonlinear rather than linear characteristics [14]. These unique and difficult-to-quantify complexities may introduce bias into our conclusions, limiting the model's generalizability. Thirdly, the model employed in this study assumes linear relationships between variables, whereas these relationships are likely nonlinear in reality. The effects of gasoline price increases and decreases may not be symmetrical, potentially exerting differing impacts on the CPI. Research has found that the impact of positive oil price shocks is greater than that of negative shocks, indicating that this effect exhibits asymmetry [15]. To avoid these potential systematic errors in future research, adopting nonlinear models or conducting more detailed analyses of oil price and CPI changes could yield more reliable results.

4. Conclusion

This study examines the impact of gasoline prices on the CPI before and after the COVID-19 pandemic. Using the ARDL-UECM method, it analyzes monthly gasoline prices, the monthly US Dollar Index, and monthly CPI data to estimate both short-term and long-term effects. The primary finding demonstrates a statistically significant and stable long-term transmission channel from gasoline prices to CPI: a 1% increase in gasoline prices leads to a 0.37% rise in the CPI. The error correction model results indicate that deviations from long-term equilibrium in the short term converge toward the long-term equilibrium at a rate of 1.48% per month. Furthermore, the study finds that the coefficient for the pandemic dummy variable is 0.130 and statistically significant. This suggests that the pandemic shock caused a permanent upward shift of 13.0% in the CPI index. Finally, the estimated USD index exhibits a long-term positive relationship with CPI: a 1% increase in the USD index leads to a 0.90% rise in CPI. This contradicts traditional economic theory and may stem from the USD's unique status and heightened global risks. This study has limitations, as it does not account for all potential inflation-influencing factors, and relationships between variables may not be linear. Future research can build upon this framework by incorporating these variables for broader analysis. The potential contributions of this paper are as follows: First, it provides new empirical evidence that holds significant practical value for policy-making departments when subsequent gasoline price fluctuations affect CPI through 2025. Second, it employs the ARDL-UECM model to quantify the short-term dynamic effects and long-term equilibrium relationships of various variables on CPI. It also analyzes the speed at which short-term impacts form long-term equilibrium, highlighting the importance of dynamic effects. Finally, the study demonstrates that the pandemic shock statistically altered the long-term transmission of the variables to CPI, indicating that the shock not only generated short-term fluctuations but also affected the economy's long-term equilibrium. The pandemic caused a systematic upward shift of 12.96% (p=0.000) in CPI's long-term equilibrium level.

References

[1] Kilian L., Zhou X. A broader perspective on the inflationary

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effects of energy price shocks. Energy Economics, 2023, 125: 106893.
[2] Casoli C., Manera M., Valenti D. Energy shocks in the Euro area: Disentangling the pass-through from oil and gas prices to inflation. 2024, 147: 103154.
[3] Kpodar K., Liu B. The distributional implications of the impact of fuel price increases on inflation. Energy Economics, 2022, 108: 105909.
[4] McCracken, Michael W., and Serena Ng. "FRED-MD: A Monthly Database for Macroeconomic Research." Journal of Business & Economic Statistics 2015, 34 (4): 574–89.
[5] Federal Reserve Bank of St. Louis. Average Price: Gasoline, Unleaded Regular (Cost per Gallon/3.785 Liters) in U.S. City Average (APU000074714). FRED, 2025.
[6] Federal Reserve Bank of St. Louis. Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL). FRED, 2025.
[7] Federal Reserve Bank of St. Louis. Nominal Broad U.S. Dollar Index (DTWEXBGS). FRED, 2025.
[8] Presno I., Prestipino A. Oil price shocks and inflation in a DSGE model of the global economy. FEDS Notes, Federal Reserve Board, 2024.
[9] Rehman A., Ma H., Ahmad M., Ozturk I., Işık C. Estimating the connection of information technology, foreign direct investment, trade, renewable energy and economic progress in Pakistan: evidence from ARDL approach and cointegrating regression analysis. 2021, 28: 50623–50635.
[10] Aastveit K. A., Bjørnland H. C., Cross J. L. Inflation expectations and the pass-through of oil prices. Review of Economics and Statistics, 2023, 105(3): 733–747.
[11] Kripfganz S., Schneider D. C. ardl: Estimating autoregressive distributed lag and equilibrium correction models. The Stata Journal, 2023, 23(4): 983–1019.
[12] Taylor L., Barbosa-Filho N. H. Inflation? It's import prices and the labor share! International Journal of Political Economy, 2021, 50(2): 116–142.
[13] Alvarez J. A., Kroen T. The Energy Origins of the Global Inflation Surge. IMF Working Paper No. 091, International Monetary Fund, 2025.
[14] Adolfsen J. F., Ferrari M. M., Mork J. E., Van Robays I. Gas price shocks and euro area inflation. 2024, 149: 103183.
[15] Pal D., Mitra S. Oil price pass-through to inflation in the U.S.: Evidence using multiple threshold nonlinear ARDL. Energy Economics, 2023.