Energy Consumption and Trade Liberalization: Investigating Performance of Economic Growth for French Economy

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Abstract

This study is organized to determine the performance of economic growth in the French economy. For this purpose, this study considers the role of energy consumption, trade openness and consumer prices as determining factors. The ARDL bounds test will be used for the sample from 1986 to 2022 to obtain empirical results. The results confirm that economic growth and its determinants are cointegrated in the long run. Moreover, the results also reveal that only energy consumption and trade openness significantly boost economic growth. It is further witnessed that capital accumulation is expanding economic growth in France. Among these three factors, trade openness's impact is stronger than the other factors taken in this research.

Keywords: Per Capita GDP; Trade Openness, Energy Consumption, France.

Introduction

Economic growth represents the level of economic activity which is taking place in any economy. If economic activity is taking place at a grander scale, then it reflects a higher size of economic growth and vice versa. So many inputs have been used to target economic growth, but trade openness and energy consumption are among the primary inputs that may accelerate the pace of economic growth. Liberalized trade is an essential source of domestic production expansion and economic growth. It is further asserted that expansion of domestic production escalates incomes, allows people to access basic needs, and hence prevents them from being poor and expands world trade in any economy and the supply chain network, making markets more diversified. Besides this, we have also seen through the literature that energy consumption has emerged as a vital source of economic growth. The researchers have provided inconclusive debate on this linkage. The causal and impact-related findings are found in the literature. Based on this discussion, we should consider both inputs as part of our study. Therefore, this study is conducted to inquire about the changing pattern of economic growth due to changes in trade openness and energy consumption for the French economy. The literature suggests that labor force and capital accumulation are also the driving factors of economic growth. This also allows us to consider these two primary inputs as a part of the model. The French economy is considered because it is an important European Union member.

The selected economy ranks among the world's largest economies with a GDP exceeding 2.5 trillion euros and plays a significant role in shaping regional and international economic

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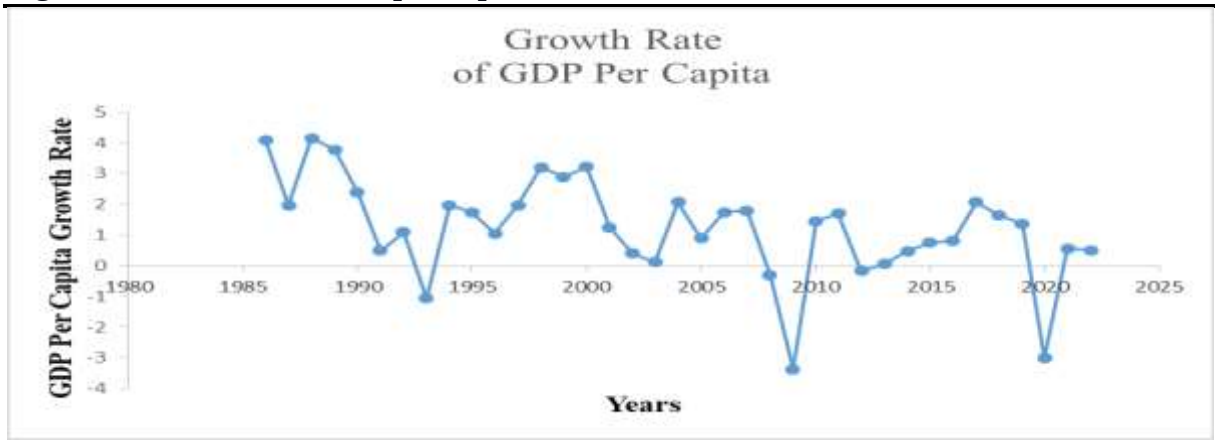
dynamics. While exploring the GDP growth determinants, the selected impacting variables include total labor force, gross fixed capital formation, consumed energy, trade openness and inflation. France is a mixed economy that contains aspects of both capitalism and socialism. The economy has considerable investments in capital infrastructure as tourism is one of the main contributors to their GDP. Learning the impact of labor and capital formation on the French economy is an essential outcome of this study. France is one of the largest electricity exporters. It generates a more significant chunk of energy using nuclear reactors, which is why energy consumed could drive economic growth. Figure 1 shows the growth rate of French per capita GDP. The economic growth has a rising trend, with a slump in 2009 as an after-effect of the Global Financial Crisis of 2008 and another downward fall in 2020 as a result of the global pandemic of COVID-19. The growth rates of per capita GDP are presented below, which reveal that the lowest growth rate of per capita GDP was witnessed during the year 2009, which was around negative 3.37 per cent, while 4.15 per cent was witnessed as the highest growth rate of per capita GDP in the year 1988.

