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The Impact of the Primary Sector on GDP of Greece, An Econometric Approach

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Abstract

The agriculture sector has long been one of Greece's most important production sectors. Its significance is multifaceted, affecting both the economy and Greek society. Agriculture plays a critical role in rural development. Although the agricultural sector's involvement in the Greek economy has declined dramatically in recent years, it remains high when compared to other EU member states. This article investigates the relationship between Greece's GDP and the agricultural, industrial, and service sectors from 1996 to 2020, including the financial crisis and the pandemic COVID-19 era. In Greece, there is a negative association between GDP and agriculture, whereas industry and services appear to be positively related to the country's GDP.

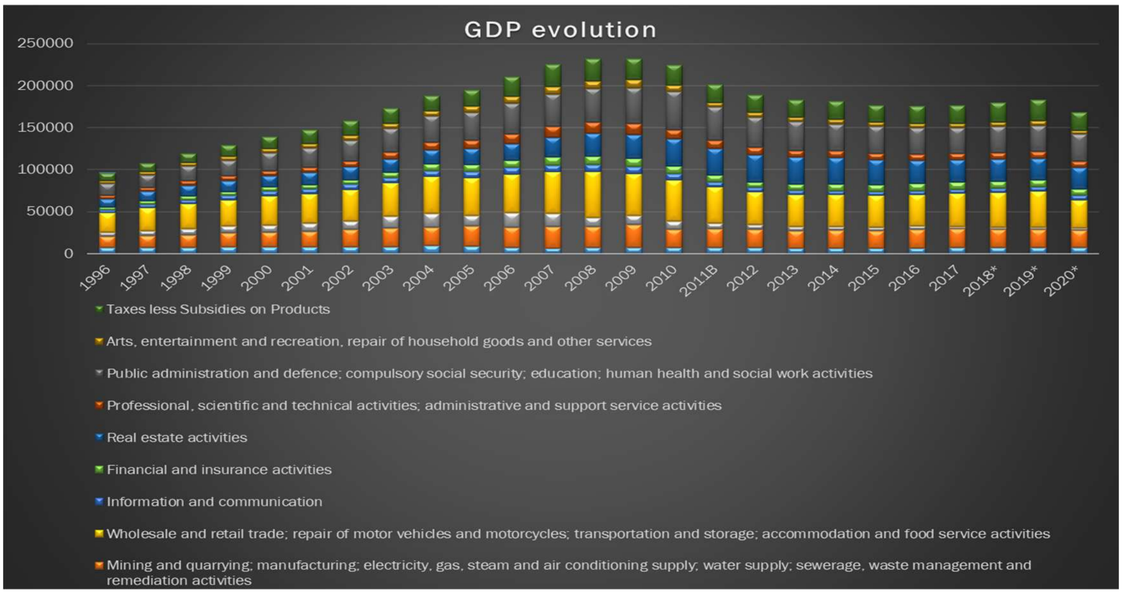
JEL Classifications: O12, O5, O5

Key words: Primary Sector, GDP, Economic Growth

1 Introduction

The added value of the primary sector as a percentage of Gross Domestic Product (GDP) reflects and measures the importance of the primary sector for a country. Given that Greece's primary sector contribution, as a percentage of GDP, averaged 4.28% from 1995 to 2019, with a low of 2.8% in 2009 and a high of 7.38% in 1995, this signifies a lot for the agriculture sector's contribution to the Greek economy, as shown in Table 1 below:

Table 1. Greek GDP Composition



Source: ELSTAT

The primary sector's contribution to Greece's GDP in 2019 is 3.65%, and while Greece owns 2.9% of the EU-27 farmland, its primary sector contribution to the EU-27 in 2020 is just 1.3%, as indicated in Table 2 below:

Table 2. Comparative Main Statistics for Greece and EY-27

	Year	Unit	EU-27	Greece	% Greece on EU-27
Gross Domestic Product	2019	EUR billion	13,963.6	183.4	1.3
Population (on 1st January)	2019	million	446.8	10.7	2.4
Land area	2016	km2	4,104,251.0	130,048.0	3.2
Farmland	2016	km2	1,566,653.0	45,538.0	2.9
Share of farmland in land area	2016	%	38.2	35.0	-

