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Inflation, Population, and Supply Chain Management in the United States (1980 - 2022)

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Abstract
The study has examined the impact of inflation and population on supply chain operations in the United States. The descriptive research design was adopted, while time series data on inflation, population, supply chain, and manufacturing exports were obtained for the period of 1980-2022. The Autoregressive distributed lag technique was adopted in analyzing the relationship that exists among the variables. It was found that inflation demonstrated both negative and positive but insignificant effect on supply chain operation in both the short run and the long run, respectively. Conversely, population was found to have promising future relationship with supply chain operations in the US. The study concludes that population dynamics are more important to supply chain operation in the US. Therefore, the study recommends that the US government invests more in capacity development for the US citizens and migrants to enable them develop capacity that will drive supply chain operations for the overall improvement of the manufacturing sector and the US economy at large.

Keywords: Inflation, Supply Chain Operations, Population, Manufacturing, Exports, United States.

I. Introduction

Inflation, population dynamics, and supply chain operations are some crucial variables for explaining and understanding the patterns of economic growth(Kyriakopoulos,;Anderson & Gruen, 1995; Furuoka, 2018; Goel, Saunoris, & Goel, 2021; Agarwal and Baron 2023;Brida, Alvarez, Cayssials, & Mednik, 2024).These three variables are significant in the economic growth of the United States. This is because, they all relate to manufacturing, which is a leading contributor to the US GDP. For instance, manufactured goods are produced at a cost and distributed within the supply chain network to a population with distinct characteristics and socioeconomic status, at a price. A sustained increase in the prices of goods and services over time is termed inflation, which determines, in part, the demand for a product(Wu, 2023). Although, there has been different pattern of inflation changes in the United States as shown in Figure 1, the effect of the changes on other economic variables, especially, supply chain operations and population is worth verifying empirically.

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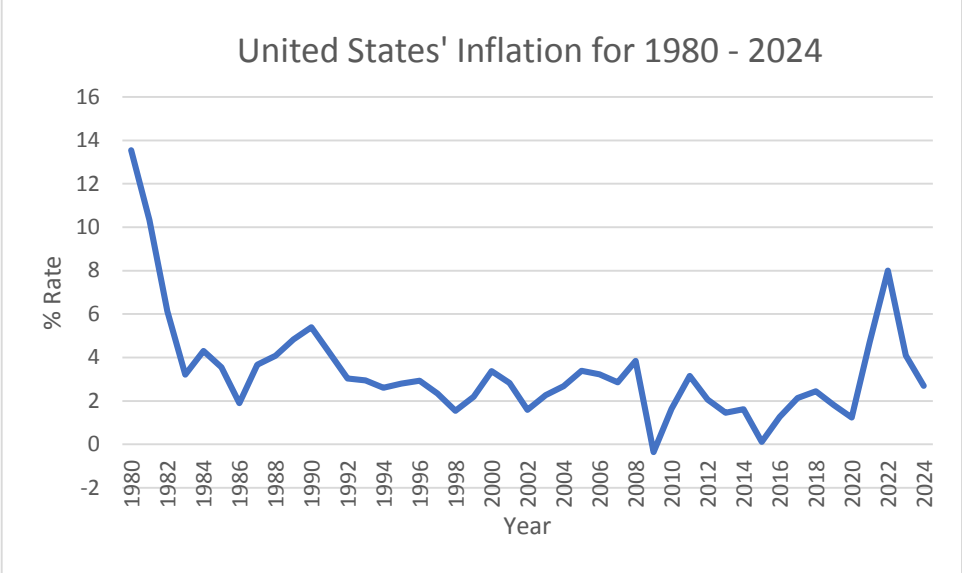

Figure 1. United States' Inflation Rates 1980-2024

Importantly, the demand for a product determines the supply of the same product and that of its substitutes. Faced by a declining product demand, the supply chain operation faces a disruption that will generate ripple effects for all critical stakeholders,such as manufacturers, warehouse operators, distributors,and raw materials suppliers.The decline in product demand as a result inflation will affect the overall economy in the form of low productivity, high unemployment, and a decline in the nation's output. Empirical and theoretical evidences suggest that economies have combated the effect rising inflation with increased productivity to increase supply in a bit to cushion the effect of demand pressure,which can be facilitated by increasing (quality) population.

