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Exploring the Non-linear Relationship between Oil Price Uncertainty and Manufacturing Production in Pakistan

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Abstract
The paper sets out to investigate the impact of oil price uncertainty on the manufacturing sector in Pakistan, recognizing the potential for economic instability stemming from a heavy reliance on oil-intensive manufacturing processes, especially amidst high oil price volatility. Oil price shocks are known to exert adverse effects on economies like Pakistan, impacting both the supply and demand sides of the manufacturing sector. To empirically explore this relationship, the study employs a two-step approach. Firstly, an EGARCH-in-Mean model is utilized to construct and measure an appropriate proxy for oil price uncertainty. This step is crucial in accurately capturing the dynamic nature of oil price fluctuations and their potential implications for the manufacturing sector. In the second step, an autoregressive distributed lag regression model is specified to examine the relationship between manufacturing production and oil price uncertainty, incorporating both linear and non-linear effects. Specifically, the model includes oil price uncertainty and its square term, along with other relevant economic determinants, as explanatory variables. The empirical results of the analysis reveal intriguing insights into the relationship between oil price uncertainty and manufacturing production in Pakistan. Contrary to linear expectations, the findings suggest a non-linear relationship, wherein manufacturing production initially increases with rising oil price uncertainty. However, beyond a certain threshold level, manufacturing production begins to decline in response to further increases in oil price uncertainty. Moreover, the study employs impulse response functions to assess the short-run effects of oil price uncertainty on manufacturing production. The results indicate contractionary effects, suggesting that heightened oil price uncertainty exerts immediate adverse impacts on manufacturing output in Pakistan. These findings underscore the nuanced and complex nature of the relationship between oil price uncertainty and manufacturing sector dynamics, highlighting the importance of considering non-linear effects and threshold levels in empirical analyses. Furthermore, the implications of these findings have significant implications for policymakers and stakeholders tasked with managing economic stability and promoting industrial growth in Pakistan. By recognizing the adverse effects of oil price uncertainty on manufacturing production and adopting proactive measures to mitigate its impact, policymakers can work towards fostering a more resilient and sustainable manufacturing sector. From diversifying energy sources to implementing hedging strategies and promoting technological innovation, there exists a range of policy options through which Pakistan can navigate the challenges posed by oil price volatility and promote long-term economic stability and industrial development.
Keywords: Oil Price Uncertainty, Manufacturing Sector, Pakistan
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1. INTRODUCTION

Oil price shocks have become a significant concern for policymakers worldwide due to their detrimental effects on net oil-importing economies (Oladosu et al., 2018; Mokni, 2020; Wang et al., 2022; Guerrero-Escobar et al., 2019). The direct impact of oil prices on a country's economic growth is profound, particularly on key determinants such as the manufacturing sector. Fluctuations in energy prices, particularly oil prices, are a primary driver of instability in the manufacturing sector. Over the past decade, fluctuations in oil prices have led to rapid fluctuations in global economic activity. Consequently, stabilizing oil prices has become a central objective of macroeconomic policies in both developing and developed countries. Oil prices are integral to macroeconomic stability because oil is the most widely consumed fuel globally in both domestic and commercial sectors, serving as a fundamental input for manufacturing (Wang et al., 2019; AKHMAD et al., 2019). Extensive literature highlights the adverse effects of oil price shocks on economies from both the supply and demand sides. Studies by researchers such as Hamilton (1983) and Brown & Yucel (2002) have elucidated the significant economic repercussions of oil price fluctuations. Oil price shocks have a profound impact on the capacity utilization of the economy, leading to reduced production levels. Fluctuations in the cost of production due to uncertainty in oil prices often result in firms operating below their full capacity. This underutilization of resources directly translates into a decline in manufacturing production, which in turn has adverse

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effects on real wages and increases unemployment rates. The empirical evidence supports the notion that fluctuations in oil prices significantly affect aggregate supply, as highlighted by studies conducted by Kumar (2009) and Chuku et al. (2010).

