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Can Nuclear Energy Stimulates Economic Growth? Evidence from Highly Industrialised Countries

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ABSTRACT: This paper attempts to examine the causal relationship between nuclear energy consumption and economic growth for four industrialised countries; the US, Canada, Japan, and France, between 1965 to 2010. In a multivariate framework that accounts for other key determinants such that of oil demand and price, a modified version of the Granger causality test developed by Toda and Yamamoto (1995) is applied. Results show that there is one-way causality from nuclear energy consumption to economic growth in Japan denoting that an energy conservation policy that aims to minimise nuclear energy consumption may adversely affect economic growth. Oppositely, increasing real GDP causes additional nuclear energy consumption in France. In the US and Canada, there is evidence that support the neutrality hypothesis. Looking at the other investigated channels, the level of real oil prices seems to have a vital role in deriving the demand for nuclear power in three out of four countries. There is also a causal linkage between oil and nuclear energy consumption in the US, Japan, and France, suggesting that the uncertainty surrounding the global oil market plays a key role in determining the demand for nuclear energy. This means that the policies in these countries should endeavor to overcome the constrains on nuclear energy consumption to face any un-expected hikes in oil prices, which may adversely affect economic growth in such oil importing countries.

Keywords: Nuclear Energy consumption; Oil consumption; Economic growth; Oil prices; Granger causality test; Industrialised countries
JEL Classifications: Q40; Q43; Q48

1. Introduction

In the recent decade, the challenge of balancing between the increase in energy consumption as a result of growing economies and simultaneously grappling with the greenhouse gas emissions received a wide attention among economic researchers. This is so because fossil fuel energy sources, which are blamed for global warming via the release of co_2 emissions, accounts for almost 87% of the total energy needs (IEA, 2012).[1] However, fossil fuels are not only important for economic growth; its main sources including oil and gas are associated with highly volatile prices. They are also concentrated in unstable regions of the Middle East, which may affect the security of supply. Energy security and environmental challenges made many countries having no option rather than finding another secure and clean alternative to fossil fuels. It is widely believed that investing in nuclear power would provide some solutions to these problems. Therefore, a number of countries considered investments in nuclear power as a way to decrease reliance on foreign oil, increase the availability of secure energy, stabilizing the oil and gas prices attributed to the increase demand of fossil fuels, and reduce greenhouse gas emissions (Adamantiades and Kessides (2009);Toth and Rogner (2006); Vaillancourt et al. (2008)). Many authenticate that nuclear energy, as almost carbon free energy sources, could afford a key solution to global warming and energy security concerns (Elliott, 2007); Ferguson, 2007). Even countries which do not pay proper attention to the logics of developing nuclear

[1] For more information, see http ://www.iea.org/publications/freepublications/publication/kwes.pdf

power plants are now showing an increasing awareness of its potential advantages in providing an alternative clean and stable energy source (IEA, 2011).[2] However, the projection for developments in nuclear energy are tolerated with partial disagreements with issues associated with the operational safety, radioactive waste disposal, proliferation risk of nuclear material along with the public perception and acceptance of nuclear power (Toth and Rogner, 2006).

Given that the power of nuclear is an important potential energy source that provides secure, safe and clean energy supply for sustainable developments, many researchers examine its impact on economic. One of the main streams in literature focuses on examining the causal linkage between nuclear energy consumption and economic growth. This empirical investigation gives essential information on nuclear energy as an alternative to fossil-based energy, which enhances the general understanding for this relationship, analyzes its impact on economic growth for sustainable development, and accordingly provides logical reason of investing in nuclear energy for economical concern or for environmental and social concerns (Apergis et al. (2010)). Additionally to this, the wide swing of fossil fuel prices tolerate nuclear energy to be converted into reasonably competitive energy source regardless of the high costs of developing and maintaining nuclear power plants. Moreover, many existing nuclear power plants witnessed a clear increase in the rate of its capacity utilization (EIA, 2009). Vaillancourt et al. (2008) underline that embracing the alteration from fossil fuels to renewable or other carbon-free energy sources should be considered in designing effective energy and environmental policies to meet the massive growth of global energy needs. Apergis and Payne (2010) broaden this vision by stating nuclear power as a key energy option in the development of such long-term energy and environmental policies. In literature, high demand for oil and fossil based fuels have been blamed for the increasing concern on global warming. Lee and Chiu (2011) state that diversifying the supply of energy and finding a safe, low-cost, and clean energy source is one of the main concerns of energy and environ mental policy makers. All the above debates entail paying more attention to identify the direction of causality between nuclear energy consumption and economic growth.