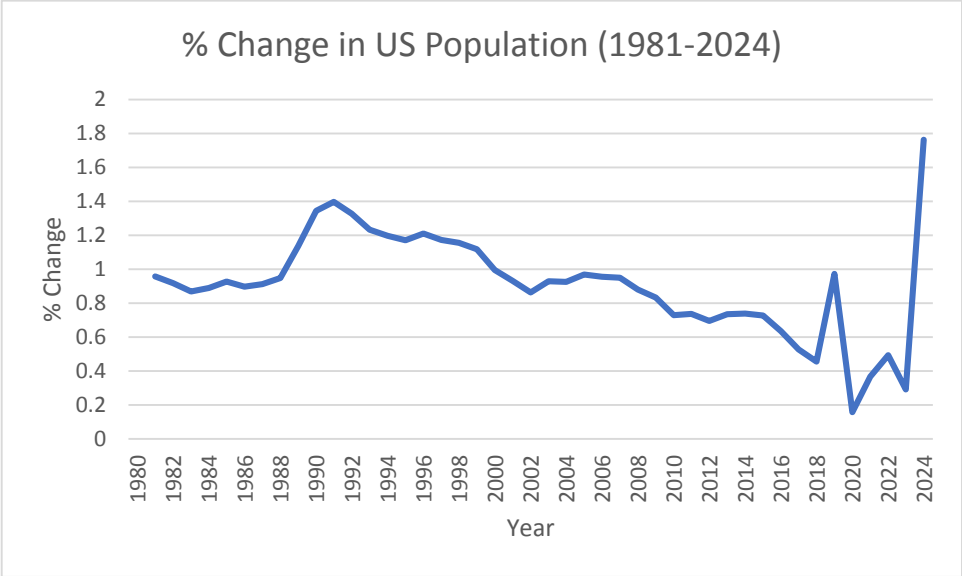

Figure 2. United States' Population Changes (1981-2024)

Population growth rate in the United States for 1981-2024 as shown in Figure 2 depicts cases of rise and fall in the growth rate of US population over the years under reference (WDI, 2023, US Bureau of Commerce, 2024). The population dynamics play some crucial roles in the growth experience of the US over the years. The place of population, especially its growth, in the

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development of a society has been examined variously by scholars (Baldini, 2015; Wesley & Peterson, 2017). Whilst population is believed to play active role in the development of a society, concerns have risen on some of its consequences, which scholars have identified as negative impacts on living standards, depletion of natural resources, increase in environmental degradation among others. In particular, growth theories in economics identified positive roles for population growth, which, if combined with necessary capital assets and technology, can catalyze an unprecedented growth for a society. In agreement to this position, Piketty (2014) identified two components for economic growth, demographic and economic components, though he concluded that the economic component is capable of improving the standard of living.

However, in order toimprove the living standards of a nation, a functional manufacturing sectoris required. The functionality of the manufacturing sector in turns require a resilient and highly (socially, operationally, risk-managed, and economically) guarded supply chain management. The roles of supply chain economic growth has been empirically and theoretically established in the production and operations management literature. Rising costs of input factors, the overheads, operations, warehousing, and distribution have implications for the cost of product. As perceived by Lapinskaitė&Kuckailytė (2014) the costs of producing a product, when considered in terms of complete supply chain process, are important to the final price. A higher product price will reduce consumers' surplus, thereby leading to a boycott of the affected product in favor of the close substitutes. With a widespread cost and price increase, consumption pattern will fall and this will adversely affect supply chain operations, the manufacturing sector, and by extension, the entire US economy. Against this background, this paper examines the relationship between inflation, population, and supply chain management in the United States.

