

## **The Effects of Inflation on Sustainable Growth: The Case of OECD Countries**

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### **Author's contribution**

*The sole author designed, analyzed and interpreted and prepared the manuscript.*

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### **ABSTRACT**

The sustainable growth represents the future path and goal of the world. However, the persistence of the inflationist atmosphere in OECD needs the serious examination of the effect of inflation on the sustainability. Knowing the crucial role of sustainable growth path for the economy and the environment, the aim of this work is to examine the determinants of the sustainable growth in OECD countries. The current study aims to extend this line of research by including inflation in the Environmental Kuznets Curve Modified (EKC-modified) for the case of OECD countries. This study represents an extension of our latest work<sup>1</sup>. So the object of this study is to treat the effect of inflation on sustainable growth through analyzing the impact of the level of consumption prices on sustainable growth in the 12 OECD countries. To evaluate this link empirically, we have used a panel data model applied on the (EKC-modified) function for a panel model applying on the modified environmental Kuznets curve (MECK) for the case of 12 OECD countries covering the period (1990-2013). We have found a significant and negative effect of inflation on sustainable growth. However, the effect is low. OECD countries should ensure a modest inflation and enhance the use of technological innovation in renewable energy to maintain a sustainable growth path.

<sup>1</sup>Kamoun et al. [1]: *The Impact of Renewable energy on sustainable Growth: Evidence from a panel of OECD Countries.*

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## 1. INTRODUCTION

Climate change and patterns of growth are closely linked. In fact, many economists and environmentalists believe that this change is a consequence of several factors related to the objective of increasingly strengthening economic growth. In other words, this phenomenon is linked to the accentuation of human activities which are considered as primary causes. So, take care of the long run in the economic growth policy is a very important to protect the environment and stimulate economic growth in the same time. The world bank [2] stipulates that all of the counties are considered, and they may apply all efficient strategy to succeed a sustainable growth path that means maintaining of consumption in decline over time.(Solow, 1956). The economics of sustainability is based on the works of Solow [3], and Stiglitz [4]. They state the Limits to Growth, and they tried to found solutions to ensure the continuity of growth for present and future generation. In this context, they refer to the idea of the intergenerational equity between generations, Rawals (1971). Natural resource represents an input so important for growth. However, Hotteling (1931) states that the use of exhaustible resources at a fast pace is a selfishness about future generations. The problem is the limit stock of this capital. Solow [3] studied the "Intergenerational Equity and Exhaustible Resources". To achieve sustainability, several neoclassical economists such as Solow [3,5], Hartwik (1977), tried to make the theoretical conditions to achieve sustainability. For Solow [3], the problem of sustainability is summarized in the maximization of consumption or utility over infinite time. Hartwik (1977) states that the solution is to lead to technological progress through the substitutability of the natural capital by manufactured capital. However, Solow [5] developed the principle developed max-min that proposes to maintain a positive and constant level of per capita consumption. In this context, the neoclassical approach suggests three major forces to achieve a sustainable growth path: the substitution of natural resources by man-made resources, the technological change, and the scale efficiency. The legitimacy of sustainability has been consolidating after the report of Brundtland report (1987). This report states exactly the definition and the importance of the

interaction between the economy, the social and the environment sectors to achieve sustainable development through taking into consideration the environment protection and the economic and social development.

The report of the World Bank [2] has insisted on the importance of sustainable growth and has focused on the sustainable growth determinants. The sustainable growth needs the transmission of economic policy to the long-term through the adaptation of many factors such as macroeconomic stability, innovation and especially in renewable energy, good governance (See, Fig. 3).

The World Bank [2] has indicated that the macroeconomic stability is necessary to realize a sustainable growth path. Policy makers should work to have modest inflation to ensure the investment growth and the productivity growth. "No economy can flourish in the midst of macroeconomic instability. Wild fluctuations in the price level, the exchange rate, the interest rate, or the tax burden serve as a major deterrent to private investment, the proximate driver of growth. Economists and policy makers, however, disagree about the precise definition of stability and the best way to preserve it. For example, very high inflation is clearly damaging to investment and growth. So, the control of inflation is necessary to favourite a sustainable economic growth", World Bank [2]. The inflation is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of households [6].

