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A study on life expectancy in Turkey

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Abstract

Life expectancy, in general, is one of the crucial determinants of a country's health status. This is particularly valid for the countries where industrialization has been improving. Turkey is one of the leading countries within this category, and there are limited number of studies about causal relationship between life expectancy and its determinants. Therefore, the aim of this study is to explore causal relationship between life expectancy and its determinants during the period of 1975-2014. In order to analyze the causal relationship between life expectancy at birth and its economic and environmental determinants; gross domestic product per capita, food production index, CO_2 emissions (kt), and urbanization were identified as factors influencing life expectancy at birth. Regarding the data obtained, the causal relationship between life expectancy and its determinants was investigated employing the Granger causality test based on VECM for a sample of Turkey. The results indicated that although the variables used in the model have had a long run relationship (i.e., GDP per capita, food production index, CO_2 (kt), and urbanization), the urbanization is the only Granger cause of life expectancy at birth for Turkey.

Keywords

Cointegration, Granger causality life expectancy, urbanization.

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INTRODUCTION

Life expectancy is the crucial determinant for a country's health status especially for those countries where industrialization improves. As shown in Figure 1, while the life expectancy at birth in the world was 60,987 in 1975, this number increased by 18.68% to 71.7 in 2014. Similarly, in Turkey, life expectancy at birth was 56.1 in 1975, and it reached to 77.1 in 2014 as shown in Figure 2 (OECD, 2019). The determinants of this increase in life expectancy at birth for different countries have always attracted curiosity from different perspectives including economic, health, social, and environmental conditions.

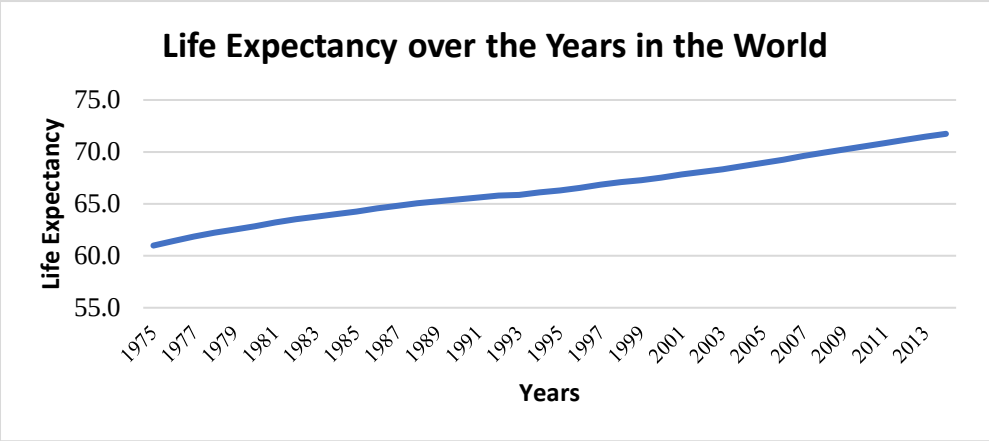

Figure 1: Life expectancy over the years in the world (OECD, 2019).

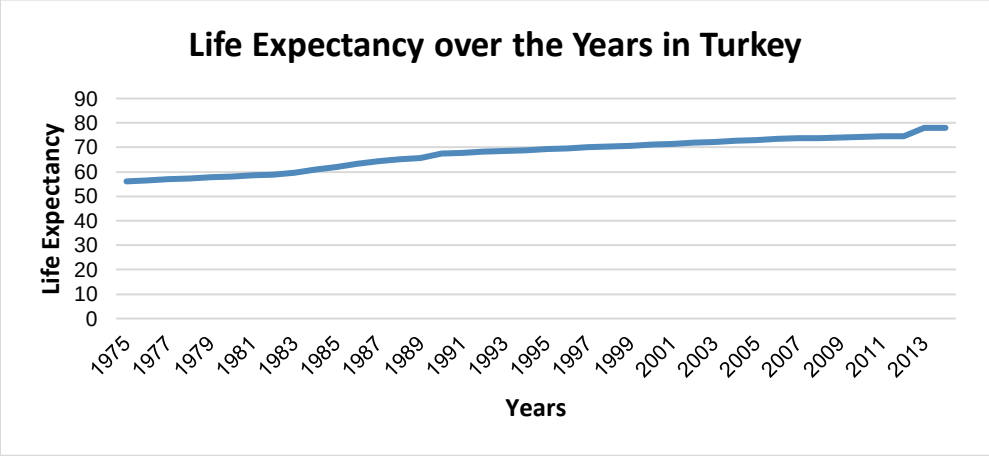

Figure 2: Life expectancy over the years in Turkey (OECD, 2019).

