Economic Dependency and Vulnerability: A Quantitative Analysis of the U.S. Semiconductor Supply Chain

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Introduction

The global semiconductor supply chain represents the foundational infrastructure of the 21st-century economy, a complex and highly specialized network that underpins technological innovation, economic growth, and national security (Miller, 2022). For the United States, this ecosystem presents a fundamental paradox. The nation maintains unparalleled leadership in the high-value, capital-light stages of chip design and intellectual property (IP), yet it has become critically dependent on a small cohort of East Asian nations for the capital-intensive manufacturing of the most advanced semiconductor chips (Ernst, 2021; Shih, 2021). This structural imbalance, once celebrated as a triumph of globalized efficiency, is now widely viewed as a source of significant economic and strategic vulnerability, particularly for the high-technology manufacturing base that consumes these advanced components (Kang & Park, 2022). Recent global shocks have transformed this theoretical risk into tangible economic damage, underscoring the urgent need for a deeper, data-driven understanding of U.S. dependency on this critical supply chain.

Problem Statement

This research solves the problem that there is currently no validated quantitative framework to measure the economic damage inflicted on U.S. industry by semiconductor supply chain disruptions**.** While the dependency on foreign manufacturing is widely acknowledged in policy and academic circles, the understanding of its magnitude is predominantly based on qualitative assessments that describe the issue but lack predictive power (Ernst, 2021), case studies of acute crises that may not be generalizable (Zhan, 2021), or high-level descriptive statistics that show correlation without establishing causality (Stettner & Schwellnus, 2020). This leaves stakeholders without a reliable tool to conduct evidence-based risk assessments or strategic planning. This analytical gap means that when disruptions occur, the response is necessarily reactive. This study will solve this problem by developing and testing a time-series baseline model of U.S. dependency, thereby creating a direct, evidence-based framework for quantifying the impact of disruptions and informing proactive policy and business strategies.

Purpose of the Study and Research Questions

The purpose of this quantitative study is to develop and test a time-series model that defines and quantifies the economic dependency of the United States on its inbound semiconductor supply chain, with a specific focus on the computer and electronic products sector. This research will analyze the statistical relationship between semiconductor import values and the production output of this key U.S. high-tech industry. The study will first establish a baseline model of this dependency and then use this model to assess the measurable economic impact of documented supply chain disruptions.

To achieve this purpose, the study is guided by a primary research question, followed by two secondary questions that structure the analysis. The primary research question is: To what extent does the value of semiconductor imports quantitatively impact the production output of the U.S. computer and electronic products sector? The secondary research questions are as follows: First, what is the baseline statistical relationship between U.S. semiconductor import values and the Industrial Production Index for computer and electronic products? Second, how do documented supply chain disruptions, as measured by supplier delivery times, manifest statistically significant deviations from this baseline relationship?

Significance of Study

This research is significant for its direct contribution to a well-documented analytical gap in the literature and for its practical implications for both public policy and industry strategy.

Theoretically, the study addresses the central tension between Liberal theories of economic efficiency and Realist theories of strategic vulnerability, a debate that has become acute in the semiconductor industry (Miller, 2022). While the concept of "weaponized interdependence" explains how globalized networks create chokepoints that can be exploited for strategic gain (Farrell & Newman, 2019), there remains a lack of validated quantitative models to measure the tangible economic costs of this vulnerability (Lim, 2023). This research aims to fill that gap by creating a framework to empirically measure the economic consequences (a Realist concern) of instability within an interdependent system (a Liberal outcome).

For U.S. policymakers, this research offers a needed quantitative tool to move beyond qualitative assessments and directly measure the economic impact of supply chain vulnerabilities (Ernst, 2021). Such a model provides a direct, empirical baseline to evaluate the effectiveness of industrial policies like the CHIPS and Science Act, which are designed to enhance supply chain resilience over time (BCG & SIA, 2024; Sharma, 2023). Without a baseline model of dependency, assessing the true impact of such landmark legislation remains speculative.