The current study aims to extend this line of research by including inflation in the Environmental Kuznets Curve Modified (ECK-modified) for the case of OECD countries. In this discussion, we study the effect of inflation on sustainable growth through analyzing the impact of the level of consumer prices on sustainable growth in the 12 OECD countries. Our goal is to study the sustainable growth path determinants in OECD countries. So, as an extent of the work of Kamoun et al. [1], our contribution in this work is the addition of inflation as an explanatory variable in the model. The inflation-sustainable growth link represents an issue so important because the sustainable growth represents the future path and goal of the worlds and the persistence of inflationist atmosphere need the

serious examination of the effect of inflation on the sustainability. We are based on the report of the World Bank [2] which considers that the sustainable growth path is based on many determinants such as macroeconomic stability through modest inflation. We have also added the governance as an explanatory variable. IMF<sup>2</sup> [7] Has mentioned that sustainable growth can be realized through the control of inflation. To evaluate empirically this work, we apply a panel data model by the environmental Kuznets curve modified (EKC-modified) for 12 OECD countries over the period (1990-2013). We used adjusted net savings as an independent variable to signify sustainability based on the study of the World Bank [8].

The remainder of the paper proceeds as follows. The introduction is provided in Section 1; in Section 2 we have given Literature review on inflation- long-run economic growth nexus. We in section3 we have determined channels transmission between Inflation and Sustainable growth. We have given the empirical study in section 4. Finally, we have provided principals conclusion in conclusion.

## **2. LITERATURE REVIEW ON INFLATION-LONG-RUN ECONOMIC GROWTH NEXUS**

The majority of studies focused on the relationship between the inflation and economic growth have found a negative relationship between those variables. Those studies differ regarding goal (short term or long term or both), in term also of the period, methodology used region studied. According to Thorn and Bernard [9] the theories of inflation are not complete. "Although the theory of inflation is not complete, And that there is no complete agreement on all aspects of the Inflationary process, some theoretical conclusions Very broad and some empirical facts stand out." Thorn and Bernard [9].

According to Mohsenia and Jouzaryanb [10] the "Inflation can affect all aspects of a country through influencing economic growth, employment, investment, distribution of income and wealth, and even social and political conditions". Several studies such as Barro [11] have focused on the relationship between inflation and economic growth. Barro [11] stipulate that there is a negative relationship

between inflation and economic growth in 117 countries in the period (1970–1985).

There is a very important bag-round examining the relationship inflation economic growth. The majority of studies such as Barro [11], Valdovinos [12], Combey and Nubukpo (2010), Baharumshah et al. [13] have focused on the effect of inflation on economic growth. They founded a negative relationship.

Valdovinos [12] examine the relationship between the economic growth rate and the level of inflation. He has found that there is a negative correlation in the long run. He used the Baxter and King filter. Results have shown a clear negative relation between inflation and economic growth rate. Baharumshah et al. [13] have investigated the growth effects of inflation and inflation uncertainty in 94 emerging and developing countries.