Figure 1: Growth rate GDP per capita



The remaining study will provide discussion of past studies in the second section. The third section will highlight data sources and methodology. In the fourth section, results and their discussion will be carried out. In the last section, conclusion and policy implications will be presented.

Literature Review

The existing studies related to the variables under consideration are summarized below:

GDPPC and labor force: The total labor force is an essential contributor to any economy. It is always thought of as the first ingredient of economic growth. The impact of the labour force on economic growth can be found to be positive and negative. Irawan and Khoirudin (2024) state that the labour force positively impacts economic growth in the Bali province using REM. Yakubu et al. (2020) support the negative impact of labour force participation on GDP in Nigeria using VECM. Also, the causality is from labour to GDP. The researcher argues that the negative sign may be attributed to unemployment and unequal gender employment opportunities in selected countries. Haque et al. (2019) found a negatively connected labor-GDP link in the Bangladeshi context.

On the other hand, Hossain (2012) found positively associated labor-GDP links in Bangladesh. Azka et al. (2019) reported a positive link between variables under discussion in Sri Lanka. Hassan et al. (2017) studied energy, capital, and labour associations and disclosed that labour is positively connected. Shamsher et al. (2019) supported the positive impact of

labour in the case of Pakistan. Wang et al. (2022) also reported a positive coefficient of labour to target GDP in the Pakistani economy.

GDPPC and capital formation: Economic growth and capital formation are vastly explored macroeconomic variables. The existing literature indicates that capital impacted per capita GDP positively (Ntamwiza & Masengesho, 2022; Wang et al., 2022). Gibescu (2010) reported a strong positive correlation between the two variables in the study on Central and Eastern European countries using quarterly data from 2003 to 2009. Ali (2015) concluded that capital formation positively impacts growth in the Pakistani economy through VECM. Meyer and Sanusi (2019) also found a positive interconnection between variables under consideration using the South African economy's quarterly data from 1995 to 2016 while applying VECM. Kong et al. (2020) affirmed bi-directional causality between both variables for 39 African countries from 1997 to 2017. Nweke Onyinye et al. (2017) also supported bidirectional causality but insignificant impact of capital formation on economic growth in Nigeria. Erum and Hussain (2019) backed the positive association in 43 OIC member countries. Similarly, Boamah et al. (2018) in 18 Asian economies, Rahman and Velayutham (2020) in 5 South Asian countries, Appiah et al. (2020) in 15 emerging economies and Al-Araby and Nawar (2024) in 76 developing countries confirmed the positive impact of capital formation upon economic growth.

GDPPC and consumption of energy: The economic growth and energy consumption link exploration dates back to 1978, when Kraft and Kraft (1978) reported that higher GDP translated to positive energy consumption. Researchers explained that with higher per capita GDP in developed economies, consumers had more spendable money, resulting in accelerated energy utilization (Wolde-Rufeal, 2009; Lee & Chang, 2008). Energy consumption has recently become a part of the literature on economic growth. The impact of different renewable and non-renewable energy sources on GDP is still under discussion. Zeraibi et al. (2021) established negatively linked variables like energy use and economic growth for the Chinese economy. Hongxing et al. (2021) supported the positive impact of energy consumption on economic growth. Kyophilavong et al. (2015) also supported the positive association of primary energy consumption with GDP in the presence of trade openness using Bayer-Hanck combined cointegration in Thailand. Using VECM Granger causality, the feedback effect is found between variables under discussion. Gozgor et al. (2018) supported positively associated variables like renewable energy consumption and economic growth. Asiedu et al. (2020), using FMOL and DOLS, showed that an increase in energy consumption decreases the growth in 26 European countries. Also, bidirectional Granger causality is found between renewable energy consumption and GDP, whereas non-renewable energy consumption shares unidirectional causality with economic growth.

