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Revisiting electricity consumption-led growth hypothesis: Why is the rule defied in France?

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Abstract

Recent economics literature emphasises the inextricable link between economic prosperity and efficient energy supply and consumption, arguing vehemently that much of today's prosperity is predicated on secure and reliable energy use and that modern industry would grind to a halt without the necessary energy infrastructure. France is an example of an advanced country with enormous energy infrastructure, the world's second largest behind the United States. France's economic growth has been rather sluggish in recent years, despite its robust and efficient energy production and consumption. The current study analyses empirically whether France's current sustainable energy use defies the theoretical and empirical frameworks made by top energy economists. To achieve robust results, the extended Cobb-Douglas production model was applied to a time series data spanning the years 1961–2015. The Zivot-Andrews trended and de-trended structural break tests, as well as Autoregressive Distributed lag (ARDL) bounds testing were employed to analyse the data. The findings of this study demonstrate that France's economic growth is stimulated by financial development, electricity usage, capital, import, and export. The study sheds light on the feedback impact between economic growth and power usage as well as capital and economic growth. With these findings, we argue that it is not electricity that has ceased to serve a functional purpose in France, but a lack of entrepreneurial innovative capacity to create factors that require an infinite horizon for the continued use of electricity energy seems to be impeding the country's economic growth potential, among other things.

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1. Introduction

In the contemporary era, economies that are heavily reliant on international trade and strive for a certain level of economic growth are more vulnerable to the possibility of experiencing severe economic shocks, which slows economic progress (see Irwin and Terviö 2002; Frankel et al. 1996; Frankel and Romer 1999; Schneider 2005). The financial crisis of 2008–2009 alone has had a considerable impact on the majority of developed and emerging countries, wreaking havoc on export-dependent economies (Tang et al., 2015). Following the seminal work of Kraft and Kraft (1978), empirical studies identified a substantial link between energy consumption and economic growth that is far greater than what is predicted from international trade (see Al-mulali et al. 2014; Almulali 2014; Al-mulali and Ozturk 2014; Wolde-Rufael and Menyah 2010; Mehrpooya et al. 2018; Ansong et al. 2017; Heur 2017; Dos Santos et al. 2016; Afkhami et al. 2015; Kolhe et al. 2015; Usman et al. 2020).

Electricity is a necessary component of today's productive environment because there has never been a viable substitute for energy consumption that might facilitate production activities for domestic consumption or export in any given economic system (Rafindadi 2015a,&b). Electricity energy, as a necessary and indispensable factor, permits the attainment of efficient and effective economic productivity, since the essentiality of energy consumption is correlated with the important factors of

production, namely land, labour, and capital (Rafindadi 2016a). The presence of efficient, sustainable, and sufficient electricity energy consumption in any country indicates the possibility of an increase in the country's GDP and vice versa (Rafindadi and Ozturk, 2016; Rafindadi and Usman 2021).

According to Halicioglu (2009), Al-mulali et al. (2014), and Almulali (2014), achieving production optimality requires a direct link and interaction between energy sufficiency and energy efficiency. Any apparent increase in economic growth is essentially necessary by the possibility of increasing energy consumption; and therefore, established efficient and sufficient energy consumption in a country implies the existence of a fully productive economic system, which is synonymous with growth (see Wolde-Rufael 2004a, 2004b; Adom 2011).

Recently, France is one advanced country that provides interesting case study for the role of electricity consumption in economic prosperity. In 2019, France is the seventh largest economy in the world and the third largest in Europe (IMF 2020). The country ranks second in the world in terms of nuclear energy production, after only the United States. France generates around 76% of its electricity from fully operational nuclear power reactors, with the remainder coming from renewable and fossil energy sources, respectively. In 2012, France generated 425 billion kWh of energy through nuclear power, 62.5 billion kWh through hydropower, 22.5 billion kWh through coal, 20.5 billion kWh through natural gas, 19.5 billion kWh through solar and wind, and 7.5 billion kWh through biofuels and waste, for a total of 561 billion kWh (IEA 2020).

As a result of this feat, France became the world's third greatest power exporter. For example, France earned about €3 billion in 2012 from electricity exports alone (Andriamasy et al. 2014; IEA 2020). According to estimates, France utilised 464 TWh of electricity in 2013. Despite this, however, France's huge energy consumption resulted in sluggish GDP growth rates from, for example, 0.82 percent, in 2003, worsened to -2.9 percent in 2009, and moved up to only 1.5 percent in 2019 (IMF 2020).

In a similar trend, the OECD report in 2019 demonstrated that since 2013, a growing tension has hampered the French economy's ability to grow at a reasonable rate. In light of the recent economic recession's massive impact on the economies of the majority of European countries, including Germany, Italy, Spain, UK, as well as other parts of the world, it is likely that France's economy will be one of the most affected in the event of a future global economic downturn, owing largely to its non-presidential status (IMF 2020). The question we asked here is why, despite France's consistent electrical supply, GDP continues to fluctuate? Has power consumption in the country ceased to have significant contributing impacts, as originally argued by Kraft and Kraft (1978) and more recently by Al-mulali et al. (2014); Almulali (2014); and Al-mulali and Ozturk (2014)?

The purpose of this study is to determine whether electricity usage is consistent with the advanced economy like France's economic growth prospects. The study

specifically examines the extent to which electricity consumption contributes to the economic growth prospects of France, if at all. To distinguish this study from others, a comparative multivariate strategy was used, in which factors pertaining to France's financial development, capital-labour ratio, and trade openness were included in the line of analysis.

The remaining sections of this work are organised in four sections. Section 2 covers the relevant (empirical) literature in the topic, whereas Section 3 discusses the methods used in the study. Section 4 presents and discusses the empirical findings from the various analyses undertaken in this study. Section 5 presents the study's conclusion and policy implications.

2. Literature review

In the expanding fields of economic activity in economies world over, electricity has become the preferred and dominating energy source. It has been a vital contributor to the rise in living standards and has aided technological and scientific advancements. As a result, this type of energy is widely seen as being particularly crucial for economic development. The econometric literature on energy is well-documented regarding the causal relationship between various forms of energy use and GDP growth (e.g., see Ozturk 2010). Diverse studies examined a range of countries, time periods, and energy proxy variables, among other things. These investigations frequently produce contradicting empirical findings. Indeed, even the direction of causality, as well as its long-term vs. short-term impact on energy policy, varies between the studies. Policy considerations are influenced by the sort of causal relationship or the lack thereof. We will review some of the prior research on the causal links between economic growth and power demand in the next paragraphs.

Yoo (2006) investigates the short- and long-run causal relationships between power consumption and economic growth in Korea through the use of cointegration and error-correction models. From 1970 until 2002, the author uses annual data. The aggregated findings indicate that energy use and economic growth are causally related in both directions. This demonstrates that greater electricity consumption has a direct effect on economic growth, which in turn fuels increased electricity consumption. Yoo (2005) earlier discovered comparable results in a sample of ASEAN 4 member states (i.e., Malaysia, Indonesia, Thailand, and Singapore).