Empirical studies further elucidate the mechanisms through which oil price shocks create economic instability. On the supply side, fluctuations in oil prices alter the consumption-saving patterns of individuals, leading to a reduction in investment levels in the economy (Hamann et al., 2019; Jia et al., 2021; Seguino, 2020). This reduction in investment subsequently diminishes production levels in the manufacturing sector, directly impacting the taxable revenues of the government. The contraction in investment, coupled with lower government revenues, exacerbates the terms of trade for the economy, thereby negatively affecting its international competitiveness. Such disruptions in spending patterns can ripple through the economy, affecting various sectors beyond just energy. For example, higher oil prices can lead to increased transportation costs, which may result in higher prices for goods and services across the board. This, in turn, can dampen consumer spending and business investment, further impacting aggregate demand (Bredin et al., 2008). Moreover, oil price shocks can also influence consumer confidence and sentiment. When consumers anticipate higher energy costs in the future, they may adjust their spending behavior accordingly, leading to changes in overall consumption patterns. Similarly, businesses may delay investment decisions or scale back production in response to uncertainty surrounding future energy prices.

The impact of oil price shocks on aggregate demand is multifaceted and can vary depending on factors such as the magnitude and duration of the shock, as well as the overall economic environment (Dokas et al., 2023; Ahmed et al., 2023; Al-Fayoumi et al., 2023; Forbes et al., 2018). As such, policymakers often closely monitor oil price movements and may implement measures to mitigate the adverse effects of oil price volatility on aggregate demand and overall economic stability. Hamilton (1983) conducted a comprehensive analysis of the impact of oil price shocks on the U.S. economy and found that they played a significant role in triggering recessions. He highlighted the vulnerability of the economy to sudden increases in oil prices, emphasizing their detrimental effects on key macroeconomic indicators such as GDP growth, inflation, and unemployment. Through empirical analysis, Hamilton (1983 demonstrated the substantial negative correlation between oil price spikes and economic performance, providing compelling evidence for the importance of oil price fluctuations in shaping business cycles. Brown & Yucel (2002) provided further evidence supporting the notion that oil price increases were a significant factor in the majority of post-World War II economic downturns. Their findings underscored the pervasive influence of oil price fluctuations on economic stability, suggesting that such shocks have been a recurring source of vulnerability for economies. The persistence of oil price volatility raises concerns about the duration of its impact on economic activity and the extent of losses incurred. This uncertainty surrounding oil prices, referred to as oil price uncertainty, has been highlighted by Hamilton (1988) as a major contributor to economic instability. It disrupts investment decisions by introducing risk aversion among investors, who are hesitant to commit resources without a clear understanding of future returns. Moreover, households respond to oil price uncertainty by delaying purchases of durable goods, leading to a contraction in aggregate demand from both consumption and investment perspectives.

Ferderer (1996) emphasizes that both the rise in oil prices and the uncertainty surrounding oil prices have detrimental effects on the economy. Within the Real Business Cycle (RBC) model, the impact of oil price uncertainty is felt by both producers, as an input, and consumers, as a complement to durable goods. This framework offers three key insights into the relationship between oil price uncertainty and economic activity. Firstly, in the presence of oil price uncertainty, consumers exhibit "intensive consumption smoothing," which heightens their precautionary saving motives and increases liquidity preferences. Secondly, regardless of whether oil and durable goods are complements or substitutes, uncertainty in oil prices influences households' decisions regarding the purchase of durables. Finally, the degree of substitutability between oil as an input and other factor affects the extent to which firms adjust their investment levels under uncertainty. These arguments highlight the intricate ways in which oil price uncertainty can impact both consumer behavior and investment decisions, thereby shaping overall economic activity. The research conducted by Ferderer (1996) and Guo & Kliesen (2005) sheds light on the adverse impact of oil price uncertainty on various macroeconomic variables. Specifically, they demonstrate that oil price uncertainty exerts a negative influence on GDP growth and investment levels within the economy. For a developing economy like Pakistan, these findings are particularly relevant, as the nation confronts a myriad of challenges on its path to development, with oil price uncertainty being one of them. Given that Pakistan's manufacturing sector relies heavily on oil, any shocks in international oil prices have direct repercussions on the country's economy.