GDPPC and openness of trade: It is a fact that trade openness, also referred to as trade liberalization, certainly impacts an economy's growth, but the direction of impact is still inconclusive (Ramzan et al., 2019). Chang et al. (2009) related the positive impact of openness on growth to lesser labour market distortions. Chen (1999) also supported positive signs of trade-GDP links in East Asian and Latin American countries. Hashim et al. (2024) stated that trade liberalization results in increased access to various products and services, efficient resource allocation and enhanced total factor productivity, which ultimately translates into higher economic growth. Kim (2011) argued that the impact of trade liberalization on GDP depended upon the development level of economies, whereas developed countries showed a positive impact on trade.

In contrast, countries with low income reported a negative trade-growth inter-connection. Another study of Ramzan et al. (2019) indicated that the impact of openness on growth depended upon the country's total factor productivity development level. After a certain threshold level of TFP, the association is positive between the variables, whereas, below that

level, trade impacted growth negatively. The literature also contained research which supported the notion of no formal correlation between trade and long-run economic growth (Eriș & Ulașan, 2013; Ulaşan, 2014). Researchers argued that excessive trade regulations prevent productive sectors from efficiently utilizing their resources and thus restrict economic growth (Bolaky et al., 2005).

GDPPC and consumer prices: The inflation-economic growth connection is paramount to policy makers. The literature argued that there was no formal connection between the two. A study by Salamai et al. (2022) reported that GDP and inflation rate have no significant association with the Saudi Arabian economy. Mallik and Chowdhury (2001) stated that inflation impacted growth positively in South Asian countries, including Pakistan, India, Bangladesh and Sri Lanka, and it implied that moderate inflation would enhance growth positively in such economies. However, the theory supported the inverse inter-correlation between inflation and economic growth. The rising prices resulted in inflation that impeded the individuals' buying capacity and caused poverty, which hampers growth (Davcev et al., 2017). Mwakanemela (2013) supported this negative impact of inflation on growth in Tanzania from 1990 - 2011. Madurapperuma (2016) showed that inflation impacted growth negatively in Sri Lanka using an error correction method on data from 1988 - 2015.

Data and Methodology

This empirical research aims to examine the link between economic growth and macroeconomic determinants in the French economy. The per capita GDP, being the dependent variable, is examined about independent variables, including labour force, gross fixed capital formation, consumption of energy, trade openness, and inflation proxied through the consumer price index, CPI. The annual data of the French economy from 1986 to 2022 is utilized for this research analysis. The variables of the study, along with their proxies and data sources, are presented in Table 1. All the variable values are transformed to their natural logarithm form using MS - Excel.

Table 1: Variables, representation & construction

Name	Representation	Transformation	Data Source
Economic Growth	$\ln GDP\ Per\ Capita_t$	ln (Gross Domestic Product / Total Population)	WDI, 2023
Labor Force	$\ln Lab_t$	ln (Total Labor Force)	WDI, 2023
Gross Fixed Capital Formation	$\ln Cap_t$	ln (GFCF / GDP)	WDI, 2023
Energy Consumption	$\ln Energy_t$	ln (Electric power Consumption / Total Population)	WDI, 2023
Trade Openness	$\ln Trade_t$	ln (Sum of Exports and Imports / GDP)	WDI, 2023
Inflation	$\ln Prices_t$	ln (Consumer Price Index)	WDI, 2023

The descriptive stats are extracted using E-views to measure normality through Jarque–bera probability values. To determine the applicable co-integration approach, the first step is to determine the integration level of the data i.e. the level in which the data series is stationary. The KPSS unit root test is applied for this purpose. The test has a null hypothesis of data stationary, i.e. the data has no slope.

The variables of this study have mixed integration level so the co-integration approach applied here is Autoregressive Distributed Lag (ARDL). The software used for analysis is

Microfit 5.5 by Pesaran et al. (2001). The ARDL analysis reports F-statistic and W-statistic to suggest the link between variables. If these statistics are greater than their upper bound of critical levels, the existence of co-integration is supported. If F & W statistics are smaller than lower critical bound, the co-integration is supported to be absent and in case of statistics lying between lower and upper bound, the test becomes inconclusive. Long-run and short-run coefficients are estimated using same approach and ecm term is also reported using Microfit. The CUSUM and CUSUMSQ graphs are extracted to view the stability of estimated coefficients. The diagnostic checks are also extracted to determine the accuracy and consistency of the reported results.

Results and Discussion

This section discusses the empirical findings of the research conducted on the French economy. The table 2 presents the preliminary descriptive stats of the study.