Yoo and Kwak (2010) examine the causal association between electricity consumption and economic growth in Brazil, Argentina, Chile, Ecuador, Columbia, Venezuela, and Peru, using three stage approach (cointegration, Granger causality, and error correction mechanism). The data indicate that the connection between energy use and economic growth varies significantly between countries. There is a short-run unidirectional causality between electricity use and real GDP for Argentina, Chile, Brazil, Ecuador, and Columbia. This demonstrates that increased energy use has a direct effect on the economic growth of those countries. Electricity consumption and

economic growth in Venezuela are causally linked in both directions, meaning that higher energy use directly impacts economic growth, which in turn stimulates increased energy consumption. There are no causal relationships in Peru, on the other hand.

Gurgul and Lach (2012) investigate whether energy use and GDP are causally intertwined in Poland. To ensure the causal relationships remained stable throughout time, the authors conducted their research in a three-dimensional framework using quarterly data from Q1:2000 to Q4:2009. In their findings, they observed a feedback effect between total electricity use and GDP, as well as between total electricity consumption and employment. Additionally, they observed unidirectional causal links between industrial electricity use and employment, but none between industrial electricity consumption and GDP.

Halkos and Tzeremes (2014) used a panel of 36 countries from 1990 to 2011 to investigate the impact of renewable electricity usage on continental GDP growth prospects. Throughout the sample size, they discovered that the effects of renewable energy had a substantially higher increasing effect on GDP. However, after a certain point, a reasonable level of stabilisation from non-renewable energy consumption to GDP growth rate was identified. The research also found that there are significant differences across emerging markets, developing nations, and mature economies. The link was non-linear in these three categories, implying that the amount of development obtained by these three categories does not guarantee that renewable energy use will continue to have an impact on their GDP. Caraianni et al. (2015) made contrary findings on a sample of 5 emerging European countries implying that energy consumption and economic growth in the chosen countries are linked.

To support the impact of electricity consumption on economic growth, Karanfil and Li (2015) investigated the short- and long-run effects of electricity consumption and economic activity in a selected sample of 160 countries from 1980 to 2010. The study's major goal was to determine the dynamic consequences of continental electricity dependence and how this level of dependence could assist in achieving desired level of urbanisation and GDP growth. The study's findings established that the feedback hypothesis exists in the long run for the vast majority of the sample size. The authors identified unidirectional causality in the short-run between economic growth and electricity consumption in the Pacific, East Asia, North Africa, the Middle East, and lower-middle-income countries. The neutrality hypothesis was also found in Sub-Saharan Africa, North America, and upper-middle income nations, according to the study. They also discovered that there was no evidence of growth hypothesis in any of the examined strata. Their study's Granger causality finding revealed a range of outcomes in terms of urbanisation and electricity net import. This was shown to differ significantly within the subsample, demonstrating that institutional efficiency, national income strata, and other regional characteristics all influence economic growth. However, this finding revealed that the electricity-growth nexus is very

susceptible to regional variances, country income levels, urbanisation levels, and the electricity reliance ratio. The study revealed that in wealthy countries, the association between electricity consumption and economic growth has primarily short-term consequences, whereas in low-income economies, the relationship has long-term consequences. Similarly, increasing electricity consumption induced urbanisation in high-income countries, while higher electricity consumption induced urbanisation in Sub-Saharan African continents.

Oztürk and Aslan (2015) examined a sample of 23 high-income corporate entities from OECD countries between 1960 and 2005 using the nonlinear unit root test. Their study aims to identify the dynamics of the per capita power consumption of selected samples. The authors' findings established the presence of nonlinear behaviour in 70% of the sample's electricity consumption. Similar findings were made, revealing how the electricity consumption processes in 12 countries were non-stationary to varied degrees. According to the authors, power demand shocks are a distinct possibility, with long- and short-term implications for electrical policy difficulties. In comparison, a stationary process was seen in 19 OECD countries, indicating that while energy conservation efforts are anticipated to have a short-term effect, energy consumption is expected to resume its previous level in the long run.

Ziaei (2015) examined the relationship between energy use, GDP growth, financial development, and carbon dioxide emissions. The author chose the financial crisis period as the objective base year to make a comparative study from 1989 to 2011 employing a panel of 13 European and 12 East Asian countries. The study's findings demonstrated how the total influence of CO₂ emissions and energy consumption in all samples was shown to deviate significantly from other forecast parameters included in the study. On the other hand, the panel comparative result indicated the presence of large shocks in energy consumption and CO₂ emissions. Financial metrics used in the individual samples were found to be deficient, owing mostly to the consequences of the financial crisis. The most intriguing aspect of their study was their discovery that the severity of energy consumption shocks on stock return rates in European continents is greater in East Asian countries than in Oceania. This conclusion prompted the study to investigate the effect of stock return rate shocks on energy demand in East Asia and the Oceanian continents.

In their seminal research, Omri et al. (2015) utilised the dynamic panel simultaneous equation on a sample of 17 advanced and developing economies to examine the dynamic causal relationship between electricity consumption, nuclear energy, and renewable energy. The authors' unique research findings conclusively demonstrated the supremacy of nuclear energy consumption as the primary driver driving economic growth in Belgium and Spain, while finding the opposite in Canada, Bulgaria, Sweden, and Netherlands. Surprisingly, a bidirectional discovery regarding the U.S, Argentina, France, Brazil, and Pakistan was made. In the second area of their analysis,

they discovered that renewable energy consumption is the primary element stimulating economic growth in India, Hungary, Netherlands, Japan, and Sweden.

Al-mulali and Mohammed (2015) investigated whether long-run and short-run sector-by-sector GDP growth can influence energy consumption in 16 emerging economies between 1980 and 2010. The authors' findings revealed a bidirectional causal relationship between oil consumption and three critical sectors of the economy. Similar findings were made with natural gas usage and the three industries represented in the sample size. In the case of coal usage, it was determined that the same bidirectional causal relationship exists solely with the service sector. Additionally, the study discovered a positive association between renewable energy usage and the value of manufacturing activities. The same discovery was made in the manufacturing and service sectors. The existence of a unidirectional relationship was discovered solely because of oil consumption and the agriculture sector's value. The study's result emphasised how renewable energy consumption has dual effects that are powerful causal drivers of economic growth and can have a significant impact on mitigating environmental deterioration. Adom and Amuakwa-Mensah (2016); Adom et al., (2012); and Rafindadi (2016b) all report comparable findings.

Opeyemi and Paul-Francois (2019) examined the short- and long-run correlations, as well as causative relationships, between electricity consumption, trade openness, and South Africa's economic growth from 1984 to 2015 using an autoregressive distributed lag (ARDL) model. Their empirical findings indicate that both energy consumption and trade openness have a positive and significant effect on economic growth over the long run. According to a Granger-causality test, electricity consumption and trade openness both affect economic development independently of any feedback effects. This demonstrated that boosting energy output and trade openness had a significant positive effect on South Africa's economy.

Utilising a Bayesian approach, Hoang (2021) aims to re-examine whether financial development and energy consumption affect economic growth of ASEAN+6 countries from 1980 to 2016. Their study's findings indicate that both financial development and energy consumption have a significant and beneficial effect on economic growth of the countries. In addition, the Conversation hypothesis was supported by evidence for a one-way relationship between economic growth and energy use in the countries.

