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Panel Data Analysis in Investigation The Economic Growth of Turkic States

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Abstract:
This study aims to examine the relationship between macroeconomic variables and the economic growth of some Turkic states. The economic situation of some countries in the Turkish world between 2000-2018 was examined with the macroeconomic data obtained from the world bank. The relationship between selected variables and economic growth was analyzed using the panel cointegration test. The homogeneity of the data was tested, various cross-section dependency tests were applied to the data, and the interdependencies of the cross-sections that make up the panel were examined before the cointegration test. Finally, the Common Correlated Effects Model was applied with the Swamy S test. It was determined that the variables were homogeneous and there was cross-sectional dependency in the series. Afterward, the stationarity of the variables was examined and it was determined that they were not stationary at the level values, but they were stationary in the first differences. It has been determined that there is a significant long-term relationship between gross domestic product and exports of goods and services, R&D, and gross domestic product growth. However, it was observed that there was no significant long-term relationship between gross domestic product and patent applications.

Anahtar Kelimeler: *Turkic states, economic growth, regional development level, cointegration test, unit root, panel data analysis.*

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INTRODUCTION

Economic growth has been one of the important determinants of economies in recent years. Identifying the source of economic growth and implementing it in this direction is important for the well-being of individuals living in the country. Many variables make up the source of economic growth, some of these gross domestic product, growth rate, and foreign trade. Studies on the relationship between economic growth and some variables used in the study were reviewed in the literature, and some of these studies were given for literature comparison. GDP is a short form for the gross domestic product it is commonly used as a measure for economic activities in a country and it is a good indicator for a country's progress and development. Bekele and Degu (2021) stated that the individual sector per GDP and financial sector perspective and productivity have a statistically important effect on this coun economic growth. Mátyás and Sevestre (2008) showed that their studies many models and methods are suitable for the panel data analysis. Cieślik and Łukasz (2018) indicated that the developing countries cause the registered GDP to diminish, particularly in the countries that face a significant decrease in registered GDP. Over half of the decrease in official GDP stem from the reduction in overall economic activity. However, the other part is digested by the informal economy. Montobbio and Rampa (2005) indicated the relationship between GDP and exports in 9 developing countries (Argentina, Brazil, China, Colombia, India, Malaysia, Mexico, Singapore, and Thailand) between August 1985 and 1998. It has been determined that R&D expenditures have a positive effect on exports and economic growth. Schneider (2004) determined that econometric analysis, which includes 21 OECD countries and 89 developing and transition countries, in developed economies, a rise in the economy of 1% point of GDP generates a discussion in official GDP of 7.7%. Akinci et al. examined the link between financial development and economic growth in OECD member countries is investigated using panel analysis for the period 1980-2011. As a result of the research, a long-term relationship between financial development and economic growth was found. Several research studies stated that the economy affects the economic growth in emerging economies of the countries, but some of the variables have a positive effect on the economic growth in developed countries (Xu, 1996; Pastor et al., 2018; Ferreira et al., 2017). Kılıç et al. (2014) examined the relationship between research and development expenditures and technology exports in G-8 countries using panel data analysis. They found that R&D expenditures and the real effective exchange rate had a positive effect on technology exports. When analyzing the proposed relationship, it is important to consider external variables that can affect it such as services from formal institutions in the organizational surroundings. Based on the analysis of more than a hundred empirical studies of the impact of institutions and the financial performance of organizations, Boiral (2012) found a positive relationship between the implementation of quality and financial outcomes in 84.2% of cases.

Goel (2017) suggests that the effect of the shadow economy on economic growth can be both positive and negative depending on the type of variable. In addition, considering the real effective exchange rate index, which includes the CIS countries, it has been determined that some resources negatively affected the economic growth and the relationship improved in a shorter time (Sach & Warner, 1995). Zhou et al. (2021) explored the role of infrastructure investment on the quality of economic growth by using the regional panel data of Chinese provinces. Further, the analysis found that some variables positively affect economic growth. Hussain and Huque (2016) showed a positive effect on the index on the growth rate of per capita GDP. However, Ngongang (2015) suggested that the financial changes positively and insignificantly impact the growth rate of GDP per head, and a variety of time series data (King & Levine, 1993) were also prominent as increasing or decreasing between variables. Vries et al. (2014) suggested that in developed countries the productivity growth of factors is important for structural change to happen, but this may not hold for developing countries. However, Diao et al. (2017) suggested that in Africa there has been a relocation of labor from manufacturing to the service sector, but labor productivity remains stable. Moreover, Ghosh et al (2017) stated previous studies have indicated that higher competitive pressure measured by product substitutability increases new studies. Nawaz (2015) by using panel data analysis, examined the effect of institutional factors on economic growth. As a result of the research, it has been determined that countries have different components to ensure long-term economic growth. Schneider (2005) conducted panel data analysis for selected variables and developed and developing countries. Moreover, the probability of economic growth and R&D increases by 24% respectively. Makun (2018) showed that the share of R&D to the overall GDP increases for developing countries recently while it was a very small change for developed countries.