II. Literature Review

Increasing price of goods is a global phenomenon, which businesses face all over the world. Some causes of global inflation have been examined by studies with most of them pointing accusing fingers to Russia-Ukraine war and its effect on global energy supply, the incidences of terrorism in the Middle East, supply chain disruptions and its consequences on production, and supply (Lopez & Mitchener, 2021; Aharon&Qadan, 2022; Caldara, 2022; Maurya, Bansal, & Mishra, 2023; Hamza, Hamida, Mili, & Sami, 2024). According to Hamza *et al* (2024), supply chain is one of the negatively affected processes by inflation, while global banking operations also suffered worse cases of volatilities, which were the reasons for deploying radical monetary policies to rescue the situation. The authors further concluded that, on the heels of inflation, exchange rate problems were prominent, while the global economy recovers at very slow rates.

The effect of inflation on supply chain has been variously analyzed by scholars, supply chain professional and researchers. For instance, Vallejo (2022), the VP Digital Supply Chain itemized 3 ways in inflation affects global supply chain; namely: reduction in post-tax income, increase in direct and indirect product costs, increase in cost of finance as a strategy to fight inflation. Logistics and manufacturing costs such as cost of raw materials, energy, movement of goods, raw materials, and semi-finished goods including cost of warehousing are some of supply chain components that are directly affected by inflation. In 2022 analysis carried out for Swiss insurance group Zurich by Ahuchogu, Specialist Risk Engineer, procurement was described as more complex during under inflation, while increased production costs are passed to the final users of products in form of high prices. The higher the price, the more of consumers' surplus taken, and then the lower the demand for the product. By implication, the effect of inflation on supply chain operations is capable of having broad macroeconomic effects.

While the previously cited literature agreed that supply chain could be at the receiving end of the effect of global inflation, Gordon & Clark (2023)had a different perspective. Their work concluded that supply chain disruptions could lead to inflation. Specifically, findings from Gordon & Clark (2023) concluded that aggregate demand, supply forces, and supply chain disruptions are responsible for increasing prices of commodities. The findings of Gordon & Clark were further corroborated by Shapiro (2022), and Eickmeier& Hofmann (2022), who also concluded that a combination of demand and supply factors have further heightened inflation since mid-2021. Furthermore, though supply chain has been empirically established as a driver of inflation, Benigno, Giovanni, Groen & Noble (2022) affirmed that though other factors were also responsible for steady rise in products' prices, global supply factors played critical roles.

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III. Methodology

In this paper, the descriptive research design was usedwith time series data that were generated on inflation, population, manufacturing exports, and supply chain for the US, covering 1980– 2022.The data set was generated from the World Development Indicators (WDI, 2022). The purpose of the analysis is to examine the relationship, both the short run and the long run, among supply chain, population, inflation, and manufacturing exports. The Autoregressive distributed lag (ARDL) model was adopted for the analysis. Pre-regression analysis conducted were the test of variables stationarity, which was carried out using Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests. Optimal lag lengthwas adopted using the lag length selection criteria, while the post-regression analysis such the heteroskedasticity, serial autocorrelation, and model stability tests were also conducted. The outcome of the stationarity tests revealed that the variables comprised a combination of stationary variables at level and at first difference, which made the adoption of ARDL relevant.

3.1 Model Specification

The underlying theory that explains the relationship between inputs and output in an economy is the neoclassical theory of economics, which was stated in Cobb-Douglas production function as:

$$SCMC_t = f(INFL_t, POP_t, MANFEX_t) \quad (1)$$

Where: $SCMC_t$ represents supply chain management cost at time t

POP_t represents the Population

$INFL_t$ represents Inflation.

$MANFEX_t$ represents manufacturing exports.

The supply chain management cost, for the purpose of this study, is defined as the total final consumption in the United States for the period of the study. Production is deemed complete, when the product reaches the final consumer. With this foundation, and with the understanding that the sum total of all goods and services produced in an economy, as represented by the final consumption, is a good proxy for the supply chain management cost. Therefore, supply chain management cost will depend on inflation, population growth or decline, while manufacturing exports was adopted as a control variable.