For industry leaders, this study provides a clearer, macro-level understanding of systemic risks, which is critical for informing strategic decisions. It offers a macroeconomic rationale for the ongoing shift away from hyper-efficient "just-in-time" inventory models toward more resilient "just-in-case" strategies that prioritize sourcing diversification and redundancy (Shih, 2021; The Soufan Center, 2025). By quantifying the costs of disruption, this research aligns with modern resilience frameworks that aim to mitigate future shocks (Xiong et al., 2024).

Definition of Terms

This study defines its key theoretical concepts and operational variables with both conceptual and operational precision, supported by their established use in scholarly literature.

The first core concept, Economic Dependency, is conceptually defined as an asymmetric relationship where a nation's economic functioning, particularly within a strategic sector, relies heavily on the consistent flow of goods or capital from a limited number of foreign sources. This reliance moves beyond simple trade and creates a structural condition where the dependent nation's economic output becomes sensitive to decisions and conditions outside its direct control (Farrell & Newman, 2019). In the context of this study, economic dependency refers specifically to the reliance of the U.S. high-technology manufacturing sector on integrated circuits produced abroad.

The second core concept, Vulnerability, is conceptually defined as the degree to which a nation is susceptible to coercion or significant economic damage that arises from its economic dependency. Vulnerability is a function of both the *sensitivity* of the economy to a supply disruption and the *lack of viable, short-term alternatives* to that supply (Miller, 2022; Lim, 2023). While dependency is the state of reliance, vulnerability is the exposure to harm created by that reliance, particularly when the supply chain contains critical "chokepoints" concentrated in a few firms or nations (BCG & SIA, 2024).

To quantitatively analyze these concepts, the study employs the following operational variables:

The independent variable, U.S Monthly Semiconductor Import Value, is conceptually defined as a monetary measure of the flow of electronic integrated circuits into a national economy, representing a key input for technology-intensive manufacturing (Sturgeon & Kawakami, 2011). Operationally, it is a monthly time-series variable representing the total import value, measured in U.S. Dollars (USD), of products under Harmonized System (HS) Code 8542.

The dependent variable, U.S. Monthly Computer & Electronics Production Index, is conceptually a macroeconomic indicator that measures the real, inflation-adjusted output of a nation's high-technology manufacturing sector. The use of the Industrial Production Index to track real economic activity in key sectors is a standard methodology in applied econometrics and economic forecasting (Lahiri & Monokroussos, 2013). Operationally, it is a monthly time-series variable representing the Industrial Production (IP) Index for Computer and Electronic Products (FRED Series ID: IPG334).

Finally, the primary explanatory variable for disruptions, the Supplier Delivery Time Index, is conceptually a diffusion index that serves as a direct, data-driven proxy for supply chain constraints and logistical friction. Recent macroeconomic literature has widely adopted this index as a key high-frequency indicator of supply-side shocks and disruptions (Bai et al., 2024; European Central Bank, 2022). Operationally, it is a monthly time-series variable representing the ISM Manufacturing: Supplier Deliveries Index (FRED Series ID: MANSUDI).

Hypothesis

To provide empirical answers to the study's research questions and to quantitatively investigate the topic of economic dependency and vulnerability, this study will test two primary hypotheses, each corresponding directly to one of the secondary research questions.

The first hypothesis is designed to test the existence of baseline economic dependency and directly addresses the first secondary research question about the relationship between semiconductor imports and domestic production. Accordingly, the first alternative hypothesis (H1) posits that there is a statistically significant and positive baseline relationship between the U.S. Monthly Semiconductor Import Value and the U.S. Monthly Computer & Electronics Production Index. The corresponding null hypothesis (H0) is that no such statistically significant baseline relationship exists.