Data And Empirical Results

In this study, the macro data set for all sampled countries were obtained from the World Development Indicators of the World Bank. In this study, the data was obtained from the economic data of five Turkic countries. In addition, this study investigates the long-term effects of various types of GDP on multifactor productivity growth, which is the economic effect of GDP. Econometric estimates are conducted on a panel of five Turkish countries over the period 2000-2018. Sampled countries are Azerbaijan, Kazakhstan, Kyrgyzstan, Uzbekistan, and Turkey. Since the data of Turkmenistan could not be reached without loss, the country was excluded from the analysis.

The summary statistics (mean value and standard deviation) of gross domestic product (GDP-current US$), exports of goods and services (E-current US$), R&D expenditure (% of GDP), patent applications (PA), and employment to population ratio (%) are presented in Table 1. The mean GDP rates are from 4706510296 in Kyrgyzstan to 38729233108 in Azerbaijan. As for the GDP rate, exports of goods and services, Uzbekistan has the lowest exports, whereas Turkey has the highest.

Table 1. Summary Statistics of Time Series Variables

Countries		GDP	E	R&D	PA	L
Azerbaijan	Mean	38729233108	19397231638	0.234	213.578	9.023
	Stdev	25804398357	12691996328	0.057	47.210	10.154
Kazakhstan	Mean	12133154124	50578341390	0.195	1469.421	6.631
	Stdev	73254443641	28668326344	0.047	274.886	3.640
Kyrgyzstan	Mean	4706510296	19800559928	0.167	128.736	4.453
	Stdev	2412981279	979830986.2	0.041	26.601	3.189
Uzbekistan	Mean	39992752564	9707491168	0.221	416.263	6.610
	Stdev	26632924467	4448721557	0.061	214.244	1.750
Turkey	Mean	27297939033	156451370153	0.719	3071.315	5.148
	Stdev	0.001	65721941303	0.177	2482.749	4.438

Note: Stdev, GDP, E, R&D, PA, and L stand for standard deviation, per capita gross domestic product, export of goods and services, R&D expenditure, patent applications, growth

Research design

The most powerful reason for using panel data is providing a large number of data points those result in increasing the degree of freedom and absence or decreasing in collinearity in explanatory variables. The employment of panel analysis in this study is due to the numerous advantages present in panel data models. There are many significant and useful reactions to panel data that we must mention in the following points. Panel data are more accurate and measurable data as compared to using cross-section or time-series data alone, panel data includes more information and more variables than pure time-series data or cross-section data alone, panel data can estimate and model for common and special behaviors of allover the group of data at the same time.

A panel data regression differs from a regular time-series or cross-section regression in that it has a double subscript on its variables, i.e. A panel data regression has a double subscript on its variables, i.e. (Baltagi, 2013).

$$y_{it} = \alpha + x_{it}\beta + u_{it} \quad i = 1,2,\dots,N; \quad t = 1,2,\dots,T \qquad (1)$$

I denotine households, individuals, firms, countries, etc., and *t* denoting time. It is rare to be able to assume a common conditional probability density function of *y* conditional on *x* for all cross-sectional units, *i*, atriest all time, *t*. Most of the panel data applications utilize a one-way error component model for the disturbances, with

$$u_{it} = \mu_i + v_{it} \qquad (2)$$

where μ_i denotes the unobservable individual-specific effect and *it* denotes the remainder disturbance. Here (μ_i) is showing the unobservable individuals-specific effect which is at a fixed time and it reflects any influence of individuals which is not entered the regression analysis. The regression disturbance (v_{it}) varies with individuals and time as it denotes any reminder disturbance within the regression. Mainly (y_{it}) will represent output for productivity function that takes advantage of data across time and (x_{it}) will represent inputs. In addition, research studies suggested that to help justify the use of cointegration analysis on the set of cross-country panel data on selected variables and economic growth for examining the nature of causality that may exist between these selected variables, let us consider the following simple theoretical construct (Dinda & Coondoo, 2006). For the simplicity of expression, we concentrate on the case where the panel model consists of two variables. The results can, however, be generalized in the sense that more independent variables can be included in the model (Hatemi-J, 2020).