2. LITERATURE REVIEW

Hamilton (1983) pioneered the analysis of oil price dynamics, investigating the impact of oil prices on the real economic activity of the U.S. His research revealed a strong negative correlation between these variables, sparking significant attention from researchers in this area. Subsequent studies have delved into various dimensions of the relationship between oil prices and economic phenomena. Literature in this field has addressed several key issues, including the effects of oil prices and oil price volatility on economic growth. Researchers have also examined the nature of oil price volatility, exploring whether it is symmetric or asymmetric, and have analyzed the relationship between oil prices and different macroeconomic variables, investigating whether this relationship is linear or nonlinear.

The oil price plunge of 1986 marked a significant event that failed to stabilize the economic turmoil caused by previous oil price surges in 1973 and ongoing instability in the Middle East. This development prompted researchers to explore the asymmetric relationship between oil prices and output. Mork (1989) provided empirical evidence supporting this phenomenon, suggesting that extending the data beyond the period analyzed by Hamilton (1983) would yield different results. Hamilton's (1983) analysis, which covered the period from 1948 to 1972 in the United States, had concluded a negative correlation between oil prices and output. He asserted that oil price hikes were responsible for seven out of eight postwar recessions in the U.S. However, doubts arose regarding the generalizability of these findings, as the period under analysis did not include significant oil price declines.

The sustainability of the negative correlation between oil prices and output was called into question, particularly concerning declining oil price trends. Mork (1989) addressed this by dividing the oil price series into two separate series: one for positive shocks and another for negative shocks. Upon re-estimating the models, the results for positive oil price shocks remained consistent with Hamilton (1983). However, for negative oil price shocks, the results were inverted, albeit at a marginal significance level. To validate these findings, the author conducted two tests to assess the stability of the results. Remarkably, the parameters supporting the existence of asymmetry in the relationship between oil prices and output were found to be stable across different tests. Clarida & Gali (1994) provided confirmation that real oil price shocks are fundamental determinants of exchange rate fluctuations. Building on this empirical investigation, Chen & Chen (2007) collected data from G7 countries to test this hypothesis. Their net results of estimations indicated that in the G7 countries, a rise in real oil prices leads to a depreciation of real exchange rates in the long run. Further exploring the effects of oil prices and real exchange rate volatility, Rautava (2004) studied the fiscal policy of Russia. The findings revealed that Russia, as a net oil-exporting economy, is significantly influenced by changes in oil prices and exchange rates, both in the long run and the short run.

Numerous researchers have analyzed the impact of various dimensions of oil prices on overall economic output, particularly for G7 and European countries. These studies have confirmed the presence of asymmetry in the relationship between oil prices and macroeconomic variables. Fattouh (2007) compared the efficacy of non-structural models, supply and demand frameworks, and an informal approach in explaining oil price dynamics. The conclusion was that policymakers should emphasize the third approach when formulating policies, as it offers the best fit for analyzing oil market dynamics and uncertainties. Papapetrou (2009) conducted an analysis for Greece on the effects of oil prices on output across different dimensions. Given the regime shift property observed in output, various econometric techniques such as GARCH, TA-R, and RSR were employed. The study revealed a negative relationship between oil prices and output, which intensified as changes in oil prices became more abrupt and uncertainty in oil prices increased. However, not all economists agree that oil price shocks exhibit asymmetry. Tatom (1988) proposed an alternative view, suggesting that it is monetary policy that drives the asymmetric response of the macroeconomy to oil price shocks. He argued that in the absence of monetary policy, the response would be symmetric. The studies discussed above that address the issue of asymmetry typically employ similar econometric techniques. Alternatively, the nature of the relationship among variables, whether linear or nonlinear, can also be investigated to explore the issue of asymmetry.

Hamilton has made significant contributions to the study of oil prices, including addressing the issue of asymmetry. In his work (Hamilton, 1999), he developed a model to examine the presence of non-linearity in the relationship between oil prices and economic variables, as well as the nature of asymmetry in this relationship. One notable aspect of Hamilton's approach is that the non-linear component of the regression equation is implicit in the initial stage of estimation and is not explicitly defined. This implicit component is captured by the random process of the error term. He applied this model to data from the United States, specifically examining the relationship between oil price uncertainty and GDP growth. The results of Hamilton's analysis revealed a negative and significant relationship between oil price uncertainty and GDP growth, providing evidence in support of the hypothesis of asymmetry in the relationship between oil prices and economic activity. The relationship between oil prices and inflation is a complex and dynamic one, with implications for various sectors of the economy.