Source: Eurostat

In the early 1950s, Greece adopted an industrialization-focused development strategy, and by the 1970s, it had transformed its economy from agrarian to industrialized, creating new industries, changing the composition of industrial output in favor of intermediate and capital goods sectors, and shifting the gravity of its exports away from agricultural products and toward manufactured goods (Kyrkilis et al, 2013). Although empirical study for other economies has been considerable, it has not answered the theoretical issue of agricultural impact on the Greek economy. The research subject addressed by this study is the contribution and overall influence of agriculture gross value added on Greece's economic growth. A statistically significant impact on the formation of GDP is determined by using an econometric approach, which is used to analyze the GDP components (including those related to agriculture, forestry, and fishing, wholesale and retail trade, motor vehicle and motorcycle repair, transportation and storage, lodging, and food service), manufacturing, electricity, gas, steam, and air conditioning supply, water supply, sewerage, waste management, and remediation).

The paper is structured as follows. First, the most recent relevant literature review is surveyed. Then, the methodological approach is employed, and the main findings obtained are presented and critically discussed. Finally, the main conclusions are summarized, their usefulness is assessed by highlighting the limitations of the present study and considerations for its further extension are provided.

2 Literature Review

The main studies investigating the impact of the agricultural sector on the GDP of countries at the international level are summarized in Table 3 below:

Table 3. International Literature Survey

Study	Period	Country	Data	Technique	Method	Dependent Variable	Independent Variables	Conclusions
Awokuse (2009)	1971-2006	15 transition economies in Africa, Asia and Latin America	Yearly	Time Series	ARDL	GDP	Gross capital formation per worker as proxy for capital (K), population as proxy for labor (L), agricultural value added per worker (A), real exports (X) and inflation rate as proxy for domestic macroeconomic policy environment (P)	Agriculture is an engine of economic growth
Azeretal (2016)	2000-2010	Malaysia	Yearly	Time Series	Correlational and Multiple Regression Analysis	GDP	Agriculture, Services, Manufacturing	Agriculture has no significant relationship, services and manufacturing positive relationship
Enu (2014)	1996-2006	Ghana	Yearly	Time Series	OLS	GDP	Agriculture, Services, Industry	Positive relationship
Epaphra & Mwakalasya (2017)	1990-2015	Tanzania	Yearly	Time Series	OLS	Agriculture value added to GDP	Foreign Direct Investment inflow	No significant effect of FDI inflows on agriculture value added to GDP ratio
Grabowski & Self (2007)	1960-1995	Cross country analysis	Yearly	Panel Data	Regression analysis	GDP	Agriculture/fertilizer and tractor intensity, education of labor force and total factor productivity	Agriculture is a causal factor for economic growth
Hussin &Ching (2013)	1978-2007	Malaysia China	Yearly	Time Series	Regression Analysis	GDP	Agriculture, Services, Manufacturing	Positive relationship
Hye (2009)	1971-2007	Pakistan	Yearly	Time Series	ARDL	Agriculturral sector	Industrial sector	Bidirectional relationship
Izuchukwu (2011)	1986-2007	Nigeria	Yearly	Time Series	Multiple Reggression	GDP	Domestic Savings, Government Expenditure on Agriculture and Foreign Direct Investment (FDI) on Agriculture	Positive relationship
Jatupornetal (2011)	1961-2009	Thailand	Yearly	Time Series	Unit root, Granger causality test, Wald coefficient statistic, Generalized variance decomposition	GDP	Agriculture	Bi - directional causation between agriculture and economic growth
Katircioglu (2006)	1975-2002	Cyprus	Yearly	Time Series	ADF, PP, Granger causality test	GDP	Agriculture	Bi - directional causation with economic growth
Matahir (2012)	1970-2009	Malaysia	Yearly	Time Series	Cointegration, Granger causality test	Agriculturral sector	Industrial sector	Cointegrated in the long run, one way causality dorection from industrial to agricultural sector
Olajide et al (2010}	1970-2010	Nigeria	Yearly	Time Series	OLS	GDP	Agriculture	Positive relationship
Reddy & Dutta (2018)	1980-81 to 2015-16	India	Yearly	Time Series	Simple Regression Analysis	Agricultural GDP	Fertilizers, Net irrigated area, Pesticides, Electricity, Rainfall, Seeds	Fertilizers and irrigated area not statistically significant, pesticides and electricity negative relationship and rainfall and seeds positive relationship.
Sertoglu et al (2017)	1981-2013	Nigeria	Yearly	Time Series	VECM	GDP	Agriculture	Positive impact
Tsenkwo et al (2019)	1970-2017	Gambia	Yearly	Time Series	ARDL, OLS	GDP	Agriculture, Tourism, Services	Positive relationship
Uddin (2019)	1980-2013	Bangladesh	Yearly	Time Series	Granger causality test, Co intergration, VECM	GDP	Agriculture, Services, Industry	Causal relationship
Yetiz & Ozden (2017)	1968-2015	Turkey	Yearly	Time Series	Engle- Granger causality/block exogeneity Wald test, Impulse Response and Variance Decomposition Analysis	GDP	Agriculture, Industry, Services	Uni directional causality from agriculture to GDP and other sectors, but agriculture is not influenced by the others