3. Methodology

3.1 Data, variables, and the models

The methodology used in this study evolved from the theoretical model offered by the augmented Cobb-Douglas production function employing 1961–2015 dataset. In light of the method's inherent characteristics and the qualities of time series data employed, this study examined two distinct models for dealing with structural breaks. While the study used the ARDL bounds test technique to cointegration for the long-run and short-run dynamic studies, this approach was confirmed using the Johansen

cointegration test. We detect direction of causation of the forecast variables using the VECM granger causality test. Within the noble Cobb-Douglas production function (with enhancements), we specify the following functional form:

$$Y_t = f(F_t, EC_t, K_t, TO_t) \quad (1)$$

To ensure consistency, the study transformed all the series into natural log specification. This specification is then modeled as follows:

$$\ln Y_t = \beta_1 + \beta_2 \ln F_t + \beta_3 \ln EC_t + \beta_4 \ln K_t + \beta_5 \ln TO_t + \mu_i \quad (2)$$

$\ln Y$ denotes the natural log of real GDP per capita in equation 2, $\ln F$ is natural log of real domestic credit to the private sector, $\ln EC$ is the natural log of electricity consumption per capita, $\ln K$ is the natural log of real capital per capita, and $\ln TO$ is the natural log of real trade openness per capita. μ denotes the error term.

We consulted the World Bank's World Development Indicators (WDI) for compiling the data for this study, namely: GDP, domestic credit to the private sector per capita, capital stock per capita, power consumption (kg of oil equivalent) per capita, exports and imports per capita, and trade openness per capita. All these variables were measured in real terms. The data collection period was 1961–2015. The period was chosen based on the availability of data for France. For example capital stock is available up to 2015.

This paper proceeds to estimate model (2) utilising Pesaran, Shin, and Smith (2001) developed ARDL bounds test approach to cointegration. The study employs this methodology because of its superiority over all other methods of linear regression estimation, including the notable Johansen and Juselius (1990) approach¹. One of the primary distinguishing characteristics and superiority of the ARDL model over the Johansen and Juselius method is its capacity to discern between the values of the dependent and independent variables in such a sparse manner. To take this advantage for obtaining a robust solution, equation (2) is modelled using the unconditional error correction model (UECM). The following is the specification.

¹ Among the advantages cited by Ghatak & Siddiki (2001), is that the ARDL model is superior in terms of differentiating between the values of the dependent and independent variables. It can also produce strong estimates/results with a small sample data. This contrasts with the Johansen cointegration technique, which takes a significant amount of data to produce a reasonable result. Additionally, it is worth noting that the ARDL bound test does not need the estimation of variables to be integrated in the same order. This implies that I (1) and I (0) variables may, nevertheless, produce valid and robust results. Again, this contrasts with the Johansen and Juselius technique that does not accommodate I (1) and I (0) variables. The ARDL model is preferable when estimating dynamic long-run and short-run outcomes simultaneously without deteriorations (Bentzen & Engsted, 2001).

$$\begin{aligned}\Delta \ln Y_t = & c_0 + \sum_{i=1}^p c_i \Delta \ln Y_{t-i} + \sum_{i=1}^p d_i \Delta \ln EC_{t-i} + \sum_{i=1}^p d_i \Delta \ln F_{t-i} + \sum_{i=1}^p d_i \Delta \ln K_{t-i} + \sum_{i=1}^p d_i \Delta \ln TO_{t-i} \\ & + \pi_1 \ln Y_{t-1} + \pi_2 \ln EC_{t-1} + \pi_3 \ln F_{t-1} + \pi_4 \ln K_{t-1} + \pi_5 \ln TO_{t-1} + \pi_D DUM_t + u_{2t}\end{aligned}\quad (3)$$

$$\begin{aligned}\Delta \ln EC_t = & c_0 + \sum_{i=1}^p c_i \Delta \ln EC_{t-i} + \sum_{i=1}^p d_i \Delta \ln Y_{t-i} + \sum_{i=1}^p d_i \Delta \ln F_{t-i} + \sum_{i=1}^p d_i \Delta \ln K_{t-i} + \sum_{i=1}^p d_i \Delta \ln TO_{t-i} \\ & + \pi_1 \ln Y_{t-1} + \pi_2 \ln EC_{t-1} + \pi_3 \ln F_{t-1} + \pi_4 \ln K_{t-1} + \pi_5 \ln TO_{t-1} + \pi_D DUM_t + u_{2t}\end{aligned}\quad (4)$$

$$\begin{aligned}\Delta \ln F_t = & c_0 + \sum_{i=1}^p c_i \Delta \ln F_{t-i} + \sum_{i=1}^p d_i \Delta \ln Y_{t-i} + \sum_{i=1}^p d_i \Delta \ln EC_{t-i} + \sum_{i=1}^p d_i \Delta \ln K_{t-i} + \sum_{i=1}^p d_i \Delta \ln TO_{t-i} \\ & + \pi_1 \ln Y_{t-1} + \pi_2 \ln EC_{t-1} + \pi_3 \ln F_{t-1} + \pi_4 \ln K_{t-1} + \pi_5 \ln TO_{t-1} + \pi_D DUM_t + u_{2t}\end{aligned}\quad (5)$$

$$\begin{aligned}\Delta \ln K_t = & c_0 + \sum_{i=1}^p c_i \Delta \ln K_{t-i} + \sum_{i=1}^p d_i \Delta \ln Y_{t-i} + \sum_{i=1}^p d_i \Delta \ln EC_{t-i} + \sum_{i=1}^p d_i \Delta \ln F_{t-i} + \sum_{i=1}^p d_i \Delta \ln TO_{t-i} \\ & + \pi_1 \ln Y_{t-1} + \pi_2 \ln EC_{t-1} + \pi_3 \ln F_{t-1} + \pi_4 \ln K_{t-1} + \pi_5 \ln TO_{t-1} + \pi_D DUM_t + u_{2t}\end{aligned}\quad (6)$$

$$\begin{aligned}\Delta \ln TO_t = & c_0 + \sum_{i=1}^p c_i \Delta \ln TO_{t-i} + \sum_{i=1}^p d_i \Delta \ln Y_{t-i} + \sum_{i=1}^p d_i \Delta \ln EC_{t-i} + \sum_{i=1}^p d_i \Delta \ln F_{t-i} + \sum_{i=1}^p d_i \Delta \ln K_{t-i} \\ & + \pi_1 \ln Y_{t-1} + \pi_2 \ln EC_{t-1} + \pi_3 \ln F_{t-1} + \pi_4 \ln K_{t-1} + \pi_5 \ln TO_{t-1} + \pi_D DUM_t + u_{2t}\end{aligned}\quad (7)$$

In models 3 to 7 above, Δ , C_0 , and d_0 signify first differences and drifting elements, respectively. DUM refers to the dummy variables required to capture the break dates in the series². The absolute lag length is given by p ,³ and u_t is the white noise residuals. According to Pesaran et al (2001), two critical stages must be followed in order to proceed with the estimating process of the ARDL model, namely: (1) doing an F-test to determine the combined significance of the lagged variables. (2) Determining the null hypothesis for the absence of a long-run relationship by comparing it to the alternative hypothesis, i.e., $H_0 = \pi_1 = \pi_2 = \pi_3 = \pi_4 = \pi_5 = 0$, against $H_1 \neq \pi_1 \neq \pi_2 \neq \pi_3 \neq \pi_4 \neq \pi_5 \neq 0$.