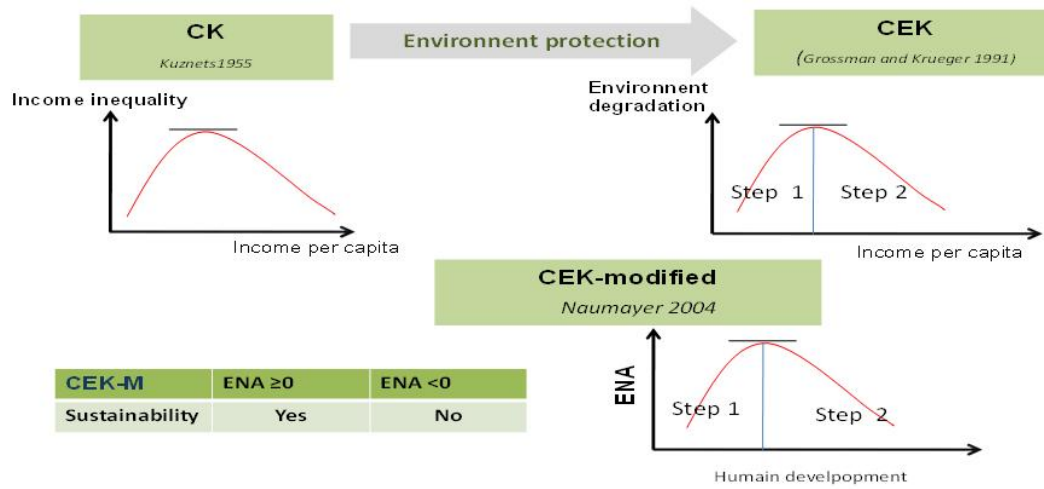
Combey and Nubukpo (2010) have tried to demonstrate the existence of a nonlinear relation Between the rate of inflation and the rate of economic growth in the Union West African Economic and Monetary Union (UEMOA) and to determine the From which an arbitrage between inflation and growth is effective. Results of this latter study have shown that the inflation.

## **3. INFLATION AND SUSTAINABLE GROWTH: CHANNEL TRANSMISSION**

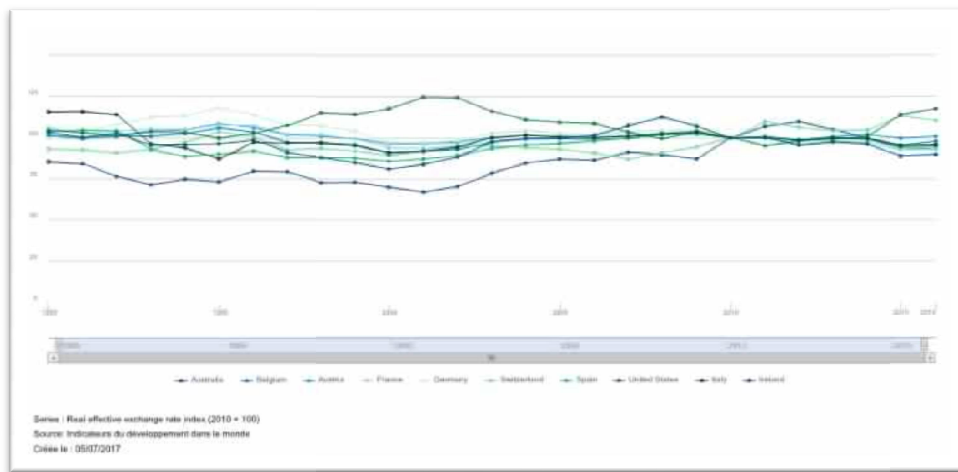
The inflation-sustainable growth nexus is not studied until now. However, this link represents an issue so important because the sustainable growth represents the future path and goal of the worlds and the persistence of inflationist atmosphere, in OECD countries, needs the serious examination of the effect of inflation on the sustainability (See Fig. 2). The inflation was being considered as meaning to ensure the economic equilibrium. But, the inflation depends on the structure of the economy. "The structures of our contemporary economies are favourable to Development of inflationary pressures, or by positing inflation as a both economic and social, resulting from new structural relationships between economic groups", [9]. There is three channel transmission related to the inflation-sustainable growth nexus such as global wealth, investment and consumption and human capital.

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<sup>2</sup> International monetary fund (Article 2016).



**Fig. 1. The environmental Kuznets Curve-Modified**  
 Source: Author



**Fig. 2. The evolution of consumption indices prices in OECD countries (1990-2016)**  
 Source: Authors conception. Data from the World Bank Database

- *Reel wealth channel*

Sustainable growth path needs an optimal reallocation of resources. However, according to Thorn and Bernard [9], higher prices, therefore, result in the less optimal reallocation of resources. He stipulated that the financial returns appreciations could be wrong because of inflation. It is known that the investment is based on those financial appreciations. So, the investments orientation can be affected and influenced negatively.