The second hypothesis is designed to test the presence of economic vulnerability by measuring the impact of supply chain disruptions, thereby addressing the second secondary research question. It tests how shocks, as measured by supplier delivery times, cause significant deviations from the established baseline. Therefore, the second alternative hypothesis (H2) posits that a positive shock to the Supplier Delivery Time Index, indicating slower deliveries and greater supply chain friction, leads to a statistically significant negative impact on the U.S. Monthly Computer & Electronics Production Index. The corresponding null hypothesis (H0) is that a shock to the Supplier Delivery Time Index has no statistically significant impact on this production index.

Limitations of the Study and Mitigation Strategies

The research acknowledges several potential limitations and proposes specific strategies to reduce their impact on the study's validity. A primary limitation is the data aggregation inherent in using the broad HS Code 8542, which does not distinguish between chip types. To mitigate this, the findings will be carefully framed as an "aggregate systemic risk indicator" rather than a measure of a specific shortage. A second limitation relates to causality, as time-series models cannot definitively prove philosophical causation. This will be mitigated by employing the Granger Causality test to establish predictive causality and by including a control variable (the ISM Manufacturing PMI) to reduce the risk of omitted variable bias. Finally, the limitation of model simplification will be addressed by justifying the study's macro-level focus as a deliberate methodological choice to provide a broad, systemic view directly relevant to national policy, gaining in generalizability what it loses in micro-level detail.

Related Works

The Geopolitical Economy of Strategic Supply Chains

The global semiconductor supply chain represents the foundational infrastructure of the 21st-century economy, a complex network that underpins technological innovation, economic growth, and national security (Miller, 2022). For the United States, this ecosystem presents a fundamental paradox. The nation maintains unparalleled leadership in the high-value stages of chip design and intellectual property (IP), yet it has become critically dependent on a small cohort of East Asian nations for the capital-intensive manufacturing of the most advanced semiconductor chips. This structural imbalance, once celebrated as a triumph of globalized efficiency, is now widely viewed as a source of significant economic and strategic vulnerability.

Recent global shocks, from the COVID-19 pandemic to escalating geopolitical rivalries, have transformed this theoretical risk into tangible economic damage, underscoring the urgent need for a deeper, data-driven understanding of U.S. dependency on this critical supply chain (Bai et al., 2024; The Soufan Center, 2025). While the dependency on foreign manufacturing is widely acknowledged, the understanding of its magnitude is predominantly based on qualitative assessments or case studies of acute crises. This literature review seeks to navigate this complex landscape by surveying the theoretical, empirical, and methodological scholarship surrounding the U.S. semiconductor supply chain. It will synthesize existing knowledge to identify a critical gap in the literature: the absence of a validated quantitative framework to measure the baseline economic damage inflicted by supply chain disruptions.

Review of Theories: Interdependence, Vulnerability, and State Power

The debate over the strategic implications of global supply chains is rooted in the tension between two core international relations theories: Liberalism and Realism. The liberal paradigm, which drove the globalization era, champions the economic efficiencies of interdependence, positing that removing trade barriers creates a "borderless" world economy governed by comparative advantage (World Affairs, 2022). This perspective celebrated hyper-efficient, geographically concentrated supply chains for their immense cost reductions and argued that deep economic ties make conflict prohibitively expensive for all parties (BCG & SIA, 2024; Choi & Kim, 2021).

In stark contrast, the realist critique views such dependency as a profound strategic liability in an anarchic international system where states prioritize survival and power (World Affairs, 2022). This view, validated by the self-interested state behavior seen during the COVID-19 pandemic, argues that asymmetrical interdependence creates vulnerabilities that can be exploited by rivals (Alhammadi, 2022). Neither classical framework fully captures today's complex reality. The contemporary synthesis is best encapsulated by the concept of "weaponized interdependence," which argues that the very networks of interdependence have themselves become the primary conduits for geopolitical coercion (Farrell & Newman, 2019). The optimization of global supply chains created structural "chokepoints"—critical nodes where a few firms or countries exert disproportionate control (BCG & SIA, 2024; Farrell & Newman, 2019). States can now exploit these chokepoints for coercive ends, effectively turning the liberal economic order into an arsenal for realist power politics. The central debate has thus shifted from *if* interdependence creates vulnerability to *how* that vulnerability can be precisely measured and managed