Early studies in energy-growth literature scrutinize the relationship between energy con- sumption and economic growth (Chontanawat et al., 2006; Lee and Chang, 2008; Payne, 2011; Ozturk, 2010). So far, results obtained from empirical literature concerning the direction of causality between energy consumption and economic growth is conflicting. There is plenty evidence to support all the four possible hypotheses. For a number of countries there is feedback causality while for others the relationship seems to be neutral. Many studies find a unidirectional causality running from energy consumption to economic growth in some countries while for others there is the opposite causality running from economic growth to energy consumption. Likewise, the inconsistent empirical results found with respect to the causal relationship between aggregate energy consumption and economic growth, the practical findings of investigating the linkage between nuclear energy consumption and economic growth are also not conclusive. A unidirectional causality running from nuclear energy consumption to GDP has been found Yoo and Jung (2005) and Yoo and Ku (2009) in Korea, and by Wolde-Rufael (2010) in India. In contrast, Payne and Taylor (2010) for the US, Yoo and Ku (2009) for Argentina and Germany; and Wolde-Rufael (2012) for Taiwan discover no causality running in any direction. Yoo and Ku (2009) show that there is bi-directional causality in Switzerland, and unidirectional causality running from economic growth to nuclear energy consumption in France and Pakistan. However, only 6 out of the 20 countries investigated by Yoo and Ku (2009) went through causality tests, since the series of the other 14 countries were not integrated of the same order, i.e. I(1). In a panel cointegration and panel causality study, Apergis and Payne (2010) find bi- directional causality running between nuclear energy consumption and economic growth providing support for the feedback hypothesis associated with the relationship between nuclear energy consumption and economic growth. In a very recent study, Naser (2014) notices that while nuclear energy stimulates economic growth in both South Korea and India, the rapid increase in China economic growth requires additional usage of nuclear energy. The above conflicting outcomes play key role in designing effective nuclear energy policy. If there is a unidirectional causality running from nuclear energy consumption to economic growth, dipping nuclear energy consumption could bust economic growth. In contrast, if there is a unidirectional causality running from economic growth to nuclear

[2] See, http: //www.iea.org/publications/f reepublications/publication/W EO2011W EB.pdf for more details.

energy consumption, it could imply that policies aimed at reducing nuclear energy consumption may be implemented with slight or no adverse impact on economic growth. On the other hand, if there is no causality running in any direction, the neutrality hypothesis is accepted, and plummeting nuclear energy consumption may not affect income and nuclear energy conservation policies may not affect economic growth. Oppositely, if there is feedback impact between them, nuclear energy consumption can stimulate economic growth and in turn economic growth may encourage more demand for nuclear energy. In this case, nuclear energy consumption and economic growth complement each other and nuclear energy conservation measures may harm economic growth.

In this paper, we attempt to analyze the causal relationship between nuclear energy consumption and economic growth in four industrialized countries including: the US, Canada, Japan, and France over the period from 1965 to 2010. This has been done using a modified Wald (MWALD) test developed by Toda and Yamamoto (1995). The key advantage of using such method is that it offers solutions for many methodological problems listed in Stern and Cleveland (2004) including the heterogeneity in variables order of integration. Also, the Toda and Yamamoto (1995) approach eliminates the need for pretesting for co-integration and therefore avoids pre-test bias and is applicable for any arbitrary level of integration for the series used. It is very important to discuss the causal linkage between nuclear energy consumption and economic growth to provide logical reasons for investing in nuclear power as well as designing effective energy policies that accounts for both economic growth and environmental protection and sustainable development.

The rest of the paper is structured as follows. Section 2 describes the model and data, Section 3 presents the results and discussion. Remarks and conclusion are provided in Section 4.