$$y_{it} = \alpha + \beta_1 x_{it} + \beta_2 x'_{it} + u_{it} \qquad (3)$$

where y_{it} denotes the dependent variable (economic growth), *i*= 1,2,…,5, where 5 is the cross-sectional dimension (as we look at the Turkic countries), the subscripts *i* and *t* represent country and time, respectively. β denotes the coefficient of the relevant variable and also the elasticity coefficients. u represents the error term also indicated that the dependent variable GDP and independent variables were determined as E, R&D, PA, G. In this direction, the model formed by the variables with logarithmic transformations to the data is given below.

$$lnGDP = \beta_0 + \beta_1 lnE_t + \beta_2 lnRD_t + \beta_3 lnPA_t + \beta_4 lnG_t + u_t \qquad (5)$$

All variables were taken in a natural logarithm. Natural logarithm use is widely accepted in regression analysis since it allows for the interpretation of differences independent variable proportion (Gelman & Hill, 2006).

Testing for cross-sectional dependency and slope homogeneity in a panel causality study is crucial for selecting an appropriate estimator (Chou, 2013: 229), and we first focus on models in which the observed individual or time homogeneity is invariant concerning variations in explanatory variables. Because they provide simple yet reasonably general alternatives to the assumption that parameters take values common to all agents at all times (Hsiao, 2014: 15). The homogeneity test is important in determining the appropriate unit root and cointegration tests for variables in panel data analysis. If the analysis is made assuming that the slope coefficient is homogeneous, overlooking the differences may result in certain countries (Aytun & Akın, 214:18).

Swamy random coefficient model, the parameters are allowed to vary over the cross-sectional units. The homogeneity of the parameters can be tested with different tests as well as with the Swamy S test, one of these tests (Tatoğlu, 2018b:97, Akçacı & Yılmaz, 2021: 390). Swamy (1970: 311) developed the slope homogeneity test on the dispersion of slope estimates separate from suitable pools estimator. However, Pesaran and Yamagate (2008: 51) suggested a standardized version of Swamy's test for testing slope homogeneity in large panels.

H_0: Slope coefficient is homogeneous ($\beta_i = \beta$)

H_1: Slope coefficient is not homogeneous ($\beta_i \neq \beta$)

Table 2. Swamy *S* Homogeneity Test Result

χ^2	s.d	*p*-value
326.86	20	0.001

In the Swamy S test, the H_0 hypothesis is rejected, it is determined that the slope coefficient is not homogeneous. As shown in Table 2, the test fitted the data fairly well overall with large chi-square statistics (χ^2 = 326.86) and a very small *p*-value (0.001) for the homogeneity. This situation reveals that the effect of the change in independent variables on GDP differs from country to country.

Several tests for error cross-sectional dependence have been proposed in the literature. However, it is the LM test that is commonly used among these tests. Breusch and Pagan (1980: 239) suggested that a widely known panel test is the LM statistic. In panel data analysis, to test the stationarity of variables, first apply cross-section dependency test to cointegration test. These tests indicate the independence of the cross-section (countries) units that make up the series in studies where panel data analysis is performed (Fang & Chang, 2016: 179). As a result, if the H_0 hypothesis is accepted, first-generation unit root tests, otherwise, second-generation unit root tests should be used (Demir & Görür, 2020:22; Baltagi, 2008:284).

H_0: There is no cross-sectional dependence

H_1: There is a cross-sectional dependence

Table 3. Cross-Sectional Dependence Test Results

Test	Statistics	*p*-value
LM	31.920	0.042
CD$_{LM}$	26.514	0.001

Cross-sectional dependence tests are reported in Table 3. The results of the tests indicate that the H_0 hypothesis is rejected (p<0.05) and it has been determined that there is a cross-sectional dependency in the series. Thus, it can be said that there is cross-sectional context at the α=0.05 significance level. This result can be explained as the shock that occurs in any country participating in the tests will affect other countries as well. In this situation, we should apply the second-generation panel unit root tests which allow for cross-sectional dependence in the next step.

Levin, Lin & Chu and pessaries unit root tests to determine whether the series is stationary. Table 4 presents the unit root test results. The hypotheses are given below to show whether the series is stationary with Levin, Lin and Chu unit root tests. The logarithmically transformed data is used to conduct the panel test.