In recent years, regional convergence in Greece and the role of agriculture in it has been the subject of empirical research as follows:

- Kyrkillis et al (2013) analyzed the contribution of agriculture and non agriculture sectors to economic growth for the years 1970-2007 using a VAR model and concluded that agriculture has no causal relationship and followed its own course
- Diamantikos (2013) aimed to highlight the contribution of agriculture to the development of Greece. He used regression analysis with independent variables agricultural production, capital, labor, livestock and land. He concluded that only capital and land have a positive impact on GDP
- Larisi (2011) studied the factors that led to the contraction of the agricultural sector for the period 1990-2011. She used agricultural income per capita, prosperity and labor to conclude that prosperity is the important factor that causes an increase to GDP by 71.44%
- Sapounas (1994) presented the factors such as capital accumulation export contribution and import penetration, which influenced the declining contribution of the agricultural sector using data from 1950-1990

3. Methodology and Results

The Hellenic Statistical Authority (ELSTAT) provided the annual time series data for the Greek GDP components from 1996 to 2020, which were used in the present study. Data on the GDP and its components from 2010 onward have been updated using 2015 as the base year.

To accomplish its goals, the study used both descriptive and inferential analysis. SPSS 26 was the statistical software program utilized to estimate the data.

To fulfill the study's goals, the growth model that was specified was as follows:

$$GDP = f(A, I, S) + \mu$$

where:

A: Agriculture (agriculture, forestry and fishing)

I: Industry (mining and quarrying; manufacturing, electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management and remediation activities)

S: Services (wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage, accommodation and food service activities)

μ: error term, containing unobserved factors that can never be eliminated (Wooldridge, 2012)

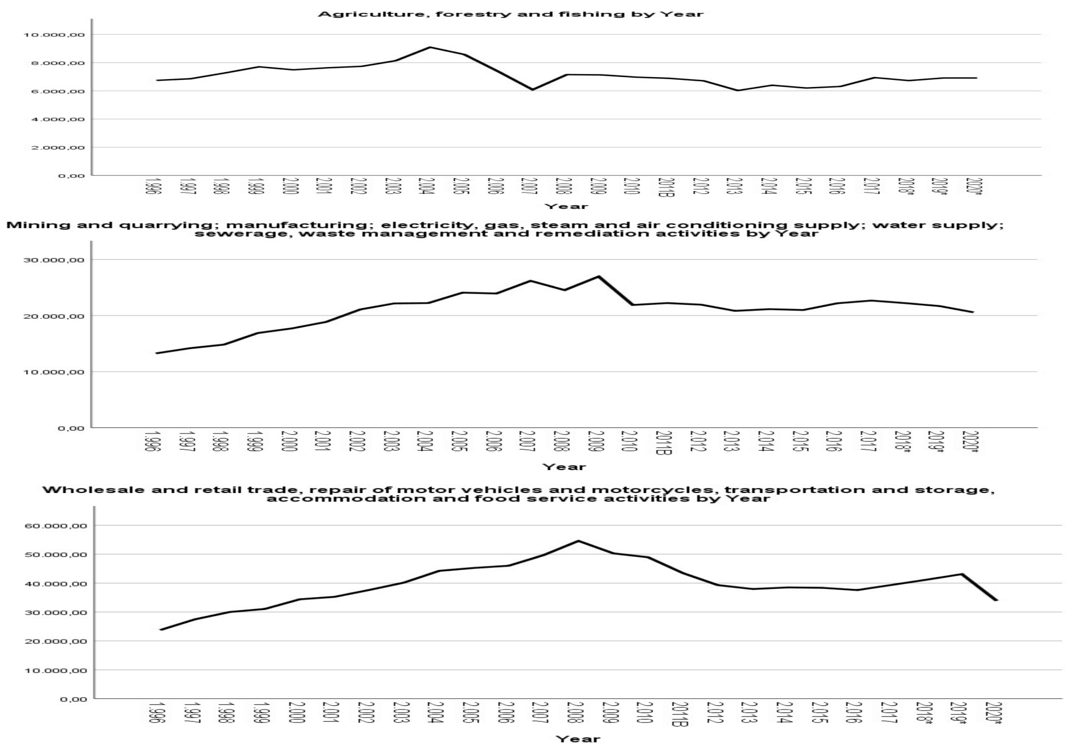
Table 4 presents the descriptive statistics for the aforementioned variables. The other GDP components were not included in the model since they were not determined to be statistically significant.

