The COVID-19 Process and the Exchange Rate Relation: An Application on Turkey

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Keywords: Covid-19, exchange rate, time series analysis

Posted Date: July 28th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-49026/v1

THE COVID-19 PROCESS AND THE EXCHANGE RATE RELATION: AN APPLICATION ON TURKEY

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ABSTRACT

The recent shocks in supply and demand in the world are not due to unexpected economic reasons; in fact, they are related to Covid-19 that causes rapidly spreading global health problems and life threats around the world. While the global powers are dealing with the social problems created by Covid-19 pandemic, they should not neglect the economic changes created by this pandemic. The most important of these economic changes in developing countries with high fragility is exchange rates, because exchange rates can directly affect many macroeconomic variables, from inflation to foreign trade, from the balance of payments to interests. In countries with high fragility due to the effect of pandemic, economic uncertainty causes fluctuations in the exchange rate. Is the reason for the change in the exchange rate, the number of cases or economic risks that may occur due to possible health problems?

In this study, the impact of the number of new cases and the number of new deaths for the process of Covid-19 pandemic on the exchange rate in Turkey is examined. The daily data consider the number of new cases, the number of new deaths and exchange rate for the period of 16.03.2020-06.05.2020. The first step of the analysis, the stationary of the series is tested by Lee and Strazicich (