Following the completion of these two stages, the lower and upper critical boundaries for the F-test are established in accordance with Pesaran et al (2001). These guidelines established that, because the lower bound's critical values are I(0) and the upper bound's critical values are I(1), the rule indicates that whenever the F-statistics are statistically greater than zero, the null hypothesis is rejected⁴. However, if the F-statistics are less than the lower bound, the null hypothesis of no long-run relationship is not rejected in this situation.

² Due to the CMR unit root test, which assumes a single unknown break in the series, the ARDL F-test model includes a dummy variable.

³ Pesaran et.al (2001) emphasised on the significance of balancing the selected lag length.

⁴ When the estimated F statistic falls between the lower and higher boundaries, the result is often regarded as inconclusive. As a result of this, another effective method for determining the presence of cointegration between variables is to examine the substantial negative outcome of the lagged error correction term (see Kremers et al. 1992)

Finally, the error correction model (ECM) technique is used to estimate the variables' long- and short-run dynamics. The vector error correction model (VECM) and Granger causality analysis can be used to detect the causal link between capital all the variables considered in this study as empirically described in equation 8 below.

$$\begin{aligned}
 \begin{bmatrix} \Delta \ln Y_t \\ \Delta \ln EC_t \\ \Delta \ln F_t \\ \Delta \ln K_t \\ \Delta \ln TO_t \end{bmatrix} &= \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \end{bmatrix} + \begin{bmatrix} B_{11,1} & B_{12,1} & B_{13,1} & B_{14,1} & B_{15,1} \\ B_{21,1} & B_{22,1} & B_{23,1} & B_{24,1} & B_{25,1} \\ B_{31,1} & B_{32,1} & B_{33,1} & B_{34,1} & B_{35,1} \\ B_{41,1} & B_{42,1} & B_{43,1} & B_{44,1} & B_{45,1} \\ B_{51,1} & B_{52,1} & B_{53,1} & B_{54,1} & B_{55,1} \end{bmatrix} \times \begin{bmatrix} \Delta \ln Y_{t-1} \\ \Delta \ln EC_{t-1} \\ \Delta \ln F_{t-1} \\ \Delta \ln K_{t-1} \\ \Delta \ln TO_{t-1} \end{bmatrix} + \dots + \begin{bmatrix} B_{11,m} & B_{12,m} & B_{13,m} & B_{14,m} & B_{15,m} \\ B_{21,m} & B_{22,m} & B_{23,m} & B_{24,m} & B_{25,m} \\ B_{31,m} & B_{32,m} & B_{33,m} & B_{34,m} & B_{35,m} \\ B_{41,m} & B_{42,m} & B_{43,m} & B_{44,m} & B_{45,m} \\ B_{51,m} & B_{52,m} & B_{53,m} & B_{54,m} & B_{55,m} \end{bmatrix} \\
 &\times \begin{bmatrix} \Delta \ln Y_{t-1} \\ \Delta \ln EC_{t-1} \\ \Delta \ln F_{t-1} \\ \Delta \ln K_{t-1} \\ \Delta \ln TO_{t-1} \end{bmatrix} + \begin{bmatrix} \zeta_1 \\ \zeta_2 \\ \zeta_3 \\ \zeta_4 \\ \zeta_5 \end{bmatrix} \times (ECM_{t-1}) + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \end{bmatrix}
 \end{aligned} \tag{8}$$

In model 8, TO_t is the trade openness comprising exports and imports, $(1 - L)$ is the difference operator, while the ECM_{t-1} is the error correction model that is obtainable from the estimated results of the long-run relationship among the variable. The ECM_{t-1} is an indication of how significant and valid the results of the long-run dynamics are. It suggests the validity, strength, and the fitness of the model. It also validates the acceptability or otherwise of the long-run coefficient results. The T-test and F-test statistics are used to determine first-differences, while lagged independent variables are used to determine the variables' short-run causal link. In the case of France, this analysis used time series data from 1961 to 2015.

4. Empirical results and discussions

The initial step in this section was to verify the variables' unit root properties. This is critical to obtaining results that are robust and error-free. This study ensured this, first, by employing the Ng-Perron unit root test, which is well-suited for small sample data sets. This unit root test produces consistent and reliable empirical results and, because to its explanatory power, it outperforms the ADF, PP, DF-GLS, and KPPS. Table-1 summarises the results of the Ng-Perron unit root. The Table demonstrates that while all the series are non-stationary at the levels (with intercept and trend), and we can reject the null hypothesis of unit root at the first difference. This indicates that all variables are cointegrated at $I(1)$ at 5% and 1% levels, respectively.

Table-1: Unit Root tests results

Variables	MZa	MZt	MSB	MPT
$\ln Y_t$	-5.24913 (1)	-1.32343	0.25212	16.2964
$\ln EC_t$	0.42424 (2)	0.23999	0.56569	76.3302
$\ln F_t$	-0.19402 (5)	-0.30163	1.55459	441.331
$\ln K_t$	-7.01357 (1)	-1.82956	0.26086	13.0459

$\ln EX_t$	-5.94145 (3)	-1.49934	0.25235	15.0515
$\ln IM_t$	-12.5424 (1)	-2.34799	0.18720	8.09920
$\ln TR_t$	-7.95355 (1)	-1.78050	0.22386	12.0059
$\Delta \ln Y_t$	-19.3972(2)**	-3.11199	0.16044	4.71158
$\Delta \ln EC_t$	-23.4457 (1)*	-3.40809	0.14536	3.98105
$\Delta \ln F_t$	-27.4054 (2)*	-3.70167	0.13507	3.32534
$\Delta \ln K_t$	-23.7261 (1)*	-3.44045	0.14501	3.86358
$\Delta \ln EX_t$	-23.3170 (3)*	-3.41408	0.14642	3.91038
$\Delta \ln IM_t$	-18.8370 (2)**	-3.05442	0.16215	4.92560
$\Delta \ln TR_t$	-23.8173 (2)*	-3.44744	0.14475	3.84666

Note: * and ** indicates p-values at 1% and 5% levels. Lag length of variables is shown in small parentheses.

However, structured breaks are quite common in almost all time series data. In this regard, unit root tests such as the Ng-Perron and augmented dickey-Fuller tests are prone to producing biased results. To address this shortcoming, the current study used the Zivot and Andrews (1992) unit root test (here after, ZA test), which is capable of accounting for a single unknown structural break. The ZA test's technical operation is based on its capacity to recognise existing break dates as they occur in the series. The technical direction of this test's operation is to ensure that the T-statistic is estimated first, in the same manner that the ADF test is determined. The break dates are then chosen based on the evidence that is discovered to be favourable to the null hypothesis. To ensure that this test runs efficiently, critical values identical to those used in the ADF unit root test are used. Table-2 contains the empirical results of this test as conducted in this study.

According to Table 2, all variables are non-stationary at the level. This discovery demonstrates unequivocally that the series contains structural breaks. The ZA test was used to determine this. The break dates detected using this test are 1982, 1986, 1978, 1985, 1988, 1976, and 1987 which correspond to economic growth, electricity consumption, exports, imports, capital, financial development, and trade openness, respectively. These variables attained stationarity at the first difference, demonstrating the robustness of the unit root analysis and, hence, verifying the fact that all variables are integrated in order of I(1).