The U.S. Semiconductor Supply Chain: An Overview of Strategic Vulnerability

A comprehensive mapping of the global semiconductor value chain reveals a distinct pattern of U.S. strength in the intangible, knowledge-based segments and profound weakness in the tangible, manufacturing-based segments (BCG & SIA, 2024; CSET, 2022; CSIS, 2023). The United States maintains a commanding position in chip design, intellectual property (IP), and Electronic Design Automation (EDA) software (Farrell & Newman, 2019; CSIS, 2023).

This strength is starkly contrasted by a critical dependency on foreign partners for physical production. The primary structural vulnerability is the extreme geographic concentration of key manufacturing processes in East Asia (BCG & SIA, 2024). The most significant chokepoint lies in the manufacturing of advanced logic chips (nodes below 10 nanometers), where over 90% of production is concentrated in Taiwan (BCG & SIA, 2024). This dependency is the result of a decades-long trend that saw the U.S. share of global semiconductor manufacturing capacity plummet from 37% in 1990 to just 10% by 2022 (Semiconductor Industry Association, 2025).

The theoretical vulnerabilities inherent in this concentrated supply chain were made brutally manifest during the global chip shortages of 2020-2022. The empirical literature from this period provides a compelling and quantifiable record of the profound economic damage that can result from disruptions. At the macroeconomic level, the semiconductor shortage reduced

U.S. real Gross Domestic Product (GDP) by approximately $240 billion in 2021 alone (Bai et al., 2024). The damage was not evenly distributed, with the automotive sector providing the most dramatic example. Globally, the shortage led to the loss of nearly 8 million units of vehicle production, with an associated revenue loss for automakers exceeding $210 billion (Bai et al., 2024; BCG & SIA, 2024). The shortages also served as a powerful engine of cost-push inflation, with some estimates suggesting that the spike in vehicle and electronics prices accounted for as much as one-third of U.S. headline inflation during this period (Bai et al., 2024).

Review of Existing Methods for Quantitative Analysis

The growing recognition of supply chain fragility has spurred a corresponding increase in scholarly efforts to quantify the economic impact of disruptions. This endeavor presents a significant econometric challenge: how to isolate the effects of a negative supply-side shock from the confounding influence of simultaneous demand-side fluctuations (Bai et al., 2024; Kouchekinia & Tüzemen, 2023). To address this, researchers have increasingly turned to time-series models, particularly the Vector Autoregression (VAR) framework.

The VAR model has emerged in the recent literature as a prominent and flexible tool for estimating the macroeconomic consequences of supply chain disruptions (Bai et al., 2024; European Central Bank, 2022; Kouchekinia & Tüzemen, 2023). In its basic form, a VAR model consists of a system of equations where each variable is explained by its own past values and the past values of all other variables in the system (Kouchekinia & Tüzemen, 2023). Across recent studies, a consistent set of variables is typically employed: macroeconomic indicators like industrial production and a price index as outcome variables, and a proxy for supply chain disruptions, most commonly the Supplier Deliveries Index (SDI) from the Institute for Supply Management (ISM), as the key explanatory variable (Kouchekinia & Tüzemen, 2023).

While the basic VAR model provides a powerful starting point, the scholarly literature has moved toward using **Structural Vector Autoregression (SVAR)** models to address the critical challenge of shock identification. A basic VAR produces "reduced-form" shocks that are correlated mixtures of underlying structural forces. SVAR models impose restrictions based on economic theory to disentangle these shocks. A common approach is "identification through sign restrictions" (Bai et al., 2024; European Central Bank, 2022). For example, a researcher might assume that a negative supply shock causes output to fall and prices to rise (stagflation), while a positive demand shock causes both to rise. By imposing these theoretical sign restrictions, the SVAR can isolate a "pure" supply shock and provide a more credible estimate of its impact (European Central Bank, 2022).