2. Model and Data

2.1. Model

Starting from the seminal work of (Granger (1969, Granger (1988)), energy-output models have been built on the basis of VAR by a number of studies to analyze the causal linkage between the endogenous variables. The fundamental idea of causality suggests that if past observations of x facilitate the estimation of the present value of y taking into account all related information, then we can say that x is Granger causing y. Sargent (1979) and Sims (1980) pioneered the VAR approach in order to establish econometric investigation with least priori economic theory assumptions (Qin (2011)). The multivariate VAR comprises other explanatory variables that may be considered as determinants of variable y (Lütkepohl (1982); Stern (1993)). There may also be indirect channels of causation from x to y, which bi-variate models could uncover. However, Park and Phillips (1989) and Sims et al. (1990) show that the asymptotic distributions cannot be applied to the traditional Wald test for exact linear restrictions on the parameters when the variables in levels VAR are integrated or cointegrated. As Engle and Granger (1987) point out, statistical inference for a VAR in levels can be undertaken properly only if all the variables are stationary. Otherwise, VAR in differences could be applied for a system of integrated and not cointegrated variables. If all series are integrated of power one, and then a Vector Error Correction model (VEC) could be established for this investigation. Nevertheless, due to the fact that the critical information associated with variables order of integration and the possibility of having cointegrated series, pre-testing a given system for unit roots and cointegration are required prior to conducting Granger causality tests. Hence, any biases in testing for unit roots and cointegration among the variables may alter the effectiveness of Granger causality tests (Clarke and Mirza (2006)). The pre-testing biases might be severe because unit root tests generally have low power, and Johansen cointegration tests can be unreliable in finite samples (Johansen (1988); Johansen and Juselius (1990); Pesaran et al. (2001)). Moreover, in the case of having different orders of integration among the tested variables, there will be an additional source of distortion, that might affect the performance of Granger causality test in the from VAR or Vector Error Correction (VEC) models. To overcome the problems discussed above, Toda and Yamamoto (1995) develop a procedure that aim to examine the causality between variables by using the Wald test statistic, which has a chi square ($\chi 2$) distribution. In this setup, the test can work efficiently regardless of the order of integration or cointegration properties of the investigated variables. The Toda and Yamamoto (1995)

(TY) method is straightforward and appropriate for stationary, non-stationary with different orders, or cointegrated variables.3

To promise TY technique of the Granger non causality test, the current article presents real output (RGDP), nuclear energy consumption (NC), oil consumption (OC), and real oil price (ROP) in the following four-variable VAR system:

$$Z_t = \emptyset_0 + \pi_1 Z_{t-1} + \dots\dots\dots + \pi_k Z_{t-k} + U_t \qquad t = 1, \dots T, \qquad (1)$$

where $U_t \sim N(0, \Omega), Z_t = (RGDP_t, OC_t, NC_t, ROP_t)$. Economic hypothesis can be expressed as restrictions on the coefficients in the model in accordance with the following:

$$H_0 = F(\pi) = 0, \qquad (2)$$

where π = vec (P) is vector of parameters in Equation (1); P = $(\pi_1 \dots . \pi_k)$; and F(.) is a twice continuously differentiable m – vector valued function.

Toda and Yamamoto (1995) suggest artificially augmenting the correct order, k, of VAR(k), where k is the lag length of the system, by the maximum number of integration, say d_{max}. Once this is done, a $(k + d_{max})^{th}$ order of VAR is estimated and the coefficients of the last lagged d_{max} vectors are ignored. Clarke and Mirza (2006) show that, despite the additional parameters, this approach shows little loss power compared to alternative of testing the restrictions on a VECM that imposes co-integrating restrictions.

Assume that the maximum order of integration which is expected to characterize the process of interest is at most one, i.e., $d_{max} = 1$. Then in order to test hypothesis (2), one estimates the following VAR by OLS:

$$Z_t = \emptyset_0 + \pi_1 Z_{t-1} + \dots\dots\dots + \pi_k Z_{t-k} + \pi_p Z_{t-p} + U_t \qquad (3)$$

where $p \geq k + d_{max} = k + 1$, i.e., at least one more lag than the true lag length k is included. The parameter restrictions (2) do not involve the additional matrices $\pi_{k+1} \dots . \pi_p$, since these consist of zeros under the assumption that the true lag length is k.