Life expectancy has significant implications on individual and human behavior which affects fertility behavior, human capital and economic growth (Coile *et al.*, 2002; Zhang *et al.*, 2001). There are numerous studies about the determinants of life expectancy from different perspectives (Coile *et al.*, 2002; Zhang *et al.*, 2001; Husain, 2002; Taban, 2006; Shaw *et al.*, 2005). So far, the results obtained regarding

these studies indicated that income, education, illiteracy, urbanization, health expenditures on health care, number of doctors, availability of safe drinking water, nutritional conditions, geographical location, developments in health technology, income inequality, and employment have had statistically significant effects on this increase in life expectancy (Messias, 2003; Taban, 2006; Shaw *et al.*, 2005; Rogot *et al.*, 1992).

Among the economic determinants, income is one of the most frequently investigated factors on life expectancy (Anand and Ravallion, 1993; Grosse and Auffrey, 1989; Kakwani, 1993; Preston, 1980; Rogers and Wofford, 1989; Wilkinson, 1992). In general, many research studies found out a positive relationship (Rogot *et al.*, 1992; Rogers and Wofford, 1989). In other words, the more the income, the higher the average number of life expectancy. According to Preston (1980), the income has an indirect relationship with life expectancy at birth, since it affects the quality of units influencing the health status such as access to food, clean water, education, and health services (Preston, 1980). Messias (2003), on the other hand, investigated the relationship between income inequality and life expectancy in Brazil using simple linear regression, and, accordingly, it has been found that there was a significant and negative relation between them (Messias, 2003). This study showed that an increase by 0.01 in income inequality caused a decrease by 0.6 years in life expectancy (Messias, 2003).

Another economic determinant found to be associated with life expectancy is employment. It has been stated that there exists differences between the life expectancies of employed and unemployed individuals. Therefore, the findings pointed out a positive and significant association between life expectancy and employment (Rogot *et al.*, 1992).

Health spending which measures goods and services related to the health is another determinant for the life expectancy from the economic perspective. A study conducted in Canada investigated the health spending and its outcomes related to health using 15 years of data from the provinces of the country (Crémieux *et al.*, 1999). Accordingly, a positive relationship between health spending and life expectancy was found, that was pointing out a decrease in health spending leading to a decrease in life expectancy. Mohan and Mirmirani (2007) found a positive relationship between life expectancy and health spending for The Organisation for Economic Co-operation and Development (OECD) countries as well (Mohan and Mirmirani, 2007).

Food availability is another concern for life expectancy. The findings supported that an

increase by 1% in food availability led to an increase in life expectancy by 0.13% (Halicioglu, 2011). It has been suggested that economic policies should be implemented to rise spending in health care and food availability (Halicioglu, 2011).

Beside economical determinants, there are also social factors acting on life expectancy. Among them, illiteracy rate is one of the important factors. It has been previously shown that there was a statistically significant and negative relationship between illiteracy and life expectancy (Messias, 2003). Accordingly, among the variables including illiteracy rate, employment and income inequality the strongest factor was found to be illiteracy rateAas the illiteracy rate increases by 10 units, life expectancy decreases by 2.2 years.

Urbanization is one of the environmental factors that affects life expectancy. The work of Halicioglu (2011) pointed out the impact of urbanization, and it was found a negative effect on life expectancy at birth. However, other studies investigated the determinants of life expectancy found out a positive effect of urbanization (Bayati *et al.*, 2013; Delavari *et al.*, 2016; Fayissa and Gutema, 2005; Kabir, 2008; Baltagi *et al.*, 2012; Thornton, 2002). Accordingly, Thornton (2002) stated that the more the urbanization, the less the death rates in the United States of America.

Another determinant factor from environmental perspective for life expectancy at birth is CO_2 emission (kt) including the consumption of solid, gas fuels, and liquid. Previous studies found both positive and negative relationship between CO_2 emission (kt) and life expectancy at birth (Fayissa and Gutema, 2005; Baltagi *et al.*, 2012; Amjad and Ahmad, 2014).