Table-2: Zivot-Andrews structural break trended unit root test

Variable	At Level		At 1 st Difference	
	T-stat.	Break year	T-stat.	Break year
$\ln Y_t$	-1.543 (1)	1985	-6.156 (2)*	1982

$\ln EC_t$	-3.738 (2)	2000	-5.442 (1)**	1986
$\ln F_t$	-3.201 (1)	1978	-11.839 (4)*	1978
$\ln K_t$	-4.120 (3)	1981	-5.499 (1)**	1985
$\ln EX_t$	-4.332 (1)	1997	-6.841 (2)*	1988
$\ln IM_t$	-4.195 (2)	1998	-7.182 (1)*	1976
$\ln TR_t$	-4.167 (3)	1998	-6.719 (3)*	1987

Note: * and ** indicates p-values at 1% and 5% levels. Lag length of variables is shown in small parentheses.

The primary limitation of the previous analysis on Table 2 (i.e., ZA unit root test) is that it only provides structural break information for a single structural break in a series and cannot provide structural break information for multiple structural breaks that may exist within a single set of data. To address this weakness, and in light of the possibility of several breaks within dataset we have in this study, this study applied the Clemente, Montanes, and Reyes (1998) test (CMR test, here after) which exposes and rectify multiple structural breaks within a series. However, this test is distinguished by its use of the additive outliers (AO) method. This is done in an attempt by the model to plug in rapid changes in the mean of the series while also affecting important gradual changes in the mean of the variables. To assure the process's efficacy, the innovation outliers (IO) model is rigorously tested using the model estimation mechanism's explicit and strict requirements. Despite this, the model demonstrated unequivocally that the additive outlier model should be favoured for series with significant structural deviations, as opposed to those with gradual shifts.

Table-3 summarises the outcomes of the analysis used to perform this estimation. The findings demonstrated that the variables under consideration were non-stationary in the presence of dual structural breaks at level, implying the presence of a unit root problem. After the CMR test dual structural breaks model is executed, all variables in the model become stationary at first difference. In this regard, the analysis concludes that the series are integrated in the same order, namely I(1).

Table-3: CMR detrended structural break unit root test

Variable	Innovative Outliers				Additive Outlier			
	T-stat.	TB1	TB2	Conclusion	T-statistic	TB1	TB2	conclusion
$\ln EC_t$	-3.536 (2)	1981	1992	Unit Root	-8.276 (2)*	1976	1989	Stationary
$\ln Y_t$	-2.993 (3)	1991	2001	Unit Root	-5.523 (1)**	1991	1998	Stationary
$\ln F_t$	-3.301 (3)	1975	2000	Unit Root	-5.699 (2)*	1975	1978	Stationary
$\ln K_t$	-4.763 (1)	1991	2002	Unit Root	-5.893 (1)*	1986	1991	Stationary
$\ln EX_t$	-3.387 (1)	1985	1996	Unit Root	-5.897 (2)*	1995	1998	Stationary

$\ln IM_t$	-3.454 (3)	1986	1997	Unit Root	-6.044 (4)**	1991	1998	Stationary
$\ln TR_t$	-3.426 (2)	1986	1997	Unit Root	-6.481 (2)*	1991	1998	Stationary

Note: * and ** indicates p-values at 1% and 5% levels. Lag length of variables is shown in small parentheses.

The ARDL model is utilised due to its efficacy and capacity to reveal the presence of cointegration among the selected variables in the presence of structural fractures (see Pesaran, 2015). Additionally, the AIC criterion is employed for lag selection. Based on the analysis conducted during the lag selection activity, the study determined that the optimal lag duration is two. After concluding the lag selection process, the study moves on to calculating the F-statistic. The findings from the F-statistics will be able to represent the presence or absence of cointegration between the series. To this end, it is self-evident that if the calculated F-statistic exceeds the critical boundaries, the investigation will proceed to reject the hypothesis of no cointegration, and vice versa.

Table-4 summarises the results of the ARDL cointegration analysis. The calculated F-statistical values exceeded the upper critical boundaries at the 1% and 5% levels, respectively. This research demonstrates unequivocally the existence of cointegration. When financial development, electricity consumption, economic growth, and capital were considered as dependent variables, the study discovered the existence of four cointegrating vectors. A similar pattern of development is observed with respect to imports and models of trade openness.

Table-4: ARDL cointegration test results

Cointegration: Bound testing approach				Diagnostics			
Models estimated	Optimal lag length	Structural Break	F-statistics	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}
$F_Y(Y/E, F, K, EX)$	2, 1, 2, 2, 2	1985	6.68**	2.0518	[1]: 0.4499	[1]: 0.5662	[1]: 0.2249
$F_E(E/Y, F, K, EX)$	2, 2, 1, 1, 2	2000	10.052*	0.2217	[1]: 0.0770	[2]: 0.4295	[2]: 1.7076
$F_F(F/Y, E, K, EX)$	2, 2, 2, 1, 2	1978	6.248**	1.6474	[1]: 0.3144	[2]: 5.6190	[1]: 2.1829
$F_K(K/Y, E, F, EX)$	2, 2, 2, 2, 1	1981	5.379***	0.8848	[1]: 0.3045	[2]: 0.2216	[2]: 0.9832
$F_{EX}(EX/Y, E, F, K)$	2, 1, 2, 1, 2	1987	3.551	3.4767	[1]: 0.5088	[1]: 0.2716	[1]: 0.0044
$F_Y(Y/E, F, K, IM)$	2, 1, 2, 1, 2,	1985	6.450**	0.6380	[1]: 0.3788	[1]: 0.6389	[1]: 3.1782
$F_E(E/Y, F, K, IM)$	2, 2, 1, 1, 2	2000	5.358***	0.5558	[1]: 1.7061	[1]: 0.2985	[1]: 1.4522
$F_F(F/Y, E, K, IM)$	2, 1, 2, 2, 2	1978	12.145*	1.5836	[1]: 0.0720	[1]: 3.6646	[4]: 1.5827
$F_K(K/Y, E, F, IM)$	2, 2, 2, 2, 1	1981	5.962**	4.6148	[4]: 0.5922	[3]: 0.0044	[2]: 1.1102
$F_{IM}(IM/Y, E, F, K)$	2, 1, 2, 1, 2,	1988	0.591	0.8152	[1]: 0.3114	[1]: 0.9130	[1]: 0.1043
$F_Y(Y/E, F, K, TR)$	2, 1, 2, 2, 1	1985	5.402***	1.0943	[1]: 0.2647	[3]: 0.1304	[2]: 0.5558
$F_E(E/Y, F, K, TR)$	2, 2, 2, 2, 2	2000	5.571**	1.5935	[1]: 0.3314	[1]: 0.9617	[3]: 1.4889
$F_F(F/Y, E, K, TR)$	2, 1, 2, 2, 1	1978	5.992**	2.6725	[1]: 3.5300	[4]: 0.0931	[1]: 1.8095
$F_K(K/Y, E, F, TR)$	2, 2, 2, 2, 2	1981	12.534*	0.6259	[1]: 1.2557	[1]: 0.2316	[1]: 0.3129
$F_{TR}(TR/Y, E, F, K)$	2, 1, 2, 2, 1	1998	1.643	2.4347	[2]: 0.0206	[4]: 1.4110	[2]: 0.0872
Significant levels	Critical values						
	Lower bounds I(0)	Upper bounds I(1)					
1 percent level	6.053	7.458					
5 percent level	4.450	5.560					
10 percent level	3.740	4.780					

Note: 1%, 5%, and 10% significant p-values are respectively indicated by *, **, and ***. The optimal lag length is determined using the AIC. While the [] refers to the order of diagnostic tests. # denotes the critical values following Narayan (2005).

