



# IS POVERTY ANOTHER CAUSE OF CANCER? AN EMPIRICAL ANALYSIS

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**Abstract – Objective:** Cancer is the most important public health issue of the century and a serious economic burden on a global scale. Economic crises that have begun to be globally experienced, accompanied by unemployment, labor, and income loss, as the process is followed by poverty, anxiety, stress and weakening of the immune system cause telomere shortening and may eventually lead to a cycle that results in cancer. This study approaches the causes and risk factors of cancer with an economic paradigm contributing to the existing factors by adding new ones. The aim of this study, which was conducted in the framework of a multidisciplinary approach, is to investigate the correlation between poverty triggered by economic crises and cancer incidence.

**Materials and Methods:** Unit Root Tests, Cointegration Tests, Engle-Granger Test, Johansen Test and Granger Causality over VECM Model have been used to investigate the short- and long-term relationship between the variables studied.

**Results:** In this study, it is empirically determined that cancer incidence is caused by poverty and that poverty is also caused by cancer incidence. There is bi-directional causality between poverty and cancer incidence.

**Conclusions:** This study, conducted with a multidisciplinary approach can provide different pieces of evidence to contribute to the known risk factors of cancer and to the economic crisis-cancer cycle. These pieces of evidence can be a starting point for future studies that will create evidence that fighting against economic crises and poverty -one of the consequences of crises- will cost a lot "cheaper", rather than bearing the humanitarian and global economic burden of cancer.

**KEYWORDS:** Poverty, Cancer incidence, Cointegration tests, Engle-Granger test, Johansen test, Granger causality over VECM model.

## INTRODUCTION

Cancer is a significant public health matter, not only because it is fatal, but also because of organ losses and disabilities, especially encountered in delayed cases. In addition to the human dimension that is psychologically shocking for both patients and their relatives, cancer also has a very serious economic dimension on a global scale due to its high costs in prevention, screening, treatment, continuous care, risk management, and palliative care. It is extrapolated that there have been 1688780 new cancer instances and 600920 deaths due to cancer in the US in 2017, and this corresponds to about 1650 deaths per day<sup>1</sup>.

Again, it is estimated that approximately 1735350 new cancer instances will be diagnosed in the United States in 2018 and 609640 individuals will pass away because of the disease<sup>2</sup>. By 2030, the global burden is predicted to reach 21.6 million new cancer instances and 13.0 million deaths from cancer<sup>3</sup>. The economic impact of cancer is also important and is increasing with each passing day. The total annual economic burden of cancer cases for 2010 was estimated at about US\$ 1.16 trillion<sup>4</sup>. For comparison, the national expenditures for cancer care in the United States in 2017 was estimated at \$ 147.3 billion. Along with the population aging and cancer prevalence increasing, costs are expected to increase in the coming



years. In addition, costs also increase with new and generally more expensive treatments being adopted as care standards<sup>5</sup>. Cancer, which has become a very serious issue, is defined as “a group of diseases with many possible causes”. Smoking and tobacco, diet and physical activity, sun and other types of radiation, viruses and other infections” and genetics are among the causes of cancer, which costs billions of dollars and human deaths<sup>6</sup>. However, recent studies indicate that immune system disorders and shortening of telomere length are also among the causes of cancer. There are findings suggesting that this cycle is triggered by stress and anxiety. In fact, the study by Chang et al<sup>7</sup> on the gene called ATF3, found important genetic evidence for the correlation between stress and cancer. As a result of the experiences gained following the global economic crises, *the cycle of economic crises - unemployment - income loss - low socioeconomic status - poverty - anxiety - stress - cancer* has begun to be questioned. This cycle needs evidence. Some studies suggest that economic crises have significant effects on production loss, labor loss, and health<sup>8</sup> and that health problems are related to poverty, inequality and other social and economic indicators of health<sup>9</sup>; for example, following the 2008 Global Financial Crisis, social changes related to health were experienced in Europe; the deterioration of socio-economic status due to unemployment and income loss had a negative impact on the health of individuals<sup>10</sup>. Following this, McLaughlin et al<sup>11</sup> found that after the 2008 Global Financial Crisis, sudden loss of wealth has led to increased signs of depression and use of antidepressant drugs in the US. Low income and poverty have a significant negative impact on health<sup>12</sup>. Unemployment has been determined to be related with a lower socio-economic status<sup>13,14</sup>. It is known that the financial situation is related to cancer incidences directly or indirectly because it affects the access to health-related social facilities, preventive medical examinations, and lifestyles<sup>15</sup>. As reported by American Cancer Society, individuals with low socioeconomic statuses (SES) have higher cancer mortality ratios than those with higher socioeconomic statuses, regardless of demographic factors like race/ethnicity. Significant evidence has been obtained regarding the correlation between lower socioeconomic statuses and decreased cancer survival due to decreased access to treatment<sup>16,17</sup>. People with low socio-economic statuses have higher rates of cancer mortality<sup>18</sup>.