The present study aimed to analyze the causal relationship between life expectancy at birth and some of its economic and environmental determinants (i.e., gross domestic product per capita, food production index, CO_2 emission (kt), and urbanization) during the period of 1975-2014 in Turkey.

METHODS

It has been planned to examine the causal association between life expectancy and its economic (gross domestic product per capita, and food production index), and environmental determinants (CO_2 and urbanization) using Granger causality test for Turkey between 1975 and 2014. The data for life expectancy was obtained from OECD database, and the data for other variables (i.e., gross domestic per capita,

food production index, CO_2, urbanization) was obtained from the World Bank database. Each variable in the model is in its natural logarithmic form. All analyses were conducted using Eviews 9 econometric program.

The model was specified as below:

$lle = \alpha_0 + \alpha_1 lgdppc + \alpha_2 lfpi + \alpha_3 lurb + \alpha_4 lCo_2 + \mu_t$

where, lle is the natural log of life expectancy at birth, lgdppc is the natural log of gross domestic product per capita (constant 2010 US$), lfpi is the natural log of food production index, lurb is the natural log of urbanization, lCo_2 is the natural log of carbon dioxide emission (kt), and μ_t is the error term in the model.

RESULTS

Descriptive statistics

The annual data between 1975 and 2014 for Turkey was obtained from the World Bank and the OECD databases. The summary of descriptive statistics associated with Turkey is presented in Table 1.

Table 1: Descriptive statistics of the variables.

	le	Gdppc ($)	Fpi (%)	Urb (%)	Co_2 (%)
Mean	67.485	7,750.696	85.25175	3.1985	179164.4
median	69.100	7,329.363	82.39000	2.4658	165555.9
Maximum	78.000	13,277.76	129.7300	6.2018	345981.5
Minimum	56.100	4,967.398	52.27000	2.0576	65697.97
Std.dev.	6.5407	2,337.810	20.82720	1.2310	83696.53

le: Life expectancy; gdppc: Gross domestic product per capita; fpi: Food production index; urb: Urbanization; Co_2: Carbondioxide emission.

Accordingly, the mean of the life expectancy at birth was 67.485, the minimum and maximum values during the period 1975-2014 were 56.1 and 78.0, respectively. Additionally, the mean of gross domestic product per capita was $7,751, and it ranged from $4,967 to $13,278. The means of the food production index, urbanization, and CO_2 emission (kt) were 85.25%, 3.19%, and 179164.4 (kt), respectively.

Testing for stationarity

In order to employ the causality test, it is compulsory to examine stationarity of time series data, since estimates with non-stationary data often causes spurious regression (Gujarati, 1995). The common tests in order to check the existence of unit root in the series are Augmented Dickey Fuller (ADF), Phillips Perron (PP), Kwiatkowski–Phillips–Schmidt–Shin KPSS), and Ziwot Andrews tests. However, for this study, Augmented Dickey Fuller, and Phillips Perron tests were employed to check stationarity in the series, respectively

(Dickey and Fuller, 1981; Phillips and Perron, 1988). The results are shown in Table 2. Hence, the findings of the ADF and PP tests showed that life expectancy at birth, GDP per capita (constant US$), food production index, urbanization (% of total population), and CO_2 emission (kt) are not stationary at level, so we failed to reject null hypothesis indicating that the series has unit root. On the other hand, after taking the first differences of the series, they became stationary providing that all the variables used in the model are integrated order (1).

Table 2: Unit root test results.

	Level		1st difference	
ADF	Probabilities		Probabilities	
Series	constant	trend	constant	trend
lle	-1.31	-1.19	-5.82***	-5.93***
lgdppc	0.71	-2.08	-6.05***	-6.37***
lfpi	-0.20	-2.44	-12.39***	-12.22***
lurb	-1.40	-2.50	-4.18***	-8.26***
lCo_2	-0.95	-2.40	-2.40***	-6.20***
	Level		1st difference	
PP	Probabilities		Probabilities	
Series	constant	trend	constant	Trend
lle	-1.25	-1.31	-5.91***	-5.97***
lgdppc	0.81	-2.15	-6.06***	-6.39***
lfpi	-0.85	-3.86	-3.86***	-12.86***
lurb	-1.83	-1.30	-4.18***	-4.12***
lCo_2	-1.09	-2.40	-6.37***	-6.26***

***denotes 0.01 significance level.

The results of the unit root test provide us to employ vector auto-regressive (VAR) and investigate the co-integration relationship among each variable. In order to make accurate predictions, optimal lag length was identified, and the results are shown in Table 3.