H_0: Series are not stationarity (Panels do not contain unit roots)

H_1: Series are stationarity (Panels contain unit roots)

Table 4. Panel Unit Root Test Results

Variables	I(0)		I(1)	
	Constant	Constant&Trend	Constant	Constant&Trend
lnGDP	-2.847 (0.512)	-2.673 (0.312)	-3.871 (0.008*)	-2.538 (0.005*)
lnE	-4.772 (0.713)	-4.822 (0.459)	-3.382 (0.001*)	-3.051 (0.001*)
lnRD	-7.439 (0.701)	-6.077 (0.605*)	-6.482 (0.001*)	-4.993 (0.001*)
lnPA	-7.739 (0.582)	-6.889 (0.447)	-6.297 (0.001*)	-6.328 (0.001*)
lnL	-9.588 (0.207)	-8.487 (0.304)	-8.239 (0.001*)	-6.966 (0.001*)

In the ADF test, the maximum delay length was taken as 2 and the optimum delay number was determined according to the Schwarz Information Criteria (SIC). *, ** and *** denote statistical significance at 1%, 5% and 10% level, respectively.

The unit root entity is first analyzed for I(0) by considering constant and constant&trend models. In the unit root tests, if the probability value is less than the *p*-value, it will be concluded that the series is stationary by rejecting the null hypothesis. If the probability value is greater than the *p*-value, it will be concluded that the series is not stationary by not rejecting the null hypothesis (Eygü & Coşkun, 2020:511). Levin, Lin & Chu (LLC) were tested with both fixed and trend models. The results of the tests all variables were found to be stationary (*p <0.05).*

The LLC test for stationarity on the first differences indicate that all first differences are stationary at both the 1%, 5%, and 10% levels of significance. The results of the tests in Table

4, it was determined that all variables are stationary at the first difference. According to these *p*-values ($p>0.05$), H_0 hypotheses were accepted for the variables in the constant&trend model.

A cointegration test was conducted to determine whether there is a cointegration relationship between variables. Cointegration is defined as a method that tests whether there is a long-term equilibrium relationship between variables and allows direct estimation of the said relationship (Pedroni, 2004, Demir & Çetin, 2020). After the non-stationary series at the level were made stationary, Westerlund (2007) panel cointegration was applied to the data set, taking into account the homogeneity situation.

H_0: There is no cointegration between variables.

H_1: There is cointegration between variables.

Table 5. Panel Cointegration Test Results

	Variables	Statistics	*z* value	*p*-value	Bootstrap *p*-value
lnGDP	lnE	Gτ -3.971	-2.486	0.007	0.300
		Gα -19.248	-2.471	0.007	0.100
		Pτ -6.909	-2.545	0.006	0.240
		Pα -17.094	-3.047	0.001	0.100
	lnR&D	Gτ -2.866	2.165	0.985	0.925
		Gα -3.288	2.121	0.983	0.965
		Pτ -2.866	3.497	0.999	0.995
		Pα -3.288	2.713	0.997	0.990
	lnPA	Gτ -1.538	2.277	0.989	0.940
		Gα -6.197	1.916	0.972	0.960
		Pτ -3.550	1.368	0.914	0.840
		Pα -5.352	1.348	0.911	0.870
	lnL	Gτ -3.232	-2.439	0.007	0.930
		Gα -1.670	-3.438	1.000	0.980
		Pτ 1.521	7.275	1.000	1.000
		Pα 1.016	3.732	1.000	0.980

*Gτ and Gα represent group mean statistics, Pτ and Pα represent panel statistics. While calculating the values, the number of bootstraps was taken as 100 and the delay length between 0-1.

Panel cointegration tests are reported in Table 5. The results indicate that with the asymptotic *p*-values ($p<0.05$), the no cointegration null is rejected only for lnE. However, the results with the bootstrapped *p* values provide stronger evidence of cointegration. The no cointegration null is rejected in three for the variable. There is a long-term relationship between these three variables. Generally evaluated according to the results of these four variables it can be reported that Pedroni cointegration test results show a cointegration relationship between the series. However, the no cointegration null is rejected only for lnE and E variable statistics are not statistically significant. In this context, it can be stated that there is a significant relationship between the variables of R&D expenditure, patent applications, growth rate, and economic growth in the long term. Therefore, these variables and economic growth act together in the long-term among Turkic countries, and analyses show that there is a long-run relationship between variables.

Moreover, the results of the CCE (Common Correlated Effects) test suggested by Pesaran (2007) are reported in Table 6. It was examined whether there is a long-term relationship between the dependent variable and the independent variables. CCE model is an estimator that can be used in N>T and N<T cases. Moreover, the model takes into account the cross-sectional dependence. The possible cross-sectional of the slope can also vary. Pesaren (2006) suggested an alternative approach that does not require estimating the number of latent factors (Sarafidis&Wansbeek, 2012: 496).

