

Agriculture, Tourism, Energy and Economic Growth: An Empirical Analysis

Athanasios Vazakidis¹, Antonios Adamopoulos²

¹Department of Applied Informatics, University of Macedonia, 156 Egnatias Street P.O. Box 54636 Thessaloniki, Greece; e-mail: vasak@uom.edu.gr

²Academic Cooperating Member of Hellenic Open University, Department of Tourism Management, School of Social Sciences and Academic Scholar in University of Western Macedonia, Department of Management and Business Administration, 34 Solonos street, Thessaloniki, Greece; e-mail: adamant@uom.gr

Abstract. This study investigates the main determinants of economic growth examining a structural system equation model taking into account the positive effect of agriculture, tourism and energy development on economic growth. Two stage least squares method is used in order to define the direct and indirect relationships between the dependent and independent variables of the estimated model. The empirical results indicated that agriculture, tourism and energy sectors promote economic growth increasing innovation and entrepreneurship.

Keywords: economic growth; agriculture; tourism; energy sector; system equation model; two stage least squares method

1 Introduction

The investigation of empirical interrelation among agriculture, tourism, energy, and economic growth consists an important issue in the modern empirical literature. Following the studies of (Maniatis 2017, Adamopoulos 2018,), a healthy economic system facilitates the tourism growth through innovation and entrepreneurship. Energy sector consists one of the most important determinants of economic growth. USA precedes many other developed countries in using renewable resources of energy. By this way, energy is conserved through the substitution of the primary sources of energy with renewable resources and so the limitation of using excessive electric power energy is achieved.

The main objectives are summarized as follows

- To examine the interrelation among economic growth, agriculture, tourism and energy development
- To estimate a system equation model with two stage least squared method

Surely, the paper examines a very powerful economy such as USA which is characterized by higher rates of economic development facilitating the tourism and energy growth. USA is regarded as one of the widely developed countries, worldwide. The model hypothesis predicts that agriculture, tourism and energy development promote economic growth for USA for the examined time period from 1995 to 2017.

Copyright © 2020 for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

Proceedings of the 9th International Conference on Information and Communication Technologies in Agriculture, Food & Environment (HAICTA 2020), Thessaloniki, Greece, September 24-27, 2020.

First of all, it is to take an approach to the methodology of this empirical study. Besides, it is to analyse the empirical results and then to formulate the final conclusions on the matter.

2 Data analysis

A system equation model is adopted to estimate the effect of agriculture, tourism development, and energy use on economic growth. For this reason, the two-stage least squares method is applied in order to find out the relationship between the examined variables, based on economic theory. The general form of the structural system equation model is the following one:

$$GDP_t = c_1 + c_2 AGR_t + c_3 REN_CS_t + c_4 EN_{t+2} + c_5 TEXP_{t-i} + c_6 TRANS_t + u_{1t} \quad (1)$$

$$AGR_t = c_7 + c_8 *GDP_t + c_9 *OUTPUT_{t-i} + c_{10} *X_{t-i} + u_{2t} \quad (2)$$

$$REN_CS_t = c_{11} + c_{12} *GDP_{t-i} + c_{13} *EL_PROD_R_{t-i} + c_{14} *CO_2_EM_t + u_{3t} \quad (3)$$

$$EN_t = c_{15} + c_{16} *GDP_t + c_{17} *EL_CS_t + c_{18} *FF_CS_t + c_{19} *ALTER_{t-i} + c_{20} *GDP_REN_t + c_{21} *INV_t + c_{22} *X_{t-i} + u_{4t} \quad (4)$$

$$TRANS_t = c_{23} + c_{24} *GDP_t + c_{25} *TRAV_t + c_{26} *INV_t + u_{5t} \quad (5)$$

$$TEXP_t = c_{27} + c_{28} *GDP_t + c_{29} *INV_{t-i} + c_{30} *TAR_{t-i} + u_{6t} \quad (6)$$

where

GDP	= Gross Domestic Product
AGR	= Agriculture
REN_CS	= Renewable energy consumption
EN	= Energy use
EL_PROD_RS	= Electricity production from renewable sources
OUTPUT	= Renewable electricity output
ALTER	= Alternative and nuclear energy
CO2_EM	= CO2 emissions from liquid fuel consumption
FF_CS	= Fossil fuel energy consumption
EL_CS	= Electric power consumption
INV	= Investments
TAR	= Tourist arrivals
TEXP	= Tourist expenditures
TRANS	= Transport services
TRAV	= Travel services
X	= exports of fossil fuels
GDP_REN	= Gross Domestic Product of renewable sources

c	= coefficient
t	= time trend
t-i	= lagged time trend
ut	= residual (error term)

Based on studies of Maniatis (2017) and Adamopoulos (2018), the variable of economic development (GDP) is measured by the real gross domestic product, investments (INV) are expressed by the gross fixed capital formation.