Table 3: Lag length selection.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	219.0402	NA	4.71e	-11.89112	-11.67119	-11.81436
1	388.8488	283.0143*	1.54e-15*	-19.93604*	-18.61645*	-.19.47547*
2	410.8594	30.57030	1.97e-15	-19.76997	-17.35070	-18.92558
3	432.9664	24.56327	2.92e-15	-19.60924	-16.09031	-18.38104
4	461.9409	24.14541	3.90e-15	-19.83005	-15.21145	-18.21803

*indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

According to the Table 3, it has been found that Sequential Modified LR test (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ) suggested lag 1 for the model.

Cointegration test

A cointegration test allows identifying the existence of long run relationship between series. The compulsory condition of cointegration is that the variables included

must be integrated at the same order (Johansen, 1992). The most common tests for cointegration testing are Johansen Cointegration test (Johansen, 1992), Engle-Granger two step methods (Engle *et al*., 1986), and Phillips Ouliaris test (Phillips and Ouliaris, 1988). In the present study, Johansen cointegration test was conducted to check the long run relationship between included variables.

The results of cointegration test are shown in Table 4. Accordingly, the findings showed that Trace tests, and max Eigen indicated 3, and 1 co-integrating equations at 10 percent significance level, respectively.

Table 4: Johansen cointegration test.

Hypotheses	Eigenvalue	Trace Statistic	Critical Value	Probabilities
H_0: r=0 H_1: r≥1	0.576723	87.77710	65.81970	0.0010***
H_0: r≤1 H_1: r≥2	0.470837	55.10741	47.49359	0.0090***
H_0 : r≤2 H_1: r≥3	0.387851	30.92199	27.06695	0.0370**
H_0: r≤3 H_1: r≥4	0.271287	12.27235	13.42878	0.1443
H_0: r≤4 H_1: r≥5	0.006461	0.246305	2.705545	0.6197
Hypotheses	Eigenvalue	Max-Eigen Statistic	Critical Value	Probabilities
H_0: r=0 H_1: r=1	0.576723	32.66969	31.23922	0.0691*
H_0: r≤1 H_1: r=2	0.470837	24.18542	25.12408	0.1284
H_0: r≤2 H_1: r=3	0.387851	18.64963	18.89282	0.1074
H_0: r≤4	0.271287	12.02605	12.29652	0.1097
H_0: r≤5	0.006461	0.246305	2.705545	0.6197

***denotes 0.01 significance level; **denotes 0.05 significance level; *denotes 0.10 significance level.

Additionally, according to the results of the normalized co-integration test shown in Table 5, gross domestic product per capita, and urbanization significantly affect life expectancy at birth negatively in the long run. On the other hand, the results showed that food production index and CO_2 emission (kt) also significantly, affect life expectancy at birth positively in the long run. Finally, it has been concluded that we could employ the Block exogeneity Wald tests based on vector error correction model (VECM) to determine the direction of causality due to the existence of co-integration among variables in the long run.

Table 5: Normalized cointegrating coefficients.

lle	lgdppc	lfpi	lurb	lCo_2
1.000000	0.327965	-0.341322	0.110738	-0.167716
	(0.04354)	(0.08344)	(0.01440)	(0.04266)

Lle: Natural log of life expectancy at birth; lgdppc:the natural log of gross domestic product per capita; lfpi: Natural log of food production index; lCo_2: Natural log of carbondiaoxide emission.

The Granger causality/block exogeneity wald test

Following the co-integration test, a causal relationship between life expectancy and its determinants were examined using the block exogeneity Wald test based on VECM to test on lagged explanatory variables, and the results of Granger block exogeneity are shown in Table 6. Accordingly, the findings have pointed out

that there is a causal relationship between life expectancy and urbanization with a probability of 0.0409 at 5% significance level. On the other hand, other variables (i.e., gross domestic product per capita, food production index, and Co_2 emission (kt)) were found to have no causal effect on life expectancy at birth at 0.01, 0.05 or 0.10 significance levels. Other variables which have causal relationship with each other are gdp per capita and fpi with a probability of 0.0495, Co_2 and gdp per capita with a probability of 0.0810 at 5%, and 10% significance levels, respectively.