Table 6. Pesaran (2007) CCE Test Results

					Number of obs = 95 Number of groups = 5 Wald chi2(4) = 21.94 Prob > chi2 = 0.0002	
lnGDP	β Coef.	Std. Err.	*z* value	*p*>|*z*|	95% Conf. Interval	
lnE	0.482	0.218	2.21	0.027^{**}	0.053	0.910
lnR&D	0.307	0.181	1.70	0.089^{***}	-0.046	0.661
lnPA	0.069	0.105	0.66	0.510	-0.136	0.275
lnL	0.065	0.017	3.71	0.001^{*}	0.031	0.100

*, ** and *** denote statistical significance at 1%, 5% and 10% level, respectively.

Based on these results, we derive the mean group estimator based on individual-specific CCE estimators. Pesaran (2006) also indicated that the CCE type estimators come close to replicating the properties of the infeasible estimators without knowledge of the residual factor structure and/or the realizations of the unobserved effects. As shown in Table 6, it was determined that there is a long-term significant relationship ($p<0.05$) between GDP and E. The estimation results suggest that the probability of one unit of increases in the exports of goods causes an increase of 48.2% in GDP. The results also indicate that long-term period is a significant relationship ($p<0.10$) between R&D to GDP. The probability one unit increase in R&D creates an increase of 30.1% in GDP. Additionally, determined that there is a long-term significant relationship ($p<0.01$) between GDP and L. One unit increase that will occur in L creates an increase by 6.5% in GDP.

CONCLUSION AND EVALUATION

This study aimed to determine the relationship between macroeconomic variables and the economic growth of some Turkic states (Azerbaijan, Kazakhstan, Kyrgyzstan, Uzbekistan, and Turkey). The factors affecting economic changes in Turkish states between 2000-2018 were examined. The direction of short-run and long-run causal relationships was also investigated using the panel error correction model. The model predicts the probability of four effect severity outcomes: exports of goods and services, R&D expenditure, patent applications, and growth rate. Before fitting the final Common Correlated Effects (CCE) model, Swamy S homogeneity test is performed to measure the association between the dependent variable and the independent variables. After finding the cointegration relation, the long-term cointegration coefficients were analyzed by Common Correlated Effect (CCE). The obtained findings are that the exports of goods and services (E) of the run relationship between GDP. The homogeneity test results are consistent with the common correlated effects model. Moreover, the results demonstrate dependent and independent variables are co-integrated, which is evident in the model. Arataş et al.'s (2013) study showed the effect on GDP with the common correlated effects model. The results also indicate that long-term period is a significant relationship between R&D to GDP. One recent study (Coşkun & Eygü, 2020: 238) found that R&D expenditures hurt exports in the short term, but with deviations from the long-term balance, R&D expenditures had a positive impact on exports in the long term. This situation matches both the expectations and the literature. The panel data analysis results show that the number of patent applications has positive effects on gross domestic product for the long term and there is a causal relationship between the related variables. One recent study (Koç & Saidmurodov, 2018: 321) study that analyzed five Central Asian (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) countries economic growth relationship using panel data. Moreover, (Purtaş, 2017) the representatives of their national cultures, the Cultural Capitals of the Turkic World host many economic events throughout the year. As concerns, the financial changes, the variable (LF) negatively and insignificantly affects the growth rate of real GDP per head (Ngongang, 2015: 376). Moreover, we confirmed that selected variables' economic growth has a positive influence on the countries. In addition, Governments should also develop policies to contribute to economic growth (Duvar & Eygü, 2022: 119). We also found out that analysis has no relationship with the patent applications variable. Exports of goods and services, R&D expenditure, and growth rate also have a significant effect on economic growth. Many variables such as long-term interest, financial systems may have a positive impact on GDP growth. In order words if the exports of goods and services, R&D expenditure spending value increases so the GDP increases, and if the R&D expenditure spending decreases so the GDP decreases for both groups of countries. Economic growth is shown to be more effective than political or social globalization in driving the growth of the economy. Moreover, this result leads us to the conclusion that R&D investments made in the country's economy, even if they have different characteristics or have something in common, are important in the context of developing human capital, and this is necessary for the sense of achieving economic growth. Therefore, future studies should take these into account as well. Future research should try to explore in more depth the impact of the component of economic growth on different organizational outcomes.

The growth in Turkish states should be examined every year continuously and the effectiveness of the implemented development policies should be followed. Therefore, economic growth stands in front of researchers as an area that needs to be constantly investigated.

Ethical Text

In this article, research and publication ethics rules are followed. The responsibility of any violation regarding the article belongs to the author(s).

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