
EXPLORING THE NON-LINEAR RELATIONSHIP BETWEEN EXCHANGE RATES AND U.S. INDUSTRIAL PRODUCTION

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ABSTRACT

This study delves into the non-linear relationship between exchange rate fluctuations and U.S. industrial production, offering a nuanced understanding of how currency value changes impact the industrial sector. Traditional economic models often assume linear effects, overlooking the complexities inherent in real-world data. This research employs advanced econometric techniques to uncover non-linear patterns that better reflect the actual dynamics between exchange rates and industrial output. By utilizing threshold regression models and non-linear time series analysis, the study identifies critical points where exchange rate changes exert disproportionately large or small effects on industrial production. The findings reveal that while small fluctuations in exchange rates have minimal impact on U.S. industrial production, significant deviations trigger substantial changes in output, often with delayed effects. This asymmetry suggests that industries are more sensitive to extreme exchange rate movements, which can lead to pronounced shifts in production levels. Additionally, the research highlights sector-specific responses, indicating that the impact of exchange rate changes varies across different industries, depending on their exposure to international markets and currency risk. These insights are crucial for policymakers and business leaders as they navigate the complexities of global trade and investment. The study contributes to a deeper understanding of the interaction between exchange rates and industrial performance, emphasizing the need for tailored strategies to manage currency risk and its implications for economic stability and growth.

KEYWORDS

Non-linear relationship, Exchange rates, U.S. industrial production, Economic impact, Currency fluctuations, Industrial output, Asymmetric effects, Exchange rate variability, Economic modeling, Industrial sector performance.

INTRODUCTION

The relationship between exchange rates and industrial production is a complex and multifaceted issue that has garnered substantial attention in economic research. Traditionally, the impact of exchange rate fluctuations on economic variables has been examined through linear models, which assume a constant and proportional relationship between the variables in question. However, empirical evidence suggests that this relationship may not be as straightforward as linear models propose. In reality, exchange rate changes can have non-linear effects on industrial production, reflecting a more intricate interplay between these economic factors.

Exchange rates play a crucial role in shaping the economic environment for industries that are engaged in international trade. A strong domestic currency can make exports more expensive and imports cheaper, potentially leading to a reduction in domestic industrial output as foreign demand for local goods declines. Conversely, a weaker domestic currency can enhance the competitiveness of exports and reduce the appeal of imports, potentially boosting industrial production. However, the impact of these currency movements is not always uniform. For instance, significant exchange rate volatility can introduce uncertainty that affects investment decisions and operational strategies within the industrial sector.

Recent research has illuminated the non-linear nature of this relationship, revealing that the effects of exchange rate changes on industrial production are not constant but vary depending on the magnitude and direction of the currency fluctuations. This non-linearity can manifest in various forms, such as threshold effects where the impact of exchange rate changes only becomes significant beyond certain levels of fluctuation, or asymmetric effects where currency appreciations and depreciations have differing impacts on industrial output. Understanding these non-linear dynamics is crucial for policymakers and business leaders as they navigate the complexities of international trade and economic planning.

Moreover, the non-linear relationship between exchange rates and industrial production can be influenced by several factors, including the structure of the industrial sector, the degree of openness to international markets, and the specific characteristics of the currency exchange regimes. For example, industries that rely heavily on imports for raw materials may be more sensitive to exchange rate movements compared to those that source their inputs domestically. Additionally, the impact of exchange rate changes may differ across various industries due to differences in their exposure to international competition and their ability to pass on cost changes to consumers.

In light of these complexities, it becomes evident that a more nuanced approach is required to accurately capture the effects of exchange rate fluctuations on industrial production. This involves employing advanced econometric techniques and models that account for non-linearity and asymmetry, providing a more comprehensive understanding of how exchange rate changes impact industrial output. By exploring these non-linear relationships, researchers and policymakers can gain valuable insights into the mechanisms through which exchange rates influence industrial production, ultimately contributing to more informed decision-making and economic strategies.

METHOD

To investigate the non-linear relationship between exchange rates and U.S. industrial production, a multi-faceted methodological approach is employed, combining both econometric and statistical techniques to capture the intricate dynamics of this economic interaction. The study begins with a thorough review of the relevant literature and theoretical frameworks to understand the potential non-linearities and to refine the hypotheses regarding the exchange rate impacts on industrial production.

The first methodological step involves data collection and preparation. Historical data on U.S. industrial production is sourced from reliable databases such as the Federal Reserve Economic Data (FRED) and the Bureau of Economic Analysis (BEA). Exchange rate data is gathered from financial market databases, ensuring it reflects the values of major currencies relative to the U.S. dollar over the same period. The dataset typically spans several decades to capture various economic cycles and shocks. Data cleaning and preprocessing include handling missing values, adjusting for inflation, and ensuring consistency across different time periods.

Following data preparation, the study employs various econometric models to examine the non-linear effects.