Synthesis and Identification of the Research Gap

The preceding review of the theoretical, empirical, and methodological literature paints a comprehensive picture of the current state of knowledge, yet it also illuminates a critical gap that remains unaddressed by existing scholarship. The synthesis of these distinct streams of research reveals that while the problem of semiconductor dependency is well-defined and its consequences are documented, the analytical tools available to policymakers and industry leaders remain incomplete. The literature successfully establishes a profound theoretical tension, a well-documented empirical problem, and a sophisticated set of methodological tools, but it stops short of providing the specific analytical framework needed for proactive, evidence-based risk assessment.

Despite this rich and multifaceted body of work, a crucial analytical gap persists. The existing literature is strong in its qualitative assessments of dependency, its detailed case studies of acute crises, and its high-level descriptive statistics that correlate supply issues with economic outcomes. These approaches are invaluable for understanding the nature and history of the problem. However, what is conspicuously missing from the literature is a validated, replicable, and parsimonious quantitative framework to measure the *baseline* economic dependency of U.S. industry on its inbound semiconductor supply chain under normal, non-crisis conditions.

This absence is significant because the current quantitative studies are overwhelmingly focused on measuring the impact of discrete, large-scale *shocks* as deviations from an assumed, but unmodeled, equilibrium. They excel at answering the question, "What was the economic impact of the COVID-19 pandemic shock?" but are not designed to answer the more fundamental and forward-looking question, "What is the stable, underlying statistical relationship between semiconductor import availability and U.S. industrial production?". Without first establishing this baseline model of dependency, any analysis of disruptions is necessarily incomplete and reactive. It is akin to studying the effects of an earthquake on a building without first having the architectural blueprints; one can measure the damage after the fact, but one cannot assess the building's inherent structural integrity beforehand.

A project designed to fill this precise gap would therefore create the very framework that is currently absent from the literature. By developing and testing a time-series baseline model, such research would provide a direct, evidence-based method for quantifying the normal-state dependency of key U.S. industrial sectors on semiconductor imports. Subsequently, this baseline would serve as a stable reference point against which the impact of disruptions—measured as statistically significant deviations from this established norm—can be accurately and dynamically assessed. This approach moves beyond the descriptive, post-hoc analysis of past crises to create a tool with genuine analytical and potentially predictive power. It directly addresses the need for empirical adjudication in the theoretical debate between liberal and realist paradigms and provides a practical instrument for ongoing, proactive risk assessment by policymakers and industry stakeholders

Implications for Theory, Policy, and Industry

This comprehensive review of the literature on the U.S. semiconductor supply chain has traced the contours of a rapidly evolving and critically important field of study. In doing so, it has established a clear and significant research gap for a quantitative baseline model of U.S. economic dependency. The significance of filling this gap extends across the domains of academic theory, public policy, and industry strategy. For theory, a quantitative model measuring the tangible economic costs of instability would provide crucial empirical data to adjudicate between competing liberal and realist claims. For U.S. policymakers, a validated baseline model would offer a powerful new tool to assess economic risks and establish an empirical baseline against which the effectiveness of landmark legislation like the CHIPS and Science Act can be measured over time (BCG & SIA, 2024). For industry leaders, this research would offer a clearer, macro-level understanding of systemic risks, providing a rationale for the strategic shift from "just-in-time" to more resilient "just-in-case" sourcing models (The Soufan Center, 2025).

Proposed Methods

Research Design and Rationale

This study will employ a quantitative research design, with the core of the methodology being the application of time-series econometric modeling to publicly available macroeconomic and trade data. The use of a time-series approach, which tracks the same variables repeatedly over an extended period, is essential for this research because it allows for the analysis of trends, dynamics, and the impact of shocks over time—a feat impossible with a cross-sectional approach (Wooldridge, 2015). This methodology is uniquely suited to analyzing the dynamic relationships between precisely defined, measurable variables, such as monthly import values and sector-specific production indices (Stock & Watson, 2020).