Table 6: The Granger causality/block exogeneity wald test.

Dependent variable D(lle)			
Independent Variables:	Chi-sq	df	Prob.
D(lgdp)	0.214375	1	0.6434
D(lfpi)	1.410477	1	0.2350
D(lurb)	4.179525	1	0.0409**
D(lCo_2)	0.153621	1	0.6951
Dependent variable: D(lGDPPC)			
Independent Variables:	Chi-sq	df	Prob.
D(lle)	0.066036	1	0.3674
D(lfpi)	1.564407	1	0.0495**
D(lurb)	0.254774	1	0.4007
D(lCo_2)	1.781793	1	0.1871
Dependent variable: D(lfpi)			
Independent Variables:	Chi-sq	df	Prob.
D(lle)	0.066036	1	0.7972
D(lgdppc)	1.564407	1	0.2110
D(lurb)	0.254774	1	0.6137
D(lCo_2)	1.781793	1	0.1819
Dependent variable: D(lurb)			
Independent Variables:	Chi-sq	df	Prob.
D(lle)	0.606858	1	0.4360
D(lgdppc)	0.151539	1	0.6971
D(lfpi)	2.16413	1	0.1411
D(lCo_2)	0.301960	1	0.5827
Dependent variable: D(lco2)			
Independent Variables:	Chi-sq	df	Prob.
D(lle)	2.285540	1	0.1306
D(lgdppc)	3.045021	1	0.0810*
D(lfpi)	0.173473	1	0.6770
D(lurb)	0.048297	1	0.8261

*denotes 0.10 significance level; **denotes 0.05 significance level.

DISCUSSION

In the current study, the causal relationship between life expectancy and its determinants were examined during the period 1975-2014 for Turkey. The determinants of life expectancy were classified as the economic and environmental perspectives. Gross domestic product per capita (constant US$) and food production index were included in the economical perspective, while urbanization (% of total population) and CO_2 emission (kt) were included in the

environmental perspective. All variables were examined using Johansen co-integration analysis, and Granger causality test based on VECM. The results of the analyses elicited a long run relationship between included variables in the model. However, only urbanization has a causal relationship with life expectancy, and has a negative effect on it. This result is in parallel to the finding of Halicioglu (2011) indicating that there is a negative relationship between life expectancy and urbanization in Turkey.

A rapid process of urbanization has been experienced in Turkey as a developing country. First of all, it is important to consider the fact that, such a rapid increase in the population in urban areas may also trigger certain disadvantages such as increased criminal rates, insufficient health services, elevated environmental pollution and limited access to clean usable water and. However, there are controversies to these expectations as well. For instance, a study in which the relationship between globalization and life expectancy in 92 countries was investigated, a positive effect of urbanization on life expectancy was found significant (Bergh and Nilsson, 2010). Within this work, urbanization has still been found as the most significant causal determinant for the life expectancy at birth in Turkey. This is in parallel with the study of Halicioglu (2011), which reported that theurbanization was found to possess a negative relationship with life expectancy at birth for the data analyzed during the period of 1965-2005 (Halicioglu, 2011). Therefore, this finding has still been found valid for the period of 1975-2014. It is important to note that this study is specific for Turkey, since there are other studies conducted in various regions of the world stating positive effect of urbanization on life expectancy. Thus, this implies that the effect of urbanization on life expectancy is region-dependent (i.e., changeable from one country to another). Regarding these both positive and negative effects of urbanization displayed previously in different studies, we have also expected to observe a causal relationship between life expectancy at birth and some other determinants used in the model for this study including CO_2 (kt), gross domestic product per capita (constant $), and food production index. However, no causal relationships were found between life expectancy and these determinants within this study for Turkey.

CONCLUSION

In this study, it was shown that Turkey has undergone a rapid urbanization during the period of 1975 to 2014. This resulted in a causal relationship with life expectancy at birth in negative manner. Policy makers should particularly focus on reducing the population intensity and increasing the accessibility to important sources related to health and hygiene. Since it has well been established that urbanization in Turkey grows up fast particularly through metropole cities, the economic investments should particularly focus on increasing the conditions of subsidiaries. From the general perspective, it was observed that the results are not comparable with other countries indicating that such determinants might have variable effects on life expectancy at birth. Therefore, the extrapolation of the results to other developed or developing countries is not possible currently.

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