Energy growth models include renewable energy consumption (REN_CS), energy use (EN), electricity production from renewable sources (EL_PROD_RS), renewable electricity output (OUTPUT), alternative and nuclear energy (ALTER), fossil fuel energy consumption (FF_CS), electric power consumption (EL_CS) and CO2 emissions from liquid fuels consumption (CO2_EM).

Transport services (TRANS) and tourist expenditures (TEXP) represent measures of tourist growth. Tourist growth model includes also travel services (TRAV) and tourist arrivals (TAR). (World Development Indicators online database, <https://data.worldbank.org>).

In this empirical study annual data are used in the matter of United States of America, while the time period ranges from 1995 to 2017. Data have been obtained from the statistical database of World Bank (World Development Indicators online database). All data variables have been transformed in constant prices regarding 2010 as a base year. The basic hypotheses of structural equation model are summarized as follows:

- Hypothesis H1: Agriculture, renewable energy consumption, energy use, tourism expenditures and transport services have a positive effect on gross domestic product.
- Hypothesis H2: Gross domestic product, renewable electricity output and exports of fossil fuels have a positive effect on agriculture output
- Hypothesis H3: Gross domestic product, electricity production from renewable sources have a positive effect on renewable energy consumption, while CO2 emissions have a negative effect on it.
- Hypothesis H4: Gross domestic product, electric power consumption, fossil fuel energy consumption, alternative and nuclear energy, and investments have a positive effect on energy use while GDP of renewable resources has a negative effect on it.
- Hypothesis H5: Gross domestic product, travel services and investments have a positive effect on transport services
- Hypothesis H6: Gross domestic product, investments and tourist arrivals have a positive effect on tourism expenditures

The following diagram depicts these theoretical hypotheses:

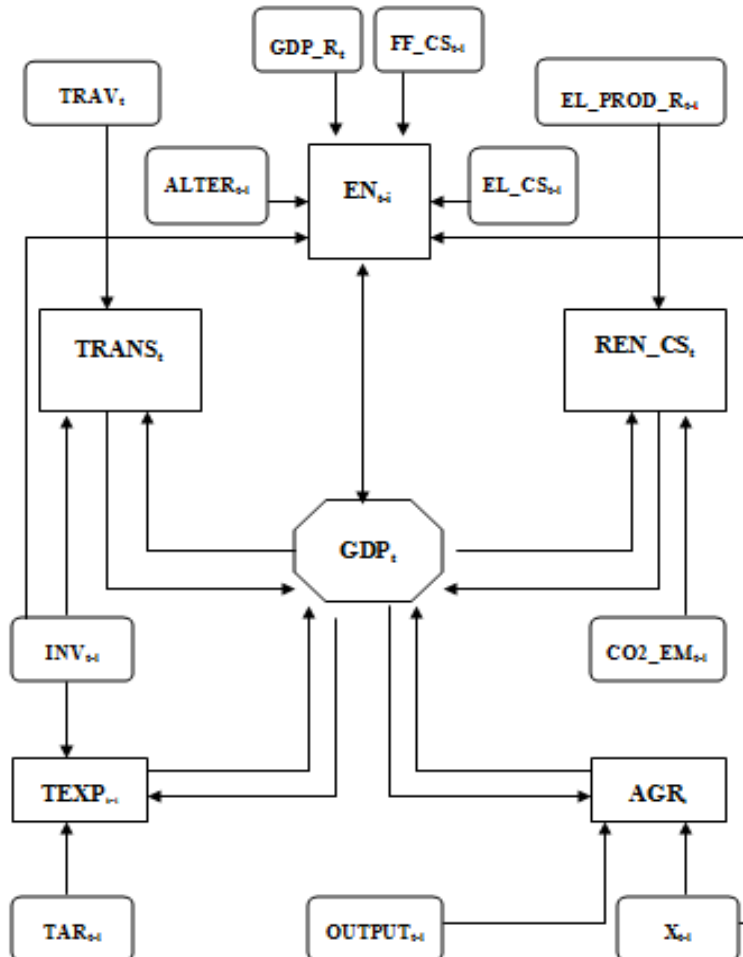


Fig. 1. Basic hypotheses of system equation model

3 Methodology

The structural system equation model is consisted by six equations. The dependent variables are (GDP_t, AGR_t, REN_CS_t, EN_t, TEXP_t, TRANS_t,) and the independent variables are (GDP_{t-3}, OUTPUT_{t-1}, X_{t-1}, EL_PROD_R_t, CO2_EM_t, EL_CS_t, FF_CS_t, ALTER_{t-1}, GDP_REN_t, INV_t, X_{t-2}, TRAV_t, INV_{t-1}, TAR_{t-3}).