Table 2: Descriptive stats

Variable	Mean	Standard Deviation	Skewness	Kurtosis	Jarque-Bera (Probability)
$\ln GDP\ Per\ Capita_t$	10.5414	0.1239	-0.6643	2.1719	3.7787 (0.151)
$\ln Lab_t$	17.1517	0.0667	-0.2745	1.5405	3.7485 (0.154)
$\ln Cap_t$	3.0841	0.0502	-0.4974	2.5085	1.8982 (0.387)
$\ln Energy_t$	8.8420	0.0897	-1.1062	3.3616	7.7474 (0.021)
$\ln Trade_t$	3.8565	0.2794	-0.4965	1.8778	3.4618 (0.177)
$\ln Prices_t$	4.4900	0.1666	-0.4590	2.0581	2.6670 (0.264)

The descriptive stats indicate mean and standard deviation of the selected variables. The labor force has highest mean value among all. The gross fixed capital formation has lowest standard deviation which hints at constant investments in capital infrastructure by Frenchs. All the variables are negatively skewed. The Jarque-Bera test indicates that all variables are normally distributed except consumption of energy. To determine the integration level of data, KPSS unit root test is applied. The results are summarized in Table 3.

Table 3: KPSS unit root test

At Level		At First Difference	
Variables	LM-Test	Variables	LM-Test
$\ln GDP\ Per\ Capita_t$	1.7987	$\Delta \ln GDP\ Per\ Capita_t$	0.5383
$\ln Lab_t$	1.9009	$\Delta \ln Lab_t$	0.6753
$\ln Cap_t$	0.2744	$\Delta \ln Cap_t$	0.0583
$\ln Energy_t$	0.6243	$\Delta \ln Energy_t$	0.6529
$\ln Trade_t$	1.8438	$\Delta \ln Trade_t$	0.4305
$\ln Prices_t$	0.8323	$\Delta \ln Prices_t$	0.6340

Asymptotic Critical Values: 1%: 0.739, 5%: 0.463, 10%: 0.347, * represents 1% critical level, ** represents 5% critical level, *** represents 10% critical level

The KPSS result reveals that gross fixed capital formation and consumed energy are stationary at level whereas per capita GDP, labor force, trade openness and inflation are stationary at their first differences. This indicates that variables of the study have mixed integration order. With such integration order and smaller data set as this, ARDL model produces consistent and accurate results. The ARDL estimates are presented in table 4.

Table 4: ARDL bounds testing approach

Estimated Model	$\ln\text{GDP Per Capita}_t = f\ (\ln\text{Lab}_t, \ln\text{Cap}_t, \ln\text{Energy}_t, \ln\text{Trade}_t, \ln\text{Prices}_t)$			
Optimal lags	(2 , 0 , 0 , 1, 0 , 0)			
F – statistics	7.1071**			
W – statistics	42.6423**			
Significance Level	Critical Bounds For F – Statistics		Critical Bounds For W – Statistics	
5 percent	3.0925	4.4099	18.5552	26.4597
10 percent	2.5564	3.7281	15.3385	22.3685
Diagnostic tests				
Serial Correlation	0.0784 [0.780]		Normality	0.9087 [0.635]
Functional Form	0.2607 [0.610]		Heteroscedasticity	0.4419 [0.506]

Note: "**" represents significance level at 5 percent while "*" shows significance level at 10 percent. The values presented in the square brackets are the Probability Values.

The F-Stat reports a value of 7.1071 whereas the W-Stat reports a value of 42.6423. Both values are above the upper critical bound even at 5% significance level which indicates that a long run equilibrium connection exists between the variables. The diagnostic tests reveal that produced results are accurate, the functional form of the estimated model is well specified, the error terms are normally distributed and the model is homoscedastic. The long run and short run coefficients are determined through ARDL and presented in table 5 and table 6 respectively.

Table 5: Long run coefficients

Dependent Variable = $\ln\text{GDP Per Capita}_t$

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$\ln\text{Lab}_t$	-0.2207	0.1765	-1.2506	0.2222
$\ln\text{Cap}_t$	0.2366	0.0348	6.7898	0.0000
$\ln\text{Energy}_t$	0.2167	0.0268	8.0955	0.0000
$\ln\text{Trade}_t$	0.3771	0.0293	12.8715	0.0000
$\ln\text{Prices}_t$	0.0479	0.0777	0.6160	0.5433
Intercept	10.0162	2.6300	3.8085	0.0008