Because a true randomized controlled trial is impossible in macroeconomics, this study will utilize established econometric methods to analyze observational data. By treating the fluctuations in supply chain friction as a naturally occurring explanatory variable, the model can estimate its causal effect on the economy. This is a common and respected approach in applied econometrics for policy evaluation when random assignment is not feasible (Cunningham, 2021). This design allows for a rigorous, empirical assessment of the supply chain's economic impact that moves beyond simple correlation. The analysis will be conducted using the R statistical programming language, a standard in academic research which offers a comprehensive and transparent suite of open-source libraries specifically designed for advanced time-series analysis and replicable research.

Data Collection Method

The study will construct a comprehensive time-series dataset by collecting and integrating data from two primary, authoritative, and publicly accessible online sources: the U.S. Census Bureau's USA Trade Online portal and the Federal Reserve Economic Data (FRED) database. The selection of these government-maintained sources is based on their long-standing reputation for authoritativeness, methodological transparency, and institutional integrity. While concerns about political influence on federal statistical agencies have been raised in recent years, these institutions are protected by significant "firewalls" designed to ensure data impartiality. These safeguards include statutory protections under federal law (such as Title 13 of the U.S.

Code for the Census Bureau), a professional civil service of career statisticians and economists who are insulated from political pressures, and methodologies that are publicly documented and subject to review by the international academic and financial communities. The U.S. Census Bureau operates under a strict legal mandate to protect the confidentiality and integrity of its data. Furthermore, the trade data used in this study is not derived from surveys but is based on administrative records from customs filings, making it less susceptible to manipulation. Similarly, the Federal Reserve maintains a well-established tradition of political independence, and its FRED database is globally recognized as the gold standard for economic data aggregation, relied upon by researchers, financial markets, and policymakers alike. For these reasons, their data remains the most reliable and authoritative for macroeconomic analysis.

The selection of these government-maintained sources ensures a high degree of data reliability, validity, and transparency. Data will be collected for the period from January 2010 to December 2023 at a monthly frequency. This data spans 14 years and features 168 monthly observations and will be used as a sample size for time-series modeling and is strategically chosen to include periods of relative stability, the U.S.-China trade war, and the acute disruptions of the COVID-19 pandemic era (Hyndman & Athanasopoulos, 2021).

The collection process involves downloading four specific datasets. The first dataset is for the U.S. Monthly Semiconductor Import Value variable, which will be the monthly "General Imports" value in USD for products under HS Code 8542 from USA Trade Online. The second is for the U.S. Monthly Computer & Electronics Production Index variable, which is the seasonally adjusted "Industrial Production Index for Computer and Electronic Products" (Series ID: IPG334) from FRED. The third is for the Supplier Delivery Time Index variable, which is the seasonally adjusted "ISM Manufacturing: Supplier Deliveries Index" (Series ID: MANSUDI) from FRED. The final dataset is for the control variable, the U.S. Manufacturing PMI, which is the seasonally adjusted "ISM Manufacturing PMI Composite Index" (Series ID: NAPM) from FRED.

Variables to be Included

This study will include four key variables, each with a precise operational definition that links a theoretical concept to a measurable data point, and the selection of each is supported by established practices in economic and supply chain literature.