The estimation of the structural system equation model is mainly based on some basic specification tests. Eviews 9.0 (2015) software package is used to conduct these tests. Initially, ordinary least squares method is applied to estimate a linear regression

model for statistical significance. This method defines that the regression line is fitted to the estimated values by minimizing the sum of squares residuals, which indicates the sum of the vertical distances between each point and the relative point on the regression line. The shorter the distances, the better fitted the regression line. A regression model has a general form as follows:

$$Y_t = a + bX_t$$

Estimating a regression model with ordinary least squares method, mainly we have to find the estimations of constant term (\hat{a}) and the slope of equation model (\hat{b}), namely to solve the following patterns (Seddighi et al, 2000)

$$\hat{b} = \frac{n \sum X_t Y_t - \sum X_t \sum Y_t}{n \sum X_t^2 - (\sum X_t)^2} \text{ and } \hat{a} = \bar{Y}_t - \hat{b} \bar{X}_t,$$

where \bar{Y} is average of values of Y (dependent variable) and \bar{X} average of values of X (independent variable). The final estimated model has the general form as follows

$$\hat{Y}_t = \hat{a} + \hat{b}X_t$$

Finally, two-stage least squares method is used for estimation of structural system equation model.

4 Empirical Results

The significance of the empirical results is dependent on the variables under estimation. The number of fitted time lags was selected for the best estimation results and to ensure statistical significance in each equation model. The basic hypothesis denotes that there is a positive interrelation between agriculture tourism, energy use and economic growth. Estimating the structural system equation model with two-stage least squares method we can infer that there is a statistical significance in coefficients of independent variables, based on probabilities and t-student distribution test statistics, the empirical results of two-stage least squares method are summarized as follows:

$$\text{GDPt} = -0.9 + 0.22 \text{AGRt} + 0.24 \text{REN_CSt} + 0.58 \text{ENt-2} + 0.46 \text{TEXPt} + 0.43 \text{TRANSt} + u1 \quad (1)$$

$$\text{AGRt} = 0.01 + 0.58 * \text{GDPt} + 0.24 * \text{OUTPUTt-1} + 0.25 \text{Xt-1} \quad (2)$$

$$\text{REN_CSt} = 0.9 + 0.7 * \text{GDPt-3} + 0.06 * \text{EL_PROD_RSt} - 0.63 * \text{CO2_EMt} \quad (3)$$

$$\text{ENt} = 0.14 + 0.26 * \text{GDPt} + 0.3 * \text{EL_CSt} + 0.6 * \text{FF_CSt} + 0.08 * \text{ALTERt-1} - 0.68 * \text{GDP_REnt} + 0.15 * \text{INVt} + 0.02 * \text{Xt-2} \quad (4)$$

$$\text{TRANSt} = 0.27 + 0.29 * \text{GDPt} + 0.11 * \text{TRAVt} + 0.26 * \text{INVt} \quad (5)$$

$$\text{TEXPt} = -0.27 + 0.55 * \text{GDPt} + 0.33 * \text{INVt-1} + 0.48 * \text{TARt-1} \quad (6)$$

As we can see from the estimated results, renewable energy consumption, energy use, transport services, and tourism expenditures have a positive direct effect on economic growth, while CO2 emissions and GDP of renewable sources have a

negative direct effect on it. Also, alternative and nuclear energy, fossil fuel energy consumption, electric power consumption, electricity production from renewable sources, tourist arrivals and travel services and investments, exports of fossil fuels have a positive indirect effect on economic growth.

5 Conclusions

The purpose of this paper was to examine the interrelation between agriculture, tourism and energy development and economic growth for United States of America for the period 1995-2017 estimating a simultaneous system equations model by the two-stage least squared method. This model is consisted by six linear equations which represent the effect of agriculture, tourism growth and energy use on economic growth taking into account the empirical studies of Maniatis (2017), Adamopoulos (2018). Indeed, the empirical results indicated that agriculture, tourism development in conjunction with the development of energy consumption have a positive direct effect on economic growth for USA. Future interest should be focused on the comparative analysis of empirical results for many other countries using alternative modern econometric methodology.

References

1. Adamopoulos, A. (2018) "A simulation model of economic development: an empirical analysis for United Kingdom", paper presented in International Conference of Development and Economy (ICODECON), Kalamata, Greece, 3-6 May 2018, <https://icodecon.com/proceedings.html>
2. Eviews 9.0. (2015) Quantitative Micro Software, Irvine, California.
3. Maniatis, A., (2017), "The Right to Pursuit of Happiness and Italian Tourism Law", *Tourism Development Journal*, 2017, Vol. 15, No. 1, pp. 49-58.
4. Seddighi, H., Lawler, K., and Katos, A., (2000). *Econometrics: A practical approach*, London: Routledge.
5. World Development Indicators Statistical database, <https://data.worldbank.org>.