2.2. Data

To investigate the causal linkage between nuclear energy consumption and economic growth in the case of the US, Canada, Japan, and France, this paper uses annual data for the period of 1965 - 2010 on real gross domestic product per capita (RGDP), and nuclear energy consumption per capita (NC). Following, Lee and Chiu (2011a), who highlighted the importance of accounting for the impacts from oil price and oil consumption changes on nuclear energy development under international crude oil price hikes and oil supply shortages, this paper included both real oil prices (ROP) and oil consumption (OC) into the investigated system. Both Nuclear energy and oil consumption are obtained from BP Statistical Review of World Energy (2011), where NC is expressed in terms of Terawatt- hours (TWh) and OC is measured in thousand barrels daily. Oil consumption (OC) is the sum of inland demand, international aviation, marine bunkers, oil products consumed in the refining process, and consumption of fuel ethanol and biodiesel. Real GDP per capita measured in constant 2005 US dollars and obtained from the World Development Indicators (WDI, 2011). Real oil price is defined as the US dollar price of oil. Following Lee and Chiu (2011b), oil price is converted to the domestic currency and then deflated by the domestic consumer price index (CPI), which is derived from International Financial Statistics (IFS, 2011) published by the International Monetary Fund (IMF). All data are expressed in natural logarithms in the empirical analysis.

3. Empirical Results

Undertaking the procedure of TY, two steps are required. First, to determine the lag length (k) of the VAR model and augment that with the maximum order of integration (dmax) of the variables used in the model. This paper uses Akaike, Hannan and Quinn, and Schwarz's Bayesian information criteria to determine the optimal lag structure (k) of the VAR model.[4] Following Lütkepohl (1993) procedure, this paper links the maximum lag lengths (kmax) and the number of endogenous variables

[3] Zapata and Rambaldi (1997) use the available econometric packages for Seemingly Uncorrelated Re- gression (SUR) to apply the TY approach.

[4] In causality testing, if the chosen lag is less than the true lag length, this can cuase bias due to omission of relevant lags.

in the system (m) to the sample size (T) according to the formula $m \times kmax = \bar{T}^{\frac{1}{3}}$ Konya (2004). In the case of conflicting results of the different Information criterion as shown in Table 1 below, the choice done based on AIC results as suggested by Pesaran and Pesaran (1997). We also use the augmented Dickey and Fuller (1979) (ADF), Phillips and Perron (1988) (PP), and Kwiatkowski et al. (1992) (KPSS) to determine the order of integration of the series, dmax. Table 2) reports the results of unit root tests, which indicates that the results are slightly contradictory. However, all variables are roughly non stationary at level and integrated of power one- I(1).

Table 1. Lag selection criteria

	K	AIC	HQIC	SBIC
USA	1	-11.6764*	-11.3731*	-10.849*
	2	-11.665	-11.119	-10.176
	3	-11.673	-10.884	-9.522
	4	-11.612	-10.581	-8.799
Canada	1	-9.819	-9.515*	-8.991*
	2	-9.655	-9.109	-8.166
	3	-9.889*	-9.101	-7.738
	4	-9.851	-8.820	-7.038
Japan	1	-8.635	-8.332	-7.808*
	2	-8.286	-7.740	-6.796
	3	-8.313	-7.525	-6.162
	4	-9.536*	-8.505*	-6.722
France	1	-10.757*	-10.453*	-9.929*
	2	-10.499	-9.953	-9.010
	3	-10.344	-9.555	-8.193
	4	-10.721	-9.690	-7.908

Notes: AIC, HQIC and SBIC stand for Akaike, Hannan and Quinn and Schwarz's Bayesian information criteria, respectively. In the case of conflicting results, I use AIC results as suggested by Pesaran and Pesaran (1997).

The order of empirical VAR system is specified by determining the optimal length of lags, k, and the maximum order of integration, dmax. Then VAR (k+dmax) model is estimated, where the Modified Wald test proposed by Toda and Yamamoto (1995) is conducted in the second step to examine the causal linkage among the relevant variables.[5] According to the causality results reported in Table (3) below, nuclear energy consumption and economic growth show no direct causal relationship in both the US and Canada, which is in line with Payne and Taylor (2010) findings for the US. This neutrality between nuclear demand and economic growth suggests that energy conservation policies do not exert an adverse impact on economic growth and that nuclear energy consumption is not affected by economic performance. However, in the US there may be indirect causality running from nuclear energy consumption to economic growth by way of oil consumption since we find a causal impact running from nuclear energy to oil consumption and from oil consumption to economic growth. In France, there is evidence of a unidirectional relationship running from economic growth to nuclear energy consumption, implying that the growth in its economy derive the usage of more nuclear energy. The use of nuclear power to fulfil the increasing needs of energy is a valuable method on the basis of Kyoto protocol. Alternatively, social aims like advanced technologies in medicine, public health and agriculture call attention to spend more in nuclear power sector as proposed by Nazlioglu et al. (2011). Oppositely, a unidirectional causality running from

[5] Zapata and Rambaldi (1997) argued that the MWALD test requires no priori knowledge of cointegra- tion or no cointegration of the system and it can be applied regardless of the order of integration (i.e., I(0), I(1), or I(2)) of the series as long as $k \geq 1 = d$.

nuclear energy consumption to economic growth is found in Japan, which is similar to the outcomes from Wolde-Rufael and Menyah (2010). This indicates that nuclear energy conservation policies that aim to reduce the usage of nuclear power may harm economic growth in Japan.