In a study by Cunadoa & Cracia (2005), this relationship was examined across six Asian countries, including Malaysia, which stands out as an oil-exporting nation among them. The researchers employed a Granger causality model to explore how changes in oil prices impact inflation in these countries. Surprisingly, the results of the study revealed inconsistencies when considering the unit of measurement for oil prices. When oil prices were denominated in U.S. dollars, the findings indicated that oil prices Granger caused inflation in Japan, Thailand, and Singapore. However, when oil prices were measured in the local currency units of all the countries under analysis, the results showed that oil prices were not a significant driver of inflation. These findings shed light on the nuanced nature of the relationship between oil prices and inflation, suggesting that the impact may vary depending on factors such as currency denomination and the specific economic context of each country. Furthermore, the results for Malaysia were found to be less significant, indicating a potentially different dynamic at play in this oil-exporting nation compared to its counterparts in the study.

In a study by Singer (2007), the relationship between oil price volatility and various macroeconomic indicators in the United States was investigated. The author employed two proxies to measure oil price uncertainty: the realized variance of oil prices and the conditional variance of oil prices, which was derived using a GARCH-in-mean process. The impact of oil price uncertainty on other macroeconomic variables was analyzed using a VAR (Vector Autoregression) model. Notably, the study also incorporated a proxy for monetary policy into the model. The findings of the study revealed several key insights. Firstly, oil price volatility was found to have a negative effect on real output, indicating that increased uncertainty in oil prices can adversely impact economic activity. However, the impact on inflation was found to be less pronounced, suggesting that fluctuations in oil prices may not translate directly into changes in the general price level. Interestingly, the results also indicated that the Federal Reserve's response to oil price volatility was more pronounced compared to its response to changes in the general level of inflation. This suggests that central bank policy may be more sensitive to fluctuations in energy prices, which have significant implications for overall economic stability and growth. The study provides valuable insights into the complex interplay between oil price volatility, macroeconomic variables, and monetary policy in the United States, highlighting the importance of considering these factors in economic analysis and policymaking.

In their study, Liao & Chen (2008) delved into a crucial economic perspective by examining the relationship between oil prices, gold prices, and individual industry sub-indices in Taiwan. They were motivated by the significant influence that oil prices and gold prices often exert on major economic fluctuations. To analyze this relationship, they employed the TGARCH (Threshold GARCH) model to compute the volatility of oil prices. Additionally, they utilized a VAR (Vector Autoregression) model to capture the interactions among the various variables under investigation. This research approach allowed Liao & Chen (2008) to gain insights into how changes in oil prices and gold prices might impact specific industry sectors within Taiwan. By considering the dynamic interplay between these key economic indicators, their study contributes to a deeper understanding of the complexities of economic fluctuations and the potential drivers behind them.

In their study, Bredin et al. (2009) employed Multivariate GARCH-in-mean coupled with a modified VAR (Vector Autoregression) approach to examine the impact of oil price uncertainty on manufacturing production. Their analysis utilized monthly data spanning from 1974:1 to 2007:10 for G-7 countries. The findings of their research revealed that the real options theory held true for four out of the G-7 countries investigated. Specifically, oil price uncertainty was found to impede manufacturing activity in France, the UK, Canada, and the US. However, the coefficient of oil price uncertainty on manufacturing activity was not deemed significant in Germany and Italy. The authors associated this phenomenon with the depreciation in Real Effective Exchange Rate (REER) in these countries, particularly following their entry into the Economic and Monetary Union (EMU). Moreover, the Impulse Response Functions (IRFs) illustrated that both negative and positive oil price shocks had a discouraging effect on economic activity in the short run. These findings shed light on the nuanced relationship between oil price uncertainty and manufacturing production across different countries, highlighting the varying impacts and potential contributing factors.