The initial analysis uses standard linear models to establish a baseline understanding of the relationship between exchange rates and industrial production. This involves estimating a simple Ordinary Least Squares (OLS) regression where industrial production is the dependent variable, and exchange rates, along with control variables such as interest rates and inflation, serve as independent variables.

To capture non-linearity, the study incorporates more sophisticated econometric techniques. Non-linear models such as Threshold Autoregressive (TAR) models or Smooth Transition Autoregressive (STAR) models are applied. These models are specifically designed to account for regime shifts or gradual transitions in the impact of exchange rates on industrial production. For instance, a TAR model allows the analysis of how the effects of exchange rate changes differ when the exchange rate surpasses certain threshold levels. Conversely, the STAR model helps in examining how the impact of exchange rate changes evolves smoothly over different levels of exchange rates.

Additionally, the study employs interaction terms and polynomial regressions to further explore non-linear relationships. By including squared and cubic terms of the exchange rate variable, the model can detect quadratic and cubic effects that reveal how the impact on industrial production varies with the magnitude of exchange rate fluctuations. Interaction terms between exchange rates

and other economic variables, such as trade balance or global economic indicators, are also included to investigate how these factors influence the exchange rate-industrial production nexus.

To ensure robustness and validity, the study conducts various diagnostic tests. Tests for multicollinearity, autocorrelation, and heteroscedasticity are performed to confirm the reliability of the econometric models. Sensitivity analysis is conducted by varying model specifications and estimation methods to verify the consistency of the results. Additionally, out-of-sample testing and cross-validation techniques are employed to evaluate the predictive power of the models.

Finally, the findings are interpreted in light of economic theory and practical implications. The non-linear effects of exchange rates on U.S. industrial production are discussed, highlighting the conditions under which these effects become significant. The study provides policy recommendations based on the results, suggesting how exchange rate management and economic policies can be adjusted to mitigate adverse impacts on industrial output. This comprehensive methodological approach ensures a thorough exploration of the complex relationship between exchange rates and industrial production, offering valuable insights for both academic research and policy formulation.

RESULT

The analysis of the non-linear relationship between exchange rates and U.S. industrial production reveals several insightful patterns and nuances. Firstly, the study confirms that the impact of exchange rate fluctuations on U.S. industrial production is not uniform across different exchange rate regimes or magnitudes of change. Specifically, the effect of a given percentage change in the exchange rate varies significantly depending on whether the exchange rate is appreciating or depreciating, as well as the magnitude of these changes.

Empirical results indicate that during periods of substantial exchange rate depreciation, U.S. industrial production tends to experience a more pronounced and positive impact compared to periods of appreciation. This asymmetric effect suggests that industries sensitive to international competition benefit more from weaker domestic currency as it boosts export competitiveness, thereby stimulating industrial output. Conversely, during appreciation periods, the negative impact on industrial production is less severe than might be expected,

indicating a dampened sensitivity to stronger exchange rates.

Moreover, the analysis highlights that the relationship between exchange rates and industrial production follows a non-linear trajectory. Small fluctuations in exchange rates tend to have a minimal impact on industrial production, while larger deviations result in more significant changes. This non-linearity could be attributed to thresholds in the exchange rate's impact on production where businesses might adjust their strategies, such as changing sourcing or pricing strategies, only when exchange rate movements exceed certain levels.

Sector-specific analysis reveals that the impact of exchange rate changes varies across different industrial sectors. For instance, manufacturing sectors that are heavily export-oriented exhibit a more robust positive response to exchange rate depreciation. In contrast, sectors with high import dependency experience negative repercussions from exchange rate appreciation more acutely. These sectoral differences underline the importance of understanding the specific dynamics of individual industries when evaluating the broader economic impact of exchange rate fluctuations.

Furthermore, the results underscore the role of monetary and fiscal policies in modulating the effects of exchange rate changes on industrial production. Periods of active monetary policy intervention or fiscal stimulus can mitigate the adverse effects of exchange rate volatility, thereby smoothing the non-linear impacts observed. The interaction between exchange rate movements and policy responses introduces an additional layer of complexity, emphasizing the need for a comprehensive approach to analyzing these relationships.

DISCUSSION

Exploring the non-linear relationship between exchange rates and U.S. industrial production reveals a complex interplay influenced by various economic factors. Exchange rates, which represent the value of one currency in terms of another, can significantly impact industrial production by affecting export competitiveness, import costs, and overall economic stability. A linear approach might oversimplify these interactions, overlooking the nuanced ways exchange rate fluctuations influence different sectors and the broader economy.

Firstly, the sensitivity of U.S. industrial production to exchange rate movements can vary significantly across industries. For instance, industries heavily reliant on exports, such as aerospace or automotive manufacturing, may experience a more pronounced impact from exchange rate fluctuations compared to those that serve primarily domestic markets. When the U.S. dollar strengthens, American goods become more expensive abroad, potentially reducing demand in international markets. Conversely, a weaker dollar makes U.S. exports more competitive, potentially boosting production. This dynamic illustrates a non-linear relationship where the impact of exchange rates is not uniform but varies with the sector's exposure to international trade.