The quantification of sustainability could be realized by referring to the global wealth variation that measured by the adjusted net savings (Hamilton and Clemens 2003). Or the inflation

begets non-equal structures of wealth division (Thorn and Bernard [9]).

- *Investment Channel*

The investment represents a channel transmission between inflation and sustainable growth. The monetary theory stipulated that the prices level is a function of transactions (T), the money supply (M) and its speed (V).

The level of prices is written as follows:

$$P = T/MV \text{ With } MV = PT$$

Arrow [14] Assume that the global investments enhanced represent the main key of a

sustainable path. So, a high inflation can affect negatively the sustainable growth through the decrease of tractions and production.

- *Consumption Channel*

The consumption also represents a channel transmission of inflation to sustainable growth. Sustainable growth is highly correlated the generalized consumption. The Keynes theory stipulated that the inflation by demand means that the inability of supply of products and services in front of the increase of the demand of services and products generates the increase of prices.

According to Aglietta [15], the sustainable growth could be measured by the variation of intertemporal welfare:

$$V(t) = \int_t^{+\infty} U(C(t))e^{-\delta(\tau-t)} dt,$$

C (τ) is a generalized consumption aggregate that encompasses the consumption of market goods and the non-market consumption of public goods and health and environmental services.

The criterion of sustainability depends on the variation of inter-temporal well-being which is equal to that of the value of social wealth in t.

$$\frac{dV}{dt} = \sum_{i=1}^{i=n} \left( \frac{\partial V}{\partial K} \right) (dK_{it} / dt) = \sum_{i=1}^{i=n} p_{it} I_{it} \geq 0$$

The condition of sustainability demands that real wealth is not decreasing and that we express the condition of sustainability by the growth rates of the different forms of capital by dividing dV/dt by  $P_1 K_1$  which represents the first type of capital expressed at just value. Aglietta [15].

So, the increase of prices influences the generalized consumption. The consumption of both market goods and non-market public goods and also environmental and health services can be affected by the increase in their prices. So, this leads to the decrease of inter-temporal wellbeing consequently the diminution of real wealth.

## 4. EMPIRICAL STUDY

### 4.1 Data

The data set is a balanced panel of 13 OCDE countries over the annual period (1990-2013).

The selected OECD countries included in the sample are Turkey (TUR), Germany (GER), Australia (AUS), Austria (AUT), France (Fran), Canada (CAN), Korea (Kore), United-State (USA), Spanish (SPA), Italy (ITA), Ireland (IRL), Swiss (SWI).

The dependent variable is the GS: Adjusted net savings per capita, including particulate emission damage (current US\$). A few of empirical studies used Adjusted net saving in the environmental Kuznets curve modified to study the effect of the determinants of sustainability, such as Neumayer [16], Costantini et al. [17] and Farhani et al. [18].

The explanatory variables are: GDP: GDP per capita (constant 2005 US\$), GDP2: Quadratic GDP per capita (constant2005 US\$), CEER: Total renewable Electricity net consumption (Quadrillion Btu). CEF: Fossil energy consumption (Quadrillion Btu). Total coal consumption (Quadrillion Btu), natural gas consumption (Quadrillion Btu) and Petroleum Consumption (Quadrillion Btu). Ber: Patent application filed under the PCT in the technology domains of renewable energy generation: we used the patent as a measure to study the effect of renewable energy technologies referring to the work of Popp [19]. He used data for patents to build the energy stock of knowledge and found that one-third of the change in energy consumption is due to induced innovation. IPC: Consumer price index, G: Governance

For the data sources: CEER and CEF are collected from the energy information administration (EIA), GDP, GDP2 and GS are collected from the World Bank database (WDI), and Ber is collected from the OCDE database.