Apart from the previously mentioned application of the ARDL bounds testing approach to the cointegration test, and in order to obtain a compelling and robust conclusion, the current study conducted a comparative investigation of the cointegration determination process. As a result, the Johansen cointegration test was used to determine the series' long-run robustness. Table-5 summarises the findings from this empirical study. According to the results in that table, both the Maximum Eigenvalue and the Trace statistics are significant. This reinforces the importance of rejecting the null hypothesis of no cointegration, hence validating the existence of cointegrating vectors between the series, as the ARDL results clearly indicate. Concerning this conclusion, the study indicates that the resulting parallels between the two dynamic outcomes as discovered in the two analyses are strong.

Table-5: Johansen cointegration test results

Hypothesis	Trace Statistic	Max. Eigen Value
$Y_t = f(E_t, F_t, K_t, EX_t)$		
$R = 0$	141.3335*	68.4811*
$R \leq 1$	72.8524*	34.3347**
$R \leq 2$	38.5176	24.3003
$R \leq 3$	14.2173	8.6101
$R \leq 4$	5.6071	5.6071
$Y_t = f(E_t, F_t, K_t, IM_t)$		
$R = 0$	127.8559*	45.0066*
$R \leq 1$	82.8493*	38.4511*
$R \leq 2$	44.3981**	31.6897*
$R \leq 3$	12.7084	9.7468
$R \leq 4$	2.9615	2.9615
$Y_t = f(E_t, F_t, K_t, T_t)$		
$R = 0$	134.308*	57.7443*
$R \leq 1$	76.5643*	38.4684*
$R \leq 2$	38.0959	24.9707
$R \leq 3$	13.1251	8.7558
$R \leq 4$	4.3693	4.3693

Note: Significant values at 1% and 5% levels are indicated by * and **, respectively.

The long-run dynamic findings from the ARDL estimation are presented in Table 6. The data in this table established that financial development has a considerable beneficial effect on the possibilities for economic growth in France. Additionally, the study notes that a 1% improvement in financial development in France results in a 0.02 percent boost in economic growth. Similar findings have been made regarding electricity use and economic growth. Moreover, this study also establishes that a 1% increase in energy consumption in France results in a 0.27 percent rise in economic growth. This finding contrasts with the findings of Karanfil and Li (2015) and Wolde-Rufael and Menyah (2010), who concluded that increasing electricity usage has a negligible effect on advanced economies' GDP (French inclusive).

On the other hand, we observe that a 1% increase in physical capital enhances economic development by 0.18 percent in France, significant at 1% level. Additionally, it was determined that French exports had a favourable and considerable effect on the country's economic growth. As a result of this link, a 1% rise in exports has a significant effect on the country's economic growth of 0.15 percent. This finding is less than the contribution of electricity consumption, which is 0.27 percent, implying that electricity consumption in France contributes more to the country's economic growth than any other variable considered in this study. Similarly, this analysis reveals a favourable and statistically significant link between imports and economic growth in France. According to the study's findings, a 1% increase in imports results in a 0.18 percent rise in French economic growth. Trade openness has a statistically significant effect on economic growth and is statistically significant at the 1% level.

Table-6: Long and Short Runs Results (Dependent variable = $\ln Y_t$)

Long Run Analysis						
Variables	Coeff.	T-stat.	Coeff.	T-stat.	Coeff.	T-stat.
Constant	4.7345*	24.5898	5.2010*	19.5478	4.9423*	23.940
$\ln F_t$	0.0163**	2.2559	0.2815*	14.5480	0.2708*	14.774
$\ln EC_t$	0.2744*	14.688	0.0200**	2.7073	0.0135***	1.9216
$\ln K_t$	0.1798*	6.6848	0.0831**	2.1247	0.1237*	3.9669
$\ln EX_t$	0.1487*	8.7552	...	...	...	...
$\ln IM_t$	...	...	0.1774*	7.7777	...	...
$\ln TR_t$	...	...	...	...	0.1725*	9.1224
Short-Run Analysis						
Variables	Coeff.	T-stat.	Coeff.	T-stat.	Coeff.	T-stat.
Constant	0.0038**	2.3806	0.0051*	2.8994	0.0038**	2.3056
$\ln F_t$	0.0056	1.1929	0.0056	1.0826	0.0059	1.2437
$\ln EC_t$	0.1334*	3.1069	0.1722*	3.2487	0.1306**	2.7187
$\ln K_t$	0.1802*	5.0623	0.1354**	2.5551	0.1242*	2.8709
$\ln EX_t$	0.1572*	5.1486	...	...	...	...
$\ln IM_t$	...	...	0.1204*	2.9153	...	...
$\ln TR_t$	...	...	...	...	0.1790*	4.5446
ECM_{t-1}	-0.3686*	-2.4552	-0.5306*	-3.2308	-0.4395*	-2.6129
R^2	0.8571		0.8191		0.8528	
F-statistic	43.2053*		32.6186*		41.7260*	
D. W	1.5509		1.5359		1.6520	
Short Run Diagnostic Tests						
Test	F-stat.	P-value	F-stat.	P-value	F-stat.	P-value
χ^2_{NORMAL}	5.4026	0.0671	3.2525	0.1966	1.2038	0.1212
χ^2_{SERIAL}	2.5905	0.0694	0.3153	0.8339	2.1414	0.1462
χ^2_{ARCH}	1.7716	0.1909	1.9436	0.1712	1.7056	0.1996

χ^2_{WHITE}	3.1184	0.0664	1.1671	0.1491	2.3603	0.0531
χ^2_{REMSAY}	1.1955	0.2399	0.5363	0.5951	0.1058	0.9163

Note: *, ** and *** is indicating significant values at 1%, 5%, and 10% respectively.

Table 6 summarises the results of the short-run analysis's estimation. These results revealed a favourable and significant association between France's financial development and the country's economic growth potential. To demonstrate this, Table 6 shows that a 1% rise in financial development results in a 0.01 percent gain in economic growth in France. Additionally, the study revealed that energy usage in France had a positive association with the country's economic growth potential. Although the finding revealed a statistically insignificant value, it is worth noting that economic growth in France would be impossible without energy usage.

In addition to the preceding analyses, empirical evidence indicates that the relationship between capital and economic growth in France is positive and significant. Additionally, at the 1% level, this analysis revealed a statistically significant positive association between exports, imports, and trade openness and economic growth in France. In light of this finding, this study observes that the error correction mechanism (ECM) is negative and statistically significant, with the exports, imports, and trade models estimated to have equilibrium adjustment coefficients of -0.3686, -0.5306, and -0.4395 respectively, implying that short-run deviations from long-run equilibrium would be corrected at a rate of 36.86 percent, 53.06 percent, and 43.95 percent. This relatively slow rate of adjustment indicates that the French economy benefits from some rapid adjustment/recovery processes or that it can recover from shocks more quickly. Additionally, as a robustness check, the study performed critical diagnostic tests to establish the validity of the ECM conclusion. As a result of this diagnostic test, the study determined that the error terms in the short-run model are normally distributed in all empirical models examined. Post-estimation diagnostics, on the other hand, demonstrate the absence of heteroskedasticity, serial correlation, and the ARCH problem. Additionally, the Ramsey reset test result suggested that the functional form of the short-run models was properly described.

In this study, we also examine the validity or otherwise of the long- and short-run stability of the exports model's parameters. To ensure the accuracy of this check, Brown, Durbin, and Ewans (1975) suggests using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq). The CUSUM and CUSUMsq for the overall model are shown in Figures 1 and 2. These figures are intended to demonstrate the efficacy of the respective models and the robustness of the findings in this investigation. We see from the results of this empirical exercise that the plot of the CUSUM chart is inside the upper and lower critical lines and statistically significant at 5%.

Figure-1: CUSUM

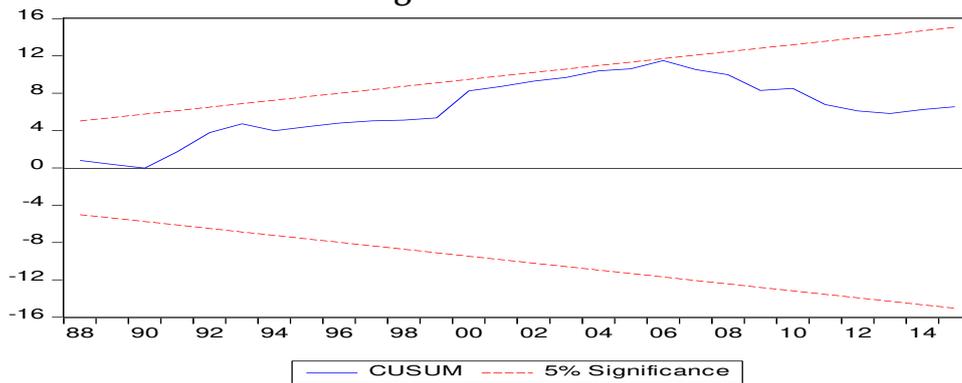
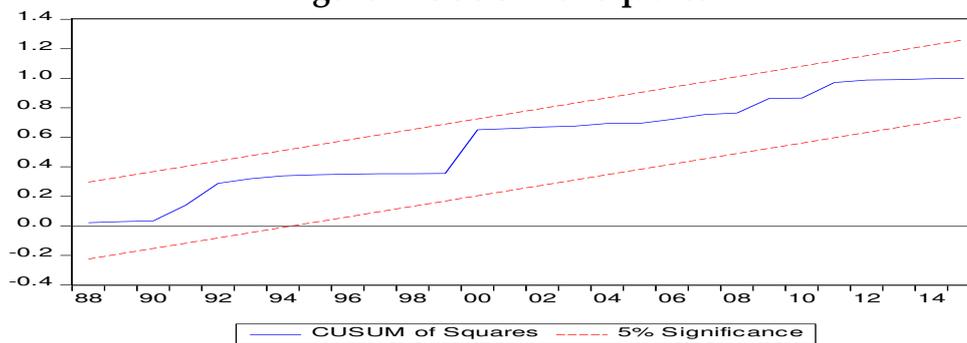


Figure-2: CUSUM of Squares



Note: The straight lines represent critical bounds at 5% significance level

Table-7: Chow Forecast Test

Forecast length: 2001 to 2012		Prob.
F-statistic	3.6025	0.3212
Log likelihood ratio	75.6132	0.0000

To further validate the CUSUM and CUSUMsq findings regarding the parameter's stability, the Chow breakpoint test was used. As illustrated in Table 7, this test confirms the absence of a significant break point that distorts the estimated model across the specified duration. This demonstrates that our estimated model is quite well fitted.

4.1 The VECM Granger Causality Analysis

The VECM Granger causality test is used to determine the direction of the causal relationship between the variables in this study. Establishing the direction of the causal relationship between the various variables will allow for the possibility of answering the research questions presented previously in this study. Additionally, the results of this test may serve as a guide for French economic policymakers, particularly in the key areas examined in this study.

Table-8 summarises the findings of the VECM Granger causality test. The table illustrates the long-run and short-run dynamics of causality. In the long run, this study proved bidirectional causality between France's economic development and power usage. This indicates that France's economic growth is a result of the country's adequate and efficient electricity consumption. As a result, any attempt to curb French electricity energy is equal to interfering with the country's economic growth trajectory (see Rafindadi 2016b). A similar pattern was observed in relation to France's capital formation prospects and economic development.

Unlike prior findings, we uncover a feedback effect in the link between French electricity use and capital. Capital and financial development developed in a similar manner. On the other hand, it was discovered that the relationship between the level of financial growth obtained in France and the country's electricity usage is bidirectional. Surprisingly, this analysis revealed that economic growth Granger causes financial development, and vice versa. Additionally, we observe unidirectional causality between exports, imports, and trade and economic growth. In the case of France, electricity consumption, financial development, and capital are Granger-causes of exports, imports, and trade openness. These findings imply that the inextricable link between French electricity energy and the country's mantra of energy security constitutes the fundamental cause of all facets of development in the country. Thus, implying that electricity consumption in France is not simply a driver of growth but also the country's heartbeat.

Table-8: VECM Granger causality results

Dependent Variable	Type of causality					
	Short Run					Long Run
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln F_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln EX_{t-1}$	ECT_{t-1}
$\Delta \ln Y_t$	...	4.1745** [0.0251]	1.1672 [0.3250]	17.5632* [0.0000]	10.7514* [0.0003]	-0.3347*** [-1.9763]
$\Delta \ln EC_t$	1.6781* [0.0000]	...	0.0934 [0.9111]	0.2128 [0.8095]	0.1472 [0.8637]	-0.4838** [-2.4603]
$\Delta \ln F_t$	0.1297 [0.8686]	0.5753 [0.5686]	...	0.0074 [0.9926]	0.2079 [0.8134]	-1.0004* [-3.9696]
$\Delta \ln K_t$	27.4559* [0.0000]	1.5326 [0.2324]	0.0363 [0.9648]	...	0.6268 [0.5411]	-0.2917** [-2.7502]
$\Delta \ln EX_t$	12.2242* [0.0001]	1.2976 [0.2876]	0.6280 [0.5403]	0.9417 [0.4008]	...	...
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln F_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln IM_{t-1}$	
$\Delta \ln Y_t$	...	5.0905** [0.0123]	4.5044** [0.0192]	3.9775** [0.0290]	15.8681* [0.0000]	-0.2305*** [-1.8153]
$\Delta \ln EC_t$	1.0110 [0.3759]	...	0.3736 [0.5914]	0.0928 [0.9116]	0.5965 [0.5571]	-0.5087* [-4.2218]
$\Delta \ln F_t$	7.7339** [0.0348]	0.1253 [0.8826]	...	0.7382 [0.4865]	2.0005 [0.1529]	-0.6617* [-3.0982]
$\Delta \ln K_t$	2.5232*** [0.0971]	1.1841 [0.3199]	1.9641 [0.1579]	...	1.9382 [0.1616]	-0.2164** [-2.7020]

$\Delta \ln IM_t$	9.3251* [0.0007]	0.6030 [0.5530]	16.2080* [0.0000]	7.0109* [0.0031]	...	...
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln F_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln TR_{t-1}$	
$\Delta \ln Y_t$	...	7.3639*** [0.0024]	0.8278 [0.4464]	4.4349** [0.0202]	16.2868* [0.0000]	-0.1631* [-4.4861]
$\Delta \ln EC_t$	0.7126 [0.4984]	...	0.1330 [0.8419]	0.0207 [0.9795]	0.4322 [0.6530]	-0.5961 [-4.5928]
$\Delta \ln F_t$	2.5007*** [0.0909]	0.5639 [0.5749]	...	0.0633 [0.9388]	2.0707 [0.1433]	-0.8204* [-3.2507]
$\Delta \ln K_t$	10.3237* [0.0004]	0.8177 [0.4510]	0.1896 [0.8283]	...	0.8246 [0.4481]	-0.2657* [-3.3544]
$\Delta \ln TR_t$	16.2790* [0.0000]	1.4137 [0.2585]	2.0118 [0.1510]	0.3139 [0.7328]	...	...

Note: *, ** and *** indicate the level of significance at 1%, 5%, and 10% respectively.

The VECM Granger causality results reported in Table 8 reveals that the relationship between economic growth and electricity consumption in France is bidirectional in the short run. Through the feedback effect, the short-run result also reveals the existence of a relationship between capital and economic growth. Similarly, exports and economic growth are causally related in a bidirectional manner, but financial development and capital accumulation promote imports. On the other side, between financial development and economic progress, we identified a feedback effect. We also discover trade openness to be the Granger-cause of economic growth. The opposite of this also true.

5. Conclusion and Policy Implications

Recent development economics literature appears to accentuate an essential link between economic prosperity and efficient energy supply and consumption, among other factors. According to the argument, much of today's prosperity is based on secure and reliable energy access/use and without the essential energy infrastructure, modern industry comes to a halt. France is a case in point of a country having a substantial energy infrastructure. France has a very low carbon electricity mix due to its vast nuclear fleet, the second largest in the world after the United States. Despite its robust and efficient energy production and consumption, however, France's economic growth has been sluggish in recent years. This study examines whether electricity consumption is consistent with the advanced economy of France's economic growth potential. The study's specific objective is to determine why the French economy remains 'poor' despite the presence of efficient electricity energy in the country, and what impact this development will have on economic growth and other energy policy concerns in France. To complete this study, time series data from 1961 to 2015 was employed.

Following the study's straightforward methodology, dynamic results from the ARDL bounds test technique for cointegration demonstrated that, In France, both financial

development and electricity consumption stimulates economic growth. When they work tandemly, trade openness and capital exert strong significant effect on French economic growth. Additionally, this study sheds light on the feedback effect between economic growth and energy use. Similar conclusions about capital and economic growth have been made.

There is a bidirectional causal relationship between financial development, capital accumulation, and electricity usage. The Granger causality analysis confirmed previous findings that electricity usage has a considerable causal effect on France's economic growth. Additionally, the analysis indicated that exports, imports, and trade openness all contribute to economic growth in France. In terms of energy consumption, financial development, and capital, the study debunks the myth that power use is incompatible with French economic growth. This development is backed by the Granger causality test and corroborated by the dynamic ARDL test findings. The study demonstrated how a 1% increase in financial development, electricity consumption, capital, exports, and imports results in a 0.02 percent, 0.27 percent, 0.18 percent, 0.15 percent, and 0.18 percent increase in French economic growth, respectively.

In line with the supporting evidence in this study, it is valid to argue that neither electricity nor the efficient electricity supply in France has ceased to serve as a catalyst for economic growth (considering that a 1% increase in electricity consumption in France is associated with a 0.27% increase in the country's GDP – a value higher than all other variables considered in this study). It is sufficient to argue from the outcomes of this study that it may be a lack of entrepreneurial and technological capacity in France that prevents the utilisation of existing sufficient and efficient electricity energy. That is to say, the horizon of France's productive electricity market and energy marketing system appears to be doomed by an incapacity to generate strategic innovation and synergies for directing power consumption to an infinite number of and diversified economic functions (all things being equal). This could occur, in particular, if France's entrepreneurial development policies are ineffectual or unsuccessful. As a result, this issue has the potential to obstruct the system's ability to explore new avenues for directing the economic use of power, thereby generating a forgone alternative to what could have otherwise increased national output. The following argument establishes the intuition that France has a high cost of doing business, which may be exacerbated by the country's high tax rate, thereby dwarfing, and creating an additional loophole in the direction of how electricity energy in France could be put to productive use.

With regards to why the French economy grows slowly despite the presence of efficient and effective electricity energy, this study believes that it is the fault of inefficient, chaotic, or conflicting economic policy arrangements that allowed responsive internal factors to combine and impair the country's economic growth prospects, thereby limiting the use of electricity for productive industrial purposes.

These characteristics include France's macroeconomic stability and the effectiveness with which policy actions are formulated and guided to mitigate anticipated economic aberrations. For example, France has been continuously impacted by economic shocks such as the financial crisis and other domestic economic pressures. Lin and Liu (2016) showed that during economic depressions, the concentration of electricity energy consumption by heavy industrial outlets is often low. This will amplify the effects of low energy use on a country's economic growth potential. With this declining tendency continuing, the relative success of manufacturing industries will exacerbate inventory investment variations, resulting in a severe decline in productivity. This issue will impede efficient and effective energy use, ultimately harming a country's economic growth prospects.

The policy implications of this study for the France's future energy consumption and economic growth prospects relate to the creation of an environment conducive to entrepreneurial activity. This reflects a greater emphasis on power use in sensitive projects that can have a substantial impact on France's economic growth. Additionally, policymakers in France should examine how effectively electricity supply and consumption factors are exploited; are the costs associated with sustaining the country's research and development effective at generating a high level of applicable innovation and creativity in dealing with the country's energy system and its relationship to entrepreneurial development and economic growth? How is France's research and development system capable of enviably developing technology and science capable of allowing electricity energy to be used indefinitely? How quickly do French institutions expand to handle increased energy consumption? Apart from that, it is critical to analyse the soundness of capital accumulation and the speed with which it could expand to generate more value in France. Similarly, can the country's financial system convert capital into important channels for entrepreneurial productivity? Is the financial system sophisticated enough to channel funds in such a way that entrepreneurial activity thrives? Thus, it became critical for French energy policymakers to rethink their strategy in order to create additional opportunities for the country to use electricity indefinitely. This can be accomplished through intensive energy marketing strategies and the establishment of high-energy manufacturing and entrepreneurial enterprises that are sensitive to economic growth. To accomplish the aforementioned and reverse the deteriorating trend, this study advocates for channelling the country's positive financial development gains into the provision of productive loans to intending entrepreneurs who can at the very least put the country's enviable electricity energy to productive use.

Declarations

Data Availability Statement

The data used and/or analysed during the study are available with all the authors and they are ready to make it available upon a reasonable request.

Competing Interests:

The authors declare that they have no known competing interests.

Authors' Contributions:

Abdulkadir Abdulrashid RAFINDADI: Conceptualization, Formal analysis, Investigation, Methodology, Data curation, Writing - original draft, Writing- review & editing.

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