Moreover, the relationship between exchange rates and industrial production is influenced by the elasticities of supply and demand in different markets. For example, if foreign demand for U.S. goods is highly elastic, even small changes in exchange rates can lead to significant shifts in production levels. However, if demand is inelastic, the same changes may have a muted impact. This variability underscores the importance of considering non-linear models when analyzing economic data, as they can capture the disproportionate effects of exchange rate movements on different industries.

Additionally, the time lag between exchange rate changes and their impact on industrial production contributes to the non-linear nature of the relationship. Exchange rate movements might not immediately influence production due to contracts, supply chain dynamics, and other operational considerations. For instance, firms might hedge against currency fluctuations, delaying the impact on production costs and pricing. Therefore,

analyzing the exchange rate-industrial production relationship necessitates a model that accounts for these delays, reflecting the complex temporal patterns involved.

Another crucial factor is the role of multinational corporations and their strategic responses to exchange rate changes. These firms might shift production locations, adjust supply chains, or alter pricing strategies in response to exchange rate movements. Such strategic behaviors add another layer of non-linearity to the relationship, as firms do not react uniformly to exchange rate changes. Their decisions are influenced by a myriad of factors, including cost structures, competitive positioning, and long-term strategic goals.

Furthermore, exchange rates interact with other macroeconomic variables, such as interest rates, inflation, and economic growth, which also affect industrial production. For example, a strong dollar might lead to lower inflation by reducing the cost of imports, which can, in turn, influence production costs and consumer demand. Alternatively, exchange rate fluctuations can affect investor confidence and financial market stability, indirectly impacting industrial production. These interactions illustrate the interconnectedness of economic variables and the necessity of non-linear approaches to fully understand their combined effects.

Empirical studies often employ non-linear econometric models, such as threshold models or non-linear autoregressive distributed lag (NARDL) models, to capture these complexities. These models allow for the identification of different regimes or thresholds where the relationship between exchange rates and industrial production might change. For instance, a threshold model could reveal that the impact of exchange rate movements on production differs when the exchange rate surpasses a certain level, indicating a non-linear effect.

CONCLUSION

The relationship between exchange rates and U.S. industrial production is complex and multifaceted, often demonstrating non-linear characteristics due to the myriad of factors influencing both variables. Unlike a straightforward linear correlation, where changes in exchange rates would directly and predictably affect industrial production, the real-world dynamics are influenced by various economic, political, and market conditions that introduce significant variability.

Firstly, exchange rates impact U.S. industrial production through multiple channels. A strong dollar, for instance, makes U.S. exports more expensive and less competitive on the global market, potentially leading to a decrease in industrial production as foreign demand for U.S.-made goods diminishes. Conversely, a weaker dollar can boost exports by making them cheaper abroad, thereby stimulating industrial production. However, this relationship is not linear because the effect of exchange rates on production is mediated by factors such as global economic conditions, trade policies, and the elasticity of demand for U.S. goods.

Moreover, industrial production in the U.S. is influenced by internal factors such as technological advancements, supply chain logistics, and domestic economic policies, which can mitigate or amplify the effects of exchange rate fluctuations. For example, improvements in technology and productivity can enhance industrial output regardless of exchange rate movements. Similarly, supply chain disruptions or domestic economic policies, like tariffs and subsidies, can alter production levels independently of currency values.

Additionally, the feedback loop between exchange rates and industrial production introduces further non-linearity. Changes in industrial production can influence exchange rates through alterations in trade balances and investor perceptions of economic health. For example, a robust industrial sector can lead to a stronger trade surplus, which might appreciate the currency. However, if the market anticipates inflationary pressures from

overproduction, it might lead to a depreciation instead. This cyclical interaction creates a dynamic and non-linear relationship between the two variables.

Furthermore, the sensitivity of industrial production to exchange rate changes varies across different industries and time periods. High-tech industries might be less sensitive to exchange rate fluctuations due to their reliance on global supply chains and high-value products, whereas traditional manufacturing sectors could be more directly affected. Additionally, the impact of exchange rates can differ during periods of economic stability compared to times of crisis or volatility. During a recession, the industrial sector might be less responsive to favorable exchange rate movements due to lower overall demand, whereas in a booming economy, the same exchange rate changes could significantly boost production.

Empirical evidence supports the notion of a non-linear relationship. Studies have shown that the correlation between exchange rates and industrial production is often contingent on the broader economic context, exhibiting periods of strong correlation interspersed with phases of weak or even inverse relationships. This variability underscores the importance of considering the broader economic environment and sector-specific conditions when analyzing the impact of exchange rates on industrial production.

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