Table 2. Results of Unit root rests

Country	Variable	ADF	lags	PP (4)	PP (8)	KPSS	Lags
USA							
levels	ROP	-1.698	(0)	-1.854	-1.962	0.129	4
	OC	-3.344	(1)	-2.746	-2.720	0.086	4
	NC	-3.451	(1)	-3.748*	-4.339**	0.230**	4
	RGDP	-3.203	(1)	-2.098	-1.820	0.098	4
first	ROP	-6.566**	(0)	-6.802**	-6.808**	0.109	4
	OC	-4.165*	(1)	-3.606*	-3.846	0.104	4
	NC	-4.340**	(0)	-4.742**	-4.847**	0.163	4
	RGDP	-5.195**	(1)	-5.602**	-5.721**	0.081	4
Canada							
levels	ROP	-1.843	(0)	-1.948	-2.052	0.130	4
	OC	-2.782	(1)	-2.659	-2.666	0.104	4
	NC	-0.712	(0)	-0.743	-0.684	0.247**	4
	RGDP	-2.476	(1)	-2.261	-2.032	0.127	4
first	ROP	-7.113**	(0)	-5.461**	-5.922**	0.096	4
	OC	-3.752*	(0)	-0.630	-0.359	0.128	4
	NC	-6.276**	(1)	-1.953	-1.791	0.082	4
	RGDP	-5.012**	(0)	-0.935	-0.831	0.066	4
Japan							
levels	ROP	-1.809	(0)	-1.926	-2.066	0.116	4
	OC	-2.153	(6)	-4.108*	-3.979*	0.159*	4
	NC	-3.156	(7)	-6.627*	-6.385**	0.247**	4
	RGDP	-3.257	(0)	-3.149	-3.165	0.243**	4
first	ROP	-6.188**	(0)	-6.444**	-6.422**	0.100	4
	OC	-3.707*	(0)	-3.774*	-3.88*	0.137	4
	NC	-4.742**	(4)	-12.75**	-12.96**	0.20	4
	RGDP	-4.566**	(1)	-4.482**	-4.369**	0.0925	4
France							
levels	ROP	-1.654	(0)	-1.835	-1.936	0.158*	4
	OC	-3.999*	(1)	-3.592*	-3.545*	0.124	4
	NC	-1.548	(0)	-1.563	-1.592	0.114	4
	RGDP	-2.110	(1)	-2.009	-2.114	0.261**	4
first	ROP	-6.297**	(0)	-6.522**	-6.528**	0.108	4
	OC	-3.733*	(0)	-3.899*	-3.984*	0.141	4
	NC	-1.974*	(2)	-5.741**	-5.672**	0.059	4
	RGDP	-4.990**	(0)	-5.105**	-5.031**	0.093	4

Notes: The regression include an intercept and trend. All variables are in natural logarithms, while the lag length determined by Akaike Information Criteria and are in parentheses. ** indicate significance at the 5% level. The nulls for all test except for the KPSS test are unit root.

In this setup, the multivariate model provide another interesting advantage, where other causal linkage can be investigated as shown in Table 3. Table (3) shows that there is a unidirectional causality running from oil consumption to nuclear energy consumption in Japan while an opposite relationship appears in both both US and France. There is also a causal linkage between real oil prices and nuclear energy consumption in three out of four countries including Canada, Japan, and France, which is in line with Lee and Chiu (2011). This means that as nuclear energy is entirely a different energy source, which is unaffected by the concerns related to oil supply and prices, nuclear power plants in these countries can increase the production to satisfy the energy demand in case of any unexpected shock in international oil prices.