Table 4. Descriptive Statistics

	Mean	Std. Deviation	N
GDP	1,755,687,490	3,693,460,008	25
Agriculture	71,180,470	74,467,782	25
Industry	210,116,277	342,915,061	25
Services	396,592,159	738,095,347	25
Services	396,592,159	738,095,347	25

The intertemporal evolution of the sectoral gross value added (GVA) of each pillar is depicted by year in Figure 1 below.

Figure 1. Evolution of agriculture, industry and services on Greece's GDP through 1996-2020



97% of GDP was explained, and the model was statistically significant, as seen in Table 5 below.

Table 5. Model Summary (Initial Model)

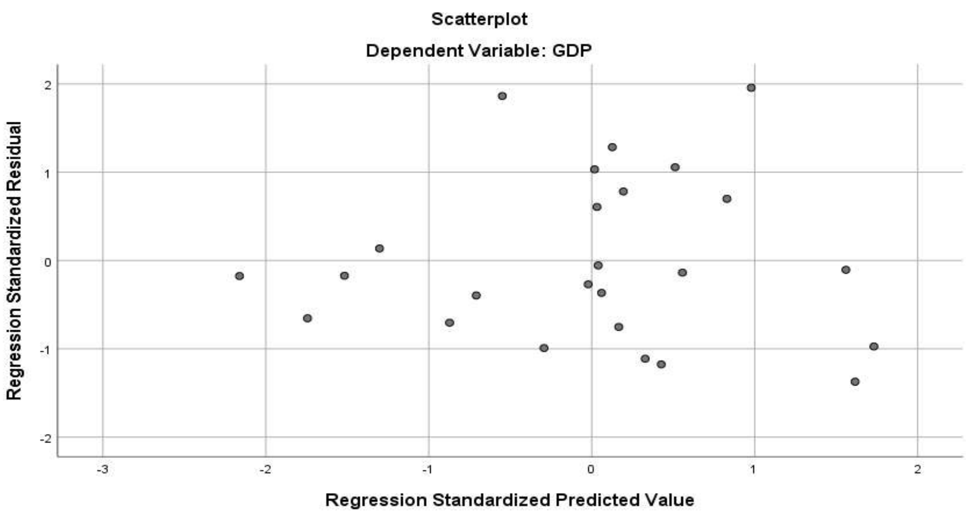
R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
				R Square Change	F Change	Sig. F Change
.985a	0.970	0.966	681,641,888	0.970	227.879	0.000

a. Predictors: (Constant), A, I, S
b. Dependent Variable: GDP

Autocorrelation, also known as serial correlation, is a data feature that demonstrates the degree of similarity between the values of the same variables over successive time intervals. Using the Durbin Watson test, it was estimated that DW=1,214, implying that there is no autocorrelation in the model under consideration at a significance level of 5%.

The presence of heteroskedasticity was tested by plotting the scatterplot of the regression standardized residuals to the regression standardized predicted value, as shown in Figure 2 below, where a cone-shaped pattern was observed, indicating the potential presence of heteroskedasticity.