All the variables, except inflation, were log-linearized for simplicity and interpretationease. A linear relationship is assumed to exist among the variablesand specified in its structural form as:

$$lnSCMC_t = \alpha_o + \alpha_1 INFL_t + \alpha_2 lnPOP_t + \alpha_3 lnMANFEX_t + \mu_t \quad (2)$$

Where:ln is the logarithm parameter, μ_t is the idiosyncratic error term that is IID $\mu_t \sim N(0,1)$;$\alpha_o - \alpha_3$represent the intercept term, and the unknown coefficients terms of the exogeneous variables.

However, the ARDL shortrun and long run model is specified as:

$$\Delta lnSCMC_t = \phi_o + \sum_{i=0}^{q} \phi_1 \Delta lnSCMC_{t-i} + \sum_{i=0}^{q} \phi_2 \Delta INFL_{t-i} + \sum_{i=0}^{q} \phi_3 \Delta lnPOP_{t-i} + \sum_{i=0}^{q} \phi_4 \Delta lnMANFEX_{t-i} + \vartheta_1 \Delta lnSCMC_{t-i} + \vartheta_2 \Delta INFL_{t-i} + \vartheta_3 \Delta lnPOP_{t-i} + \vartheta_4 \Delta lnMANFEX_{t-i} + ECT_{t-1} + \mu_t \quad (4)$$

3.2 Data Sources and Measurement

Table 1 *Measurement of Variables and Data Sources*

Variable	Measurement	Sources
Supply Chain Management Cost	Manufacturing, value added (Constant 2015US$)	World Development Indicators, 2023
Inflation	Consumer prices (annual %)	World Development Indicators, 2023.
Population	Total US population	World Development Indicators, 2023.
Manufactures exports	% of merchandise exports	World Development Indicators, 2023

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IV. Presentation of Results and Discussion of Findings

4.1 Discussion of findings

The pre-regression analyses were conducted and the outcomes aligned with the basic standards for adopting Autoregressive distributed lag model.

Table 2 ARDL Results of the Impact of Inflation and Population on Supply Chain Management

Variable	Coefficient	Std Error	t-Stat	Prob.	R-Sqd	Adj. R-Sqd	DW-Stat
D(LNSCMC(-1))	0.71	0.14	4.91***	0.00	0.87	0.80	2.17
D(LNMANFEX)	-0.02	0.03	-0.88	0.39			
D(LNMANFEX(-1))	-0.07	0.03	-2.99***	0.01			
D(INFL)	-0.00	0.00	-0.11	0.92			
D(INFL(-3))	0.01	0.00	3.11***	0.01			
D(LNPOP)	-6.30	1.37	-4.61***	0.00			
D(LNPOP(-1))	9.23	1.19	7.77***	0.00			
CointEq(-1)*	-0.27	0.06	-4.29***	0.00			
LNMANFEX	0.17	0.02	7.76***	0.00			
INFL	0.02	0.01	1.73	0.10			
LNPOP	1.31	0.03	40.64***	0.00			

*, **, and *** represent 10%, 5%, and 1% level of significance; Note: R-Sqd is R-Squared
Source: Authors' Computation, 2025.

4.2 Discussion of findings

The regression results for the short run and the long run analyses of the impact of inflation and population on supply chain management are presented in Table 2. As shown in the results, there is a positive short run effect of the previous value of supply chain management on its current value. Inflation is found to have a negative but insignificant effect on supply chain operations in the short run. Conversely, in the 3 lagged periods, inflation was found to have a positive and significant impact on supply chain operation. The impact, though positive,appeared very small (t=3.11, $p < 0.01$). Unexpectedly, population has significant but negative effect on supply chain operations in the US. Specifically, a percentage increase in the US population will reduce supply chain management value by a percentage to 6.30 ($t = -4.61$, $p < 0.01$). The effect of population on supply chain management operation in the US had in the previous period shown very strong and positive impact on supply chain operations such that one percent increase in the US population will enhance supply chain operations by 9.3 percent ($t = 7.77$, $p < 0.01$).Meanwhile, as shown in the results Table, the disequilibrium between the short run and long run period could be corrected at the speed of 0.27 percent per annum ($t= -4.29$, $p < 0.01$).