## EMPIRICAL ANALYSIS AND METHODS

In this section, the causality between poverty and cancer incidence will be investigated. The first step is to investigate the stability of the series by conducting a

unit root study. For this purpose, “Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests developed by Dickey and Fuller<sup>19</sup> and Phillips and Perron<sup>20</sup>” were applied. The Schwarz information criterion was applied to define appropriate delays. In addition, compatibility with MacKinnon criteria was also analyzed. Different techniques have been used to determine the causality relationships between poverty and cancer incidences according to the characteristics of the series. Cointegration Tests and Error Correction (VECM) Models were used. As a result of the obtained findings, short-term relationships were tested using the Granger Causality Test over the VECM model.

## THE DATA AND THE EMPIRICAL RESULTS

The hypothesis of the study conducted to test whether there is a causal relationship between poverty and cancer incidence is as follows:

H<sub>0</sub>: Poverty is the cause of cancer incidence.

H<sub>1</sub>: Poverty is not the cause of cancer incidence.

In the study, poverty data for the period of 1980-2015 taken from the United States Census Bureau and cancer incidence datum taken from the National Cancer Institute for the period of 1980-2015, were used.

$$CA_t = \alpha_0 + \alpha_1 P_t + \epsilon \quad (1)$$

CA and P refer to cancer incidence and poverty. In the econometric model, the causality relationship between poverty and cancer incidence, as well as whether or not they are integrated, will be analyzed. In regression analysis (Equity 1), poverty and cancer incidence will be taken into account as independent and dependent factors, respectively. At the beginning of the examination, the unit root characteristics of the data were tested using “the Augmented Dickey Fuller (ADF) and Philips and Perron (PP) unit root tests”. The test results can be found in Table 1. The series have the same characteristics. In “the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)” analyses, it was found that the series had a unit root value at the level. By taking the first differences, the series have been stabilized. The Engle-Granger Test and Johansen Test were used to determine the existence of a long-term relationship.

## COINTEGRATION TESTS

The Engle-Granger Test was used to test for long-term correlations between poverty and cancer incidence. As can be found in Table 2, the series are not cointegrated in the long-term.

**TABLE 1.** The results of Unit Root Test.

	Variables	Test Statistic	Critical Values		
			1%	5%	10%
<b>Poverty</b>					
ADF	Poverty, level	-2.295154	-4.243644	-3.544284	-3.204699
	Poverty, 1 <sup>st</sup> level	-5.523940	-4.252879	-3.548490	-3.207094
PP	Poverty, level	-2.376628	-4.243644	-3.544284	-3.204699
	Poverty, 1 <sup>st</sup> level	-5.522568	-4.252879	-3.548490	-3.207094
<b>Cancer incidence</b>					
ADF	Incidence, level	-1.013370	-4.243644	-3.544284	-3.204699
	Incidence, 1 <sup>st</sup> difference	-4.588228	-4.252879	-3.548490	-3.207094
PP	Incidence, level	-0.640846	-4.243644	-3.544284	-3.204699
	Incidence, 1 <sup>st</sup> difference	-6.323065	-4.252879	-3.548490	-3.207094

Note: “\*\*\*” represents a significance level of 1%. The number of delays in the ADF tests is determined according to the Schwarz criteria. In the PP tests, the number of delays determined according to Newey-West Bandwith is taken. As a test format, fixed and trend equation options are used for all variables at the level value. The fixed equation option is used to obtain the first difference of the variables. MacKinnon critical values are contemplated”.