Table 6: Short run coefficients

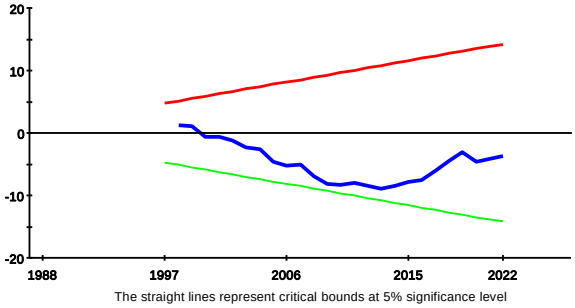
Dependent Variable = $\Delta \ln GDP\ Per\ Capita_t$

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$\Delta \ln GDP\ Per\ Capita_{t-1}$	0.0029	0.0765	0.0376	0.9703
$\Delta \ln Lab_t$	-0.1792	0.1438	-1.2463	0.2238
$\Delta \ln Cap_t$	0.1921	0.0326	5.8933	0.0000
$\Delta \ln Energy_t$	0.0962	0.0421	2.2844	0.0308
$\Delta \ln Trade_t$	0.3062	0.0235	13.0068	0.0000
$\Delta \ln Prices_t$	0.0389	0.0643	0.6049	0.5505
CointEq(-1)	-0.8120	0.0659	-12.3293	0.0000
Diagnostic tests				
R-Bar-Squared			0.8922	
F-Test (Probability Value)			41.3325 (0.000)	
DW-Test			2.0169	
Akaike Information Criterion			139.7980	
Schwarz Bayesian Criterion			123.7990	

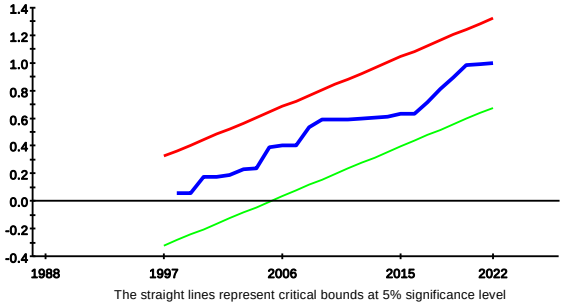
The long run ARDL model results show that labor force is insignificantly impacting economic growth. Also, the inter-connection is found to be negative. As the French economy is known for its structured infrastructure, the impact of gross fixed capital formation is found to be significantly positive. The results are in line with the study of Žarković et al. (2024). Our analysis indicates that a 1% increase in GFCF will enhance per capita GDP by 23% in the long run. The consumed energy is positively associated with economic growth such that a 1% increase in energy use will accelerate GDP by 21%. The trade openness is also significant in impacting GDP and reports that a 1% increase in openness will generate enhanced GDP by 37%. The inflation is found to be insignificant in the French economy. Similar results are reported by short run analysis. The coefficient of labor force is negative and insignificant. The impact of gross fixed capital formation, consumed energy and trade openness is positive and significant. The inflation is positively associated with GDP but the inter-connection is insignificant in the short run as well. The positive sign is supported by Mallik and Chowdhury (2001). The cointegrating term carries a negative and significant coefficient indicating that the economy has a tendency to bounce back to equilibrium in case of any shock. The ECM term indicates that it will take approximately 1.23 years for the French economy to reach equilibrium following a disturbance. The graphical representation of CUSUM and CUSUMSQ is presented in figure 2 to test the stability of estimated long and short run coefficients. The graph indicates that the mean and variance of the residuals is between the bounds and no structural instability is present.

Figure 2: Cusum and cusum square

CUSUM graph



CUSUM square graph



Conclusion

This empirical research aims to determine the impact of trade openness and consumed energy on the per capita GDP in France. The ARDL model is employed using annual data from 1986 to 2022. The results indicate that GDP has a long-run equilibrium link with its determinants, including labour force, capital formation, consumed energy, trade openness and consumer prices. The extended run analysis indicates that capital formation, energy consumed, and trade openness significantly enhance economic growth. Meanwhile, the labour force and inflation are insignificant determinants of GDP per capita in the French economy. The short-run coefficients follow the long-run impacts. The analysis indicates that inflation is positively associated with economic growth, but this result is insignificant. Also, positive investments in physical capital, trade liberalization, and energy consumption expansion are significantly escalating economic growth in the short run. This study suggests that investments in physical capital, energy consumed, and opening more doors for international trade can encourage economic growth in France.

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