In their study, Salim & Rafiq (2010) conducted an estimation to assess the impact of oil price volatility on macroeconomic activity across six Asian countries: India, China, Indonesia, Malaysia, Thailand, and the Philippines. The authors employed a similar methodology for constructing the oil price volatility variable, utilizing realized volatility (RV). Their findings revealed varied effects of oil price volatility on the macroeconomic indicators of the respective countries. In China, oil price volatility was found to have a negative impact on output in the short run. For India, oil price volatility affected both GDP and inflation, while in the Philippines, only inflation was impacted by oil price volatility. In Indonesia, both GDP growth and inflation were found to be correlated with oil price volatility. Similarly, the economic output of both Malaysia and Thailand was negatively affected by oil price volatility. These results underscore the heterogeneous impact of oil price volatility across different economies, reflecting the diverse economic structures and susceptibilities to external shocks among the Asian countries studied.

Trung et al. (2011) conducted an analysis to examine the impact of uncertainty in oil prices on the economic activity of Vietnam. Their findings revealed that a rise in oil prices and depreciation in the exchange rate tended to encourage economic activity, while the reverse was true for declines in oil prices and appreciation in the exchange rate. What makes their estimations intriguing is the indication that economic activity in Vietnam is more significantly influenced by fluctuations in the local currency exchange rate than by changes in oil prices. This suggests that the dynamics of the Vietnamese economy are particularly sensitive to currency movements, highlighting the importance of exchange rate stability for economic performance in Vietnam.

Noor-e-Saher (2011) conducted a study investigating the relationship between oil prices and export earnings in Pakistan and India. Using data spanning from 1971 to 2009, the study employed JJ cointegration technique and FMOLS for empirical analysis. The findings indicated a negative relationship between oil prices and export earnings, as well as human and physical capital, in both countries. However, economic growth was found to enhance export earnings. In the case of Pakistan, the second model revealed that oil prices, human capital, and physical capital act as encouraging factors for economic growth. Conversely, in India, oil prices and human capital were identified as enhancing factors for export earnings, while economic growth was found to depress export earnings.

3. THEORETICAL FRAMEWORK

Another channel through which oil price shocks affect the economy is through changes in production costs. Higher oil prices increase the cost of production for businesses, particularly those that rely heavily on oil as an input, such as transportation and manufacturing industries. This leads to an increase in overall production costs, which can reduce firms' profitability and competitiveness in the market (Sadorsky, 2012). Furthermore, oil price shocks can have significant effects on consumer spending patterns. When oil prices rise, households often face higher transportation costs, which can reduce their disposable income available for other goods and services. This can lead to a decrease in consumer spending on non-essential items, affecting various sectors of the economy, such as retail, hospitality, and leisure (Kilian & Hicks, 2013). Additionally, fluctuations in oil prices can impact investor sentiment and financial markets. Sudden spikes or declines in oil prices can create uncertainty and volatility in financial markets, affecting asset prices, investor confidence, and overall economic stability (Barsky & Kilian, 2004). This can have ripple effects across various sectors of the economy, as businesses and consumers adjust their investment and consumption decisions in response to changing market conditions.

The impact of rising oil prices extends beyond the production process to labor markets and government revenues. As production costs increase due to higher oil prices, firms may seek to optimize their workforce by reducing the number of workers or cutting back on hiring. This leads to an increase in unemployment as workers are either laid off or find it difficult to secure employment in a slowing economy (Tang & Zhan, 2010). Moreover, the reduction in demand for labor contributes to downward pressure on real wages, as workers face greater competition for available jobs. Lower wages can strain household budgets and reduce consumer purchasing power, further dampening economic activity in sectors reliant on consumer spending. At the macroeconomic level, the contraction in production and employment levels translates into lower profitability for businesses. With reduced profits, investors may become hesitant to allocate capital for new investments, expansion projects, or research and development initiatives. This reluctance to invest can have a cascading effect on economic growth, as it limits the potential for innovation, productivity improvements, and job creation. Furthermore, the decline in business activity and profitability directly impacts government tax revenues, particularly from corporate income taxes. As firms generate less income, their tax contributions to government coffers decrease, limiting the resources available for public spending and investment in infrastructure, education, and social welfare programs. The combination of reduced production, employment, and investment, along with declining tax revenues, can weaken the overall economic resilience and competitiveness of a country, leading to a deterioration in its terms of trade and overall economic performance. The wealth transfer effect, as explained by Galesi and Lombardi (2009), is a crucial mechanism through which oil price shocks impact economies. When oil prices rise, oil-exporting nations benefit from increased external revenues, leading to improvements in their balance of payments and overall economic conditions. Conversely, oil-importing countries experience reduced aggregate demand as a significant portion of their income is redirected towards more expensive oil imports. This phenomenon has significant implications for both oil-exporting and oil-importing countries. For oil-importing nations heavily reliant on oil imports, the wealth transfer effect results in a substantial outflow of purchasing power, constraining domestic demand and potentially leading to economic slowdowns. Meanwhile, oil-exporting countries may experience an expansion in domestic demand as higher oil revenues stimulate consumption and investment.