Because the Engle-Granger Test did not yield healthy results as the number of variables increased, the Johansen Test was also used on the series so that the long-term relationship between variables could be determined accurately (Table 2). By obtaining a result different from the Engle-Granger Test, a long-term relationship between poverty and cancer incidence has been found.

### THE GRANGER CAUSILITY TEST OVER VECM MODEL

Following the establishment of a long-term relation, Granger causality test over Error Correction Model (VECM) was used to test whether the variables are

cointegrated in the short term (Table 3, Figure 1). According to the test results, poverty causes cancer incidence and cancer incidence causes poverty (i.e. bilateral causality).

### RESULTS

Both short- and long-term causality relations between poverty and cancer incidence were analyzed in the study. The results are as follows:

- In the long-term, it was determined that there was cointegration between poverty and cancer incidence. In other words, the presence of long-term relationships between variables was identified.

**TABLE 2.** The results of The Engle-Granger Test.

<i>t</i> Statistics	Mac Kinnon Critical Values			Result
	(%1)	(%5)	(%10)	
-1.756157	-4.252879	-3.548490	-3.207094	No Long-term relationship

**TABLE 3.** The results of toThe Johansen Test.

$\Delta$ Trace Statistic Eigenvalue	$\Delta$ trace	0.05 C.V.	Prob.
0.388022	17.35192	15.49471	0.0260
0.034160	1.146988	3.841466	0.2842
$\Delta$ Max-Eigen Statistic Eigenvalue	$\Delta$ Max	0.05 C.V.	Prob.
0.388022	16.20494	14.26460	0.0244
0.034160	1.146988	3.841466	0.2842



**TABLE 4.** Short Term Findings.

Findings	Directions of Causality
I find that Poverty causes Cancer Incidence and Cancer Incidence causes Poverty (i.e. bilateral causality).	Poverty ↔ Cancer Incidence

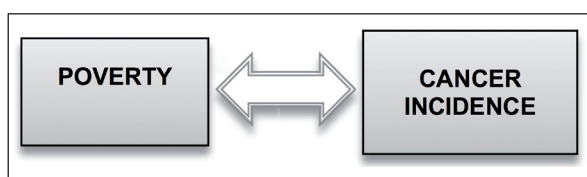
- For the short-term, the results are given in Table 3, Table 4 and Figure 1.

## DISCUSSION

To identify the causal relationship, further and more extensive studies are needed. A global study should be carried out, particularly covering countries and regions where poverty rates are high. However, the inability to access data at this point is a major trouble that we face. Failure to keep regular records of this disease that is a global burden is a serious problem. Systematic recording of cancer cases, clear expression of the problem and proving and documenting with evidence through a multidisciplinary study that it would be more appropriate and affordable to prevent the disease rather than being exposed to the heavy burden brought by this problem, would be a guideline for policymakers.

## CONCLUSIONS

This study empirically examines the relationship between poverty and cancer incidence in the USA, over the period of 1980-2015. The variables were discovered to be cointegrated in the long-term. The hypothesis that poverty is a Granger cause of cancer incidence has been confirmed. However, the incidence of cancer was also found to be the cause of poverty. Aside from being fatal, going down the socioeconomic stairs brings poverty due to the inability of affording treatment and the long-term costs of treatment, loss of business and loss of income, thus can be the cause of poverty. There is a two-way vicious cycle between poverty and cancer.



**Fig. 1.** The Granger causality test over VECM model results.

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## ETHICAL STATEMENT

The data presented in this document are the results of previous studies, so it was not necessary to seek opinions from the Ethics Committee.

## CONFLICT OF INTEREST

The Authors declare that they have no conflict of interests.

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