Figure 2. Scatterplot of the regression standardized residuals to the predicted value



As a result, the above regression was run with the hypothesis, replacing the dependent variable with the square of residuals (Crowson, 2019).

H_0 : Homoskedasticity

H_1 : Heteroskedasticity

According to the results reported in Table 6 below, the null hypothesis was rejected based on the value of significance.

Table 6. ANOVA Table (Initial Model)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	8,949,727,554,795,610	3	2,983,242,518,265,200	1	.265b
Residual	44,089,149,325,365,200	21	2,099,483,301,207,870		
Total	53,038,876,880,160,800	24			

a. Dependent Variable: RES_12
b. Predictors: (Constant), A, I, S

The presence of heteroskedasticity was also assessed using the White test presented in Table 7 below, according which the null hypothesis was also rejected and therefore the presence of heteroskedasticity was concluded.

Table 7. White Test

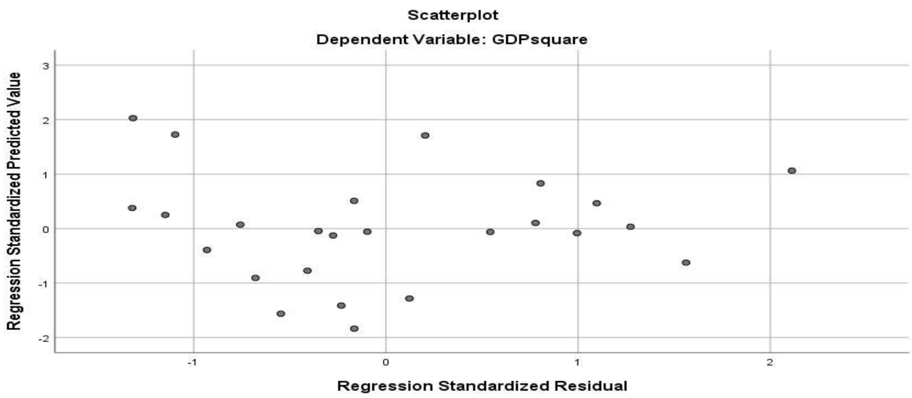
	Sum of Squares	df	Mean Square	F	Sig.
Regression	5,051,918,266,862,410	2	2,525,959,133,431,200	1	.333b
Residual	47,986,958,613,298,400	22	2,181,225,391,513,560		
Total	53,038,876,880,160,800	24			

a. Dependent Variable: RES_12

b. Predictors: (Constant), Unstandardized Predicted Value, PRE_12

A quadratic model was used to attempt to solve the heteroskedasticity problem. GDP2 is the name given to the square root transformation of GDP. Then, the square of the independent variables A2, I2, and S2 was computed. A regression of the square root of GDP was fit on the square of the independent variables, and the new residual plot, as shown in Figure 3 below, appeared random, with no cone shape visible, indicating that the assumption of homoscedasticity had been met. As a result, the variance of the standardized residuals was stabilized by using variable transformation (Astivia, Zumbo, 2019).

Figure 3. Scatterplot of the regression standardized predicted value to the standardized residual



The correlation matrix was examined to see if the model has a problem with multicollinearity. Based on the correlation matrix, a model demonstrates multicollinearity when the degree of correlation between two independent variables is greater than the degree of correlation found between the dependent and the specific independent variables. When the degree of correlation between two independent variables is greater than the degree of correlation between the dependent and the specific independent variables, the degree of multicollinearity is more severe. (Vamvoukas, 2016). According to the Pearson test presented in Table 8 below, the degree of correlation between the independent variables was smaller than the corresponding one observed between the dependent and the specific independent variables, so no indication of the appearance of multicollinearity was evidenced.