In the long run, inflation shows a positive relation with supply chain in the US. However, such relation is not statistically significant. Population was found to have strong positive on supply chain activities in the US in the long run in a manner that a percentage increase population will enhance supply chain activities in the US by 1.31 percent ($t = 40.64$, $p < 0.01$). Although, manufacturing exports was found to have both negative and insignificant effects on supply chain operations in the US during the short term, the long run results showed that manufacturing exports will enhance the US supply chain activities both positively and significantly. The Durbin Watson stat value of 2.17 showed that there is no autocorrelation problem with the variables of the models. Furthermore, the model enjoyed reasonable goodness of fit test with the R-squared and Adjusted R-squared values of 0.87 and 0.80.

4.3 Post-Estimation Diagnoses

Post-regressionanalyses were conducted to examine the reliability of the estimation outcomes. The results revealed that the obtained results were validand useful for purposes relating to predictions and forecasting. The Breusch-Pagan-Godfrey test for Heteroskedasticity produced:

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F-statistic	1.044121	Prob. F(15,18)	0.4597

Breusch-Godfrey Serial Correlation LM test also produced:

F-statistic	0.685323	Prob. F(2,16)	0.5181

The model's stability test through CUSUM and CUSUM of squares were also conducted and presented below.

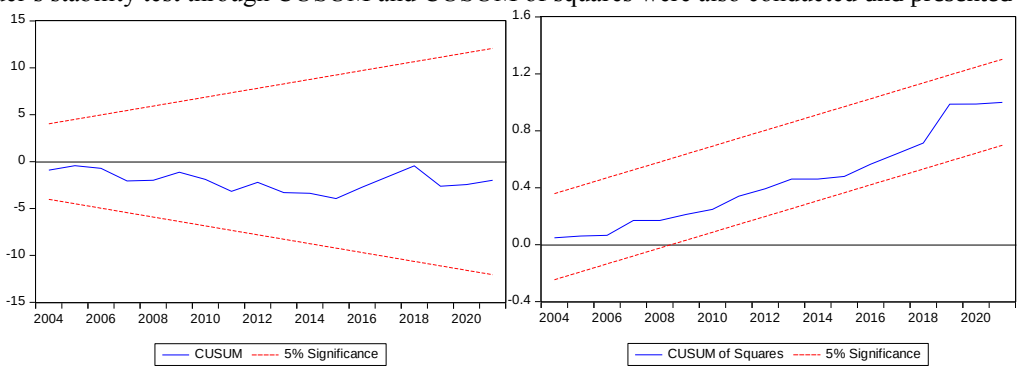

Figure 3: Model's Stability Test

V. Conclusion

This study sought to examine how population and inflation impact supply chain operations in the United States. This is because supply chain is a very significant part of both the growth of the US manufacturing sector, and the US economy. While inflation was identified in the literature as counterproductive to the business growth due to its reduction of aggregate demand, which also pulls down the aggregate supply, which itself brings about suboptimal use of resources, thereby reducing productivity and declining growth, population has been adjudged by scholars as necessary for growth, provided it is qualitative, informed, young, and agile. This study concludes that population dynamics (increase or decrease)are more important in explaining the performance of supply chain operations in the United States than inflation.

The study recommends that the US government provides the necessary regulatory support for improving the quality of the population if the USis to maintain its global leadership in economic growth. Furthermore, the study recommends that manufacturing export is an under-estimated area of the US manufacturing sector. If enhanced, it could spur more contributions of the manufacturing sector to growth of the US economy.

Author's Contributions

Munsifaruddin Mohammed conceived the idea, downloaded and reviewed the literature, and contributed to the writing and preparation of manuscript. Omotolani Akinbolajo collated relevant data, and prepared the pre-regression analyses. Williams Adeyemi reviewed the manuscript and made useful recommendations to the paper.

Conflict of Interest

There is no conflict of interest relating to the study.

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Data Availability

The study was conducted using free and open-sourced data as indicated in the article.

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