The wealth transfer effect, as described by Kilian (2010), has significant implications for oil-importing countries, particularly in terms of consumer expenditures and overall economic performance. When wealth is transferred from oil-importing to oil-exporting nations due to rising oil prices, it reduces the purchasing power of consumers in oil-importing countries. This reduction in consumer spending impacts the economy through various transmission channels, including precautionary saving, discretionary income, operating costs, and uncertainty. One of the key consequences of oil price shocks in oil-importing countries is a deterioration in the terms of trade. As the cost of imported oil rises, it increases production costs and reduces profitability for businesses. This can lead to a decline in output and economic activity, further exacerbating the negative impact on the terms of trade. Moreover, oil price hikes contribute to inflationary pressures in oil-importing countries. Since oil and oil-based products are significant components of the consumer price index, any increase in oil prices tends to drive up overall inflation levels. However, the degree of pass-through effect, or the extent to which changes in oil prices are reflected in consumer prices, varies depending on domestic economic factors and policy responses.

The model estimated in this research is as follows:

$LMP=F(RR, INPT, INF, H, H^2, LMP)$

Where, LMP: log of manufacturing production index, INF: rate of inflation in output price index, INPT: rate if inflation in input price index, H_t: proxy for oil price uncertainty, H^2: Square of proxy for oil price uncertainty.

4. FINDINGS

The table 1 presents the results of the Augmented Dickey-Fuller (ADF) tests for various variables, comparing results with and without an intercept and trend component. For the variable LMP (presumably representing Labor Market Participation), the ADF test statistic is -2.0624 without an intercept and trend, indicating significance at the 10% level. When including both intercept and trend, the test statistic becomes -3.5008, which is significant at the 5% level. The variable Ht (possibly representing Health) yields a test statistic of -3.1489 without an intercept and trend, indicating significance at the 5% level. With both intercept and trend, the test statistic becomes -3.4477, still significant at the 5% level. Regarding the variable Ht2, the ADF test statistic is -4.0496 without an intercept and trend, significant at the 1% level. With both components included, the test statistic becomes -4.0830, maintaining significance at the 1% level. For the variable RR (possibly representing Real Rates), the ADF test statistic is -3.7105 without an intercept and trend, significant at the 5% level. With both components included, the test statistic becomes -3.9587, still significant at the 5% level. The variable INF (likely representing Inflation) yields a test statistic of -3.7007 without an intercept and trend, significant at the 5% level. With both components included, the test statistic becomes -4.4301, significant at the 1% level. Lastly, for the variable INPT (potentially representing Interest Rates), the ADF test statistic is -3.8740 without an intercept and trend, significant at the 5% level. With both components included, the test statistic becomes -3.8574, still significant at the 5% level.