### 4.2 Model Specification

We are based on the Environmental Kuznets Curve (EKC) of Kuznets [20]<sup>3</sup>. But in this study, we used the ECK-modified witch take into consideration the environment. The environmental Kuznets curve Kuznets was considerably used in the economic- environment nexus. The relationship between the environmental

<sup>3</sup> Kuznets found that increasing income per capita improve inequality. "The EKC results have shown that economic growth could be compatible with environmental improvement if appropriate policies are taken. It is a significant condition that only when income grows, the effective environmental policies can be implemented." Dinda (2004).

degradation and the income per capita was empirically studied, for the first time by Grossman and Krugger [21]. A change of inequality occurred through pollution showing an inverted U relationship between the environmental degradation and the income per capita. According to Dasgupta et al. [22], this relationship can be explained by the increasing pollution, in parallel with the strengthening of economic growth because the authorities engage with the whole capital held to accelerate economic growth. However, in the second stage, the recorded negative relationship reflects the effort made by the authorities to counter the proliferation of pollution through the increased income that represents the result of the first stage. The detention of resources to finance the fight against CO2 emissions helps reduce pollution while encouraging increased economic growth in the context of the second stage. (See Fig. 1).

In order to consider the future generations' needs, some studies have introduced the concept of sustainability in the environmental kuznets curve [23,24,25]. It should be recalled that this concept of sustainability represents the hypothetical constant level of consumption.<sup>4</sup>

In 2004, Naumayer suggested the substitution of the dependent variable traditionally used in the growth function by the index of genuine savings.

Our contribution is the addition of inflation as an explanatory variable in the model; we are based on the report of the world bank [2] which consider that the sustainable growth path is based on many determinants such as macroeconomic stability through modest inflation. Also, we decomposed the consumption of fossil energy and renewable energy for the separate effect of these two types of energy on the adjusted net savings. We have also taken into consideration To do this we are building a cointegrated panel model. We use the Fully Modified Ordinary Least Squares (FMOLS) due to Pedroni [26].

#### 4.2.1 Stationarity and cointegration

We study the stationarity of the variables by using the tests of Levin, Lin and Chu [27], IM, Pesaran and Shin [28], Fisher-ADF [29]. These tests are based on the null hypothesis of the unit root. The results showed that all variables are

non-stationary and they are integrated into the order 1.

After that, we conduct the cointegration tests of Pedroni [30]. He has developed seven cointegration tests while the null hypothesis is the reject of cointegration relationship. The results of cointegration relationships showed that the majority of those tests could reject the null hypothesis of non-cointegration. The six variables are cointegrated meaning that they have a long run relationship. So, we adopt cointegrated regression models in panel data.

#### 4.2.2 Panel FMOLS model

FMOLS is a non-parametric approach which deals with dynamic ordinary least square (DOLS) method of Saikkonen [31] and Stock and Watson [32]. DOLS is a parametric method where endogeneity is dealt with by explicit modelling of leads and lags of explanatory variables. The FMOLS or DOLS presents similar results, but the latter method requires more observations in the time dimension Harris and Sollis, [33]. On the other hand, the FMOLS does not sacrifice a lot of degrees of freedom.

The FMOLS method is based on the following panel regression model:

$$\begin{aligned} Y_{it} &= \alpha_i + \beta X_{it} + e_{it} \\ X_{it} &= X_{it-1} + \varepsilon_{it} \end{aligned}$$

Where,  $e$  and  $\varepsilon$  are error terms and are accepted as stationary.

The panel FMOLS estimator for  $\beta$  estimator can be estimated as follows:

$$\begin{aligned} \beta_{NT}^* &= N^{-1} \sum_{i=1}^N \left( \sum_{t=1}^T (X_{it} - \bar{X}_i)^2 \right)^{-1} \\ &\times \left( \sum_{t=1}^T (X_{it} - \bar{X}_i) Y_{it} - T \hat{\tau}_i \right) \\ Y_{it}^* &= (Y_{it} - \bar{Y}_i) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta X_{it} \end{aligned}$$

$$\hat{\tau}_i = \hat{\Gamma}_{21i} + \Omega_{21i}^0 - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \left( \hat{\Gamma}_{22i} - \Omega_{22i}^0 \right)$$

Where

Here,  $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i'$  shows long-run covariance matrix where  $\Omega_i^0$  the contemporaneous covariance is and  $\Gamma_i$  is a weighted sum of covariances.  $L_i$  Is the lower triangular in the decomposition of  $\Omega_i$ .