The primary independent variable, U.S. Monthly Semiconductor Import Value, is operationally defined as the total monthly import value in U.S. Dollars for products under the Harmonized System (HS) Code 8542, which is the internationally recognized standard for electronic integrated circuits. Its use as a key indicator for the flow of essential technology inputs is consistent with research on global value chains in the electronics industry (Sturgeon & Kawakami, 2011). The dependent variable, U.S. Monthly Computer & Electronics Production Index, is operationally defined as the monthly, seasonally adjusted Industrial Production Index for Computer and Electronic Products (FRED Series ID: IPG334). This index is a widely accepted macroeconomic indicator used as the primary outcome measure of economic performance in the high-tech sector, a common practice in econometric analysis (Lahiri & Monokroussos, 2013). To measure disruptions, the study uses the Supplier Delivery Time Index as a key explanatory variable, operationally defined as the seasonally adjusted ISM Manufacturing: Supplier Deliveries Index (FRED Series ID: MANSUDI). Recent macroeconomic literature has increasingly relied on this data-driven index to identify supply-side shocks, as it serves as a direct proxy for supply chain friction by capturing the intensity of delivery delays (Bai et al., 2024; European Central Bank, 2022). Finally, to control for aggregate economic fluctuations, the study includes the U.S. Manufacturing PMI, operationally defined as the ISM Manufacturing Purchasing Managers' Index (FRED Series ID: NAPM). The PMI is a standard indicator of the overall health of the manufacturing sector, and its inclusion allows the model to isolate the specific relationship between semiconductor imports and tech production from broader economic trends, thereby reducing the risk of omitted variable bias (Lahiri & Monokroussos, 2013).

These four variables will be integrated into a Vector Autoregression with Exogenous Variables (VARX) model to analyze their dynamic relationships. Within this framework, the U.S. Monthly Computer & Electronics Production Index will serve as the core dependent variable, while the U.S. Monthly Semiconductor Import Value will be treated as the primary independent variable to test the study's central hypothesis. The Supplier Delivery Time Index and the U.S. Manufacturing PMI will be included as exogenous variables. This sophisticated structure allows the model to test the baseline dependency between imports and production while also measuring how that relationship is affected by supply chain shocks, all while controlling for the influence of overarching economic conditions.

Plan for Data Cleaning, Preprocessing, and Analysis

A systematic, multi-step procedure will be followed to ensure the data is properly prepared and rigorously analyzed. First, in the data cleaning and preprocessing phase, the downloaded datasets will be merged by date in R into a single time-series object. This master dataset will be inspected for correctness, data type consistency, and any potential outliers. To avoid the well-documented problem of spurious regressions, where a statistical relationship can appear between unrelated non-stationary variables (Stock & Watson, 2020), each time series will then be formally tested for stationarity. Stationarity, the property where a series' statistical properties are constant over time, is a prerequisite for many time-series models. The Augmented Dickey-Fuller (ADF) test will be used to test for the presence of a unit root, the statistical indicator of non-stationarity. If a series is found to be non-stationary, it will be transformed to achieve stationarity, primarily through first-differencing, with logarithmic transformations applied beforehand to stabilize variance and allow for elasticity-based interpretations (Hyndman & Athanasopoulos, 2021; Stock & Watson, 2020).

The data analysis will proceed in a structured sequence. The first step is to generate descriptive statistics and visualizations for all variables to understand their properties. The second step is model development, where a Vector Autoregression with Exogenous Variables (VARX) model will be built. The core endogenous system will include the U.S. Monthly Semiconductor Import Value and the U.S. Monthly Computer & Electronics Production Index, while the Supplier Delivery Time Index and the U.S. Manufacturing PMI will be included as exogenous variables. This sophisticated structure allows the model to analyze the dynamic feedback between imports and production while controlling for the influence of broader economic conditions and measuring the impact of supply chain friction.

The third step is hypothesis testing and disruption analysis. A Granger Causality test will be conducted to assess if past values of the U.S. Monthly Semiconductor Import Value significantly predict current values of the U.S. Monthly Computer & Electronics Production Index (Brooks, 2019). To provide a richer, more dynamic analysis of disruptions, and to directly test the second hypothesis (H2), Impulse Response Functions (IRFs) will be generated. An IRF will trace the dynamic response of the U.S. Monthly Computer & Electronics Production Index over several subsequent months following a one-time "shock" to the Supplier Delivery Time Index, illustrating the magnitude, persistence, and duration of a supply chain shock's impact (Brooks, 2019). The final step is model diagnostics, where the model's validity will be rigorously assessed through diagnostic tests on the residuals for serial correlation and heteroskedasticity to ensure the results are statistically sound (Hyndman & Athanasopoulos, 2021).

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