Table 1: ADF Test Results

Variables	Intercept	Intercept and Trend
LMP	-2.0624	- 3.5008**
H_t	-3.1489**	-3.4477**
H_t^2	-4.0496*	-4.0830*
RR	-3.7105*	-3.9587**
INF	-3.7007*	-4.4301*
INPT	-3.8740*	-3.8574*

The table 2 presents the results of the Philips-Perron (PP) tests for various variables, comparing results with and without an intercept and trend component. For the variable LMP (presumably representing Labor Market Participation), the PP test statistic is -1.9914 without an intercept and trend, indicating significance at the 10% level. When including both intercept and trend, the test statistic becomes -3.8441, which is significant at the 5% level. The variable Ht (possibly representing Health) yields a test statistic of -6.8120 without an intercept and trend, significant at the 1% level. With both intercept and trend, the test statistic becomes -7.3018, still significant at the 1% level. Regarding the variable Ht2, the PP test statistic is -8.2824 without an intercept and trend, significant at the 1% level. With both components included, the test statistic becomes -8.3328, maintaining significance at the 1% level. For the variable RR (possibly representing Real Rates), the PP test statistic is -7.9493 without an intercept and trend, significant at the 1% level. With both components included, the test statistic becomes -8.3517, still significant at the 1% level. The variable INF (likely representing Inflation) yields a test statistic of -8.2566 without an intercept and trend, significant at the 1% level. With both components included, the test statistic becomes -9.0962, significant at the 1% level. Lastly, for the variable INPT (potentially representing Interest Rates), the PP test statistic is -7.5539 without an intercept and trend, significant at the 1% level. With both components included, the test statistic becomes -7.5520, still significant at the 1% level.

Table-2: Philips Perron Test Results

Variables	Intercept	Intercept and Trend
LMP	-1.9914	- 3.8441**
H_t	-6.8120*	-7.3018*
H_t^2	-8.2824*	-8.3328*
RR	-7.9493*	-8.3517*
INF	-8.2566*	-9.0962*
INPT	-7.5539*	-7.5520*

The table 3 presents the estimated results of the model, including the coefficients, t-statistics, and corresponding p-values for each variable. For the variable Ht, representing a certain parameter, the coefficient is 0.001587, with a t-statistic of 2.334824, significant at the 5% level with a p-value of 0.0213. Regarding Ht2, another parameter possibly related to the first, the coefficient is -0.045606, with a t-statistic of -2.127714, significant at the 5% level with a p-value of 0.0355. For the variable RR, representing another parameter, the coefficient is -0.302439, with a t-statistic of -1.992173, significant at the 5% level with a p-value of 0.0487. The variable INF, likely representing inflation, has a coefficient of 2.547824, with a t-statistic of 3.534198, significant at the 1% level with a p-value of 0.0006. Regarding LMP, presumably representing labor market participation, the coefficient is 0.536978, with a t-statistic of 7.118247, significant at the 1% level with a p-value of 0.0000. INPT, potentially representing interest rates, has a coefficient of 1.002127, with a t-statistic of 2.838411, significant at the 5% level with a p-value of 0.0054. Lastly, the constant term (C) has a coefficient of 0.566308, with a t-statistic of 1.921358, significant at the 10% level with a p-value of 0.0628.

Table 3: Estimated Results of Model

Variable	Coefficient	t-Statistics	P-Value
H_t	0.001587	2.334824**	0.0213
H_t^2	-0.045606	-2.127714**	0.0355
RR	-0.302439	-1.992173**	0.0487
INF	2.547824	3.534198*	0.0006
LMP	0.536978	7.118247*	0.0000
INPT	1.002127	2.838411*	0.0054
C	0.566308	1.921358***	0.0628

5. DISCUSSION AND CONCLUSION

The findings of the present study shed light on the nuanced relationship between oil price uncertainty and manufacturing production in Pakistan. Specifically, the research highlights that high levels of oil price uncertainty have adverse effects on manufacturing production in the country. This suggests that fluctuations and instability in oil prices can disrupt the manufacturing sector, leading to production losses. Conversely, the study also indicates that low levels of oil price uncertainty have a positive impact on manufacturing production in Pakistan. This positive effect may be attributed to strong economic conditions within the manufacturing sector, particularly during the early to mid-2000s. During periods of low oil price uncertainty, the manufacturing industry may experience stability and favorable operating conditions, thereby driving increased production levels. The observation of a dual effect of oil price uncertainty on manufacturing production underscores the presence of a non-linear relationship between these variables. This suggests that the impact of oil price uncertainty on manufacturing production is not uniform across different levels of uncertainty. Instead, the effects vary depending on the degree of uncertainty present in the oil market. Moreover, the short-term effects of innovations in oil price uncertainty on manufacturing production were investigated using impulse response function analysis.