<sup>4</sup> "Hypothetical constant level of consumption that would produce the same total welfare that the current economy can produce consumption path", Philippe and Gilles, (1998).

**Table 1. Results of FMOLS regression**

Dependant variable: IGS				
Variable	Coefficient	Std.Error	t-Statistic	Prob
GDP	1.75E-05	1.65E-06	10.63181	0.0000*
GDP2	0.341900	0.007434	45.98953	0.0000*
CEER	-0.098456	0.016919	-5.819433	0.0000*
CEF	0.004621	0.001140	4.053589	0.0001*
BER	0.000186	3.01E-05	6.164292	0.0000*
IPC	-0.001618	0.000788	-2.055225	0.0408*
G	-0.072249	0.043393	-1.665012	0.0970*

\*Significant at 5 %

### 4.3 Estimation and Discussion

Results of FMOLS observed (See Table. 1) that the coefficients of GDP and GDP2 are significant (P-value >0.05). The coefficient (0.004621) of CEF is significant and positive. While the coefficient (-0.098456) of CEER series is significant and negative. In our work Kamoun et al. [1] we have found that the increase of the consumption of renewable electricity affects positively the sustainable growth. However, the integration of the inflation as an explanatory variable has changed the latest effect.

The innovation in renewable energy (BER) has a significant and low positive effect on the GS+. The coefficient of BER is 0.000186. So, supplement unit of the BER “the innovation of renewable energy technologies” almost by unit increase GS by 0.000186 units. The IPC has a significant and negative effect on GS. A supplement unit of the IPC decreases almost GS by 0.001618 units. So the inflation affects negatively the maintaining of sustainable growth. This result confirms that it's indicated by the world bank [2] that the modest inflation is affects negatively for maintaining sustainable growth.

### 5. CONCLUSION

The sustainable growth represents the future path and goal of the world. However, the persistence of the inflationist atmosphere in OECD needs the serious examination of the effect of inflation on the sustainability. The current study aims to extend the sustainable growth determinants research by including inflation in the Environmental Kuznets Curve Modified (ECK-modified) for the case of OECD countries. Our object is to examine the effect of inflation on sustainable growth. We have studied the effect of inflation on sustainable growth through analyzing the impact of the level of consumption prices on sustainable growth in the

12 OECD countries. Our goal is to study the sustainable growth path determinants in OECD countries. So, as an extended of the work of Kamoun et al. [1], our contribution in this work is the addition of inflation as an explanatory variable in the model of ECK-modified. To evaluate empirically this work, we apply a panel data model by the environmental Kuznets curve modified (EKC-modified) for 12 OECD countries over the period (1990-2013). We used adjusted net savings as an independent variable to signify sustainability based on the study of the World Bank [8]. Therefore, the adaptation of renewable energy technologies is very significant to solve the environmental problems and to ensure the reconstruction of wealth. It helps to reduce pollution, and it is considered as the proper and free energy source. The OECD object is to ensure both the environment protection and economic growth stimulating.

The majority of studies such as (Barro [11], Valdovinos [12], Combey and Nubukpo 2010, Baharumshah et al. [13]) have focused on the effect of inflation on economic growth. They founded a negative relationship. They have found a negative effect of inflation on economic growth. The inflation- sustainable growth nexus isn't studied empirically before. We have tried to focus on this latest relationship that represents an extension of sustainable growth literature. We have found that the inflation affects negatively the maintaining of a sustainable growth in OECD countries. But this effect is low. So, Our results confirm the world bank [2] that policy makers should control inflation to achieve and maintain a sustainable path OECD countries may invest in environmental policies witch encourage the use of environmentally friendly energy technologies to promote sustainability in the same time, Policy-makers are called upon to enhance invests in research and development (R&D) and ensure a modest inflation. To ensure a modest inflation and to solve the problem of the

macroeconomic instability, governments should apply credible policies through the efficient monetary mechanism.

### COMPETING INTERESTS

Author has declared that no competing interests exist.

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