Table 8. Multicollinearity Matrix

Correlations

		GDPsquare	Asquare	Isquare	Ssquare
Pearson Correlation	**GDPsquare**	1.000	-0.079	0.922	0.963
	Asquare	-0.079	1.000	0.011	0.078
	Isquare	0.922	0.011	1.000	0.890
	Ssquare	0.963	0.078	0.890	1.000
Sig. (1-tailed)	**GDPsquare**	.	0.353	0.000	0.000
	Asquare	0.353	.	0.480	0.356
	Isquare	0.000	0.480	.	0.000
	Ssquare	0.000	0.356	0.000	.
N	**GDPsquare**	25	25	25	25
	Asquare	25	25	25	25
	Isquare	25	25	25	25
	Ssquare	25	25	25	25

Furthermore, multicollinearity was also checked using the Variance Inflation Factor (VIF), as presented in Table 9 below. VIF coefficient values greater than ten indicate a strong problem of multicollinearity in the estimated model. Therefore, no multicollinearity was evidenced according to VIF in the model.

Table 9. Collinearity VIF Statistics

	Tolerance	VIF
(Constant)		
Asquare	0.978	1,023
Isquare	0.204	4,901
Ssquare	0.030	4.93

a. Dependent Variable: GDPsquare

The serious problem of model specialization error arises when the econometric model is not accurately and objectively formulated. The incorrect specialization of the model contributes to the violation of one of the basic stochastic assumptions of the classical linear model, resulting in incorrect estimates of the model's coefficients by the OLS method. The most common specialization errors involve the introduction of irrelevant variables into the econometric model, the omission of significant independent variables from the model, incorrect model formulation, and inaccurate measurement of model variable values. Cronbach's alpha is a scale reliability and internal consistency metric. The estimated Cronbach's alpha value in the final model was 0.62, which was acceptable, as Alpha Cronbach's values above 0.6 are considered moderate and acceptable. As shown in Table 10 below, 96.1% of the variance of the dependent variable (Greece's GDP) was explained by the overall model estimated.

Table 10 Model Summary (Final Model)

R	R Square	Adjusted R Square
0.983a	0.966	0.961

a. Predictors: (Constant), A, I, S
b. Dependent Variable: GDPsquare

The statistical significance of the final model is demonstrated by the ANOVA Table in Table 11 below.

Table 11. ANOVA Table (Final Model)

	Sum of Squares	df	MeanSquare	F	Sig.
Regression	3,617,696,461,973,610,000,000	3	1,205,898,820,657,870,000,000	197,785	.000b
Residual	128,037,215,814,873,000,000	21	6,097,010,276,898,710,000		
Total	3,745,733,677,788,480,000,000	24			

a. DependentVariable: GDPsquare
b. Predictors: (Constant), A, I, S

As shown in Table 12 below, the statistical significance of all independent variables of the final model are statistically significant (as Sig <0.05). The sign of the coefficient of agriculture value added to GDP ratio is negative, which startled us at first but supports the notion that agriculture is becoming less crucial to Greece's economic growth. These conditions, however, create concerns about the sustainability of agricultural employment and food security in the country, necessitating the implementation of essential policies to ameliorate this loss. The industry and services sectors have a positive impact on the country's GDP, as expected, and their coefficients in the model are statistically significant as well. This supports the notion that Greece has shifted its development trajectory away from the agricultural sector of the past, looking forward to new horizons that include different areas of activity such us industry and services.

Table 12. Estimated Model (Final Model)

	UnstandardizedCoefficients		Sig.
	B	Std. Error	
(Constant)	3,502,797,509,467	2,943,352,161,445	0.247
Asquare	-156,595	45,996	0.003
Isquare	24,870	8,164	0
Ssquare	15,622	1,914	0

a. DependentVariable: GDPsquare

4. Conclusions

It is apparent in the current study that while Agriculture is a significant sector for Greece's GDP, its value added to GDP ratio is negative, suggesting that is increasingly becoming less important to the economic growth of Greece. Therefore, supporting Greek agricultural entrepreneurship through structural market policy measures is of primary importance since this sector is proven to be the only one that resists in periods of crisis. As the objectives of the new CAP have already been set, appropriate policy measures could be taken to strengthen rural entrepreneurship and provide incentives to farmers towards this direction.

However, for the wider practical application of this study it would be appropriate for future research to address the limitations:

- The sample size is 25. According to the central limit theory, the ideal sample size should be over 30, so the sample could be extended to more years in the future (currently not possible with the existing time series)
- The error term μ includes many possible unobserved factors that, even if reduced, may never be eliminated.
- The OLS method was completed with the square root of dependent and independent variables. The coefficients resulted have high values. This could be addressed by using appropriate econometric techniques.

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