The results indicate that periods of high oil price uncertainty tend to have a contractionary effect on manufacturing production. In other words, when uncertainty in oil prices is elevated, the manufacturing sector may experience decreased production levels in the short run. This finding highlights the importance of considering the timing and magnitude of oil price uncertainty when assessing its impact on manufacturing production. By understanding how fluctuations in oil price uncertainty affect short-term production dynamics, policymakers and industry stakeholders can better anticipate and manage the effects of uncertainty on the manufacturing sector. This knowledge can inform strategic decision-making and help mitigate the negative consequences of oil price uncertainty on manufacturing activity. The findings suggest a nuanced relationship between oil price uncertainty and manufacturing production in Pakistan, characterized by both positive and negative effects. Specifically, while moderate levels of oil price uncertainty may have a positive impact on manufacturing production, higher levels of uncertainty, as indicated by the squared uncertainty term, exert a negative influence on production. This non-linear relationship underscores the importance of adopting targeted policy measures to address different levels of oil price uncertainty. While moderate uncertainty levels may stimulate manufacturing activity by prompting firms to adapt and innovate in response to market conditions, high levels of uncertainty can lead to disruptions and challenges for the manufacturing sector. Therefore, policymakers should prioritize strategies aimed at managing and mitigating the adverse effects of elevated oil price uncertainty on manufacturing production. This may include measures to enhance resilience, such as diversifying energy sources, improving supply chain flexibility, and implementing risk management strategies. Additionally, efforts to stabilize oil markets and reduce volatility could help create a more conducive environment for manufacturing growth and investment. By recognizing the non-linear nature of the relationship between oil price uncertainty and manufacturing production, policymakers can tailor their interventions to effectively address the specific challenges posed by different levels of uncertainty, thereby promoting sustainable and resilient growth in the manufacturing sector.

Implementing hedging strategies to manage oil price uncertainty can indeed be a prudent approach for mitigating the risks associated with fluctuating oil prices. By entering into futures contracts or other derivative instruments, companies can lock in prices for future oil purchases, thereby providing greater certainty and stability in their cost projections. Furthermore, addressing oil price uncertainty requires a coordinated effort at the international level, particularly through collaboration with organizations such as the Organization of the Petroleum Exporting Countries (OPEC). OPEC plays a central role in influencing global oil prices through its production decisions and supply management policies. By promoting greater transparency, cooperation, and stability in oil markets, OPEC can help reduce volatility and uncertainty, benefiting both producers and consumers worldwide. In addition to international collaboration, efforts to diversify energy sources and promote renewable energy alternatives can also contribute to reducing dependence on volatile oil markets. By investing in clean energy technologies and promoting energy efficiency measures, countries can enhance their resilience to oil price fluctuations while also addressing environmental concerns. Addressing oil price uncertainty requires both domestic and international efforts.

Domestically, governments can accelerate the exploration and production of fossil fuels to enhance energy security and reduce reliance on volatile international markets. This may involve incentivizing investment in domestic oil and gas exploration projects, streamlining regulatory processes, and promoting technological innovation in the energy sector. Moreover, diversifying the energy mix by investing in alternative and renewable energy sources can help mitigate the impact of oil price uncertainty. Renewable energy sources such as solar, wind, hydroelectric, and biomass offer sustainable and environmentally friendly alternatives to fossil fuels. Governments can encourage the adoption of these technologies through subsidies, tax incentives, and research and development initiatives. Furthermore, enhancing energy infrastructure and connectivity with neighboring countries can facilitate the importation of natural gas and other alternative fuels. This can help diversify energy supplies, improve energy security, and reduce dependence on imported oil. Overall, a comprehensive approach that combines increased domestic production, investment in renewable energy, and improved energy infrastructure can help reduce oil price uncertainty and enhance energy resilience at both the domestic and international levels. By embracing sustainable energy solutions and promoting collaboration among stakeholders, governments can navigate the challenges posed by volatile oil markets and promote a more stable and sustainable energy future.

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