Table 3. Granger non-causality test based on Toda and Yamamoto

Dependent variable	RGDP	OC	NC	ROP
USA				
RGDP		7.162**	0.616	1.445
		(0.027)	(0.734)	(0.485)
OC	8.711**	-	6.397**	2.306
	(0.012)		(0.040)	(0.316)
NC	2.499	0.391	-	1.973
	(0.324)	(0.822)		(0.373)
ROP	1.559	0.734	1.552	-
	(0.458)	(0.692)	(0.460)	
Canada				
RGDP	-	3.353	1.358	0.646
		(0.340)	(0.715)	(0.885)
OC	2.983	-	0.410	1.383
	(0.394)		(0.938)	(0.709)
NC	3.867	3.621	-	10.365**
	(0.276)	(0.305)		(0.015)
ROP	20.322***	16.561***	122.575***	-
	(0.000)	(0.000)	(0.000)	
Japan				
RGDP	-	12.876**	9.129*	11.717**
		(0.011)	(0.057)	(0.019)
OC	7.343	-	4.171	26.765***
	(0.118)		(0.383)	(0.000)
NC	3.396	9.091*	-	19.998***
	(0.493)	(0.058)		(0.000)
ROP	14.706***	7.865*	30.301***	-
	(0.005)	(0.096)	(0.000)	
France				
RGDP	-	0.657	0.138	0.742
		(0.417)	(0.709)	(0.388)
OC	8.534***	-	2.722*	0.520
	(0.003)		(0.098)	(0.470)
NC	7.379***	0.273	-	2.994*
	(0.006)	(0.601)		(0.083)
ROP	3.612*	3.767*	0.164	-
	-0.057	(0.052)	(0.684)	

Notes: *, ** and *** represent significants at the 10%, 5% and 1% levels, respectively. Significance implies that the column variable Granger Causes the row variable. The reported estimates are the Wald statistics. The values in brackets are p-values.

There are a number of factors discussed by Toth and Rogner (2006) that help in making this process easier. For example, a nuclear plant can store several years worth of fuel stock in a backroom, where uranium ore accounts for only 2-3% of nuclear generating costs (fuel can reach 0.6 USc/kWh). In addition, prices of nuclear fuel have been stable at a low level over a long period. The worries about nuclear energy are of totally different nature.

4. Conclusion

The increasing worries in excess of greenhouse gas emissions, the latest oil and gas prices fluctuation, the ambiguity associated with the stability of politics in oil exporting countries, and the reliance on overseas energy sources have magnetized attention in the chief role that might be played by a potential energy source such that of nuclear power. There are a number of advantages from using such energy source comprising the benefits of dipping air contamination and greenhouse gas emissions, minimize the cost and the uncertainty linked with electricity supply, and reduced reliance on imported energy. Therefore, given that there is always a need for massive energy to stimulates worldwide economic growth, energy and environmental policymakers must account essential energy sources such that of nuclear energy in their long-term plans taking into account all the worries associated with its operational safety, the disposal of radioactive waste, and the risk of proliferation of nuclear textile.

The aim of this study is to investigate the nuclear energy consumption-economic growth relationship, which might fill the gap of shortage in total energy requirements in line with dropping greenhouse gas emissions. To do so, this paper examines the causal relationship between nuclear energy consumption and economic growth in four industrialized countries. In order to avoid the issues related with the power and size properties of unit root and cointegration tests, the Toda and Yamamoto (1995) experiment for long run causality is implemented over the period of 1965 to 2010. Overall, the findings of the analysis seem not to be identical across countries. Mainly, there is one way causality running from nuclear energy consumption to economic growth in Japan implying that conservation measures taken to reduce nuclear energy consumption may negatively affect economic growth. Oppositely, increasing real GDP causes additional nuclear energy consumption in France. In the US and Canada, there is evidence that support the neutrality hypothesis. Looking at the other investigated channels, the level of real oil prices seem to have a vital role in deriving the demand for nuclear power in three out of four countries, suggesting that the uncertainty surrounding oil market influence nuclear energy consumption.

From the above discussion, this paper suggests that although nuclear safety is a global worry that needs a global solution, countries have to look at it as one of substitute energy source that has stable prices and supplies as well as is carbon free to replace oil. The appropriate balance should be taken into account in order to achieve the pursed level of economic growth, satisfying the need of massive energy, ensuring the safety of operating nuclear power plants, being more energy independent, and using a clean energy source for sustainable development.[6]

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[6] In a paper developed by Apergis et al. (2010) practical findings show that increasing the usage of nuclear power by 1% reduces the emission by 0.477% in 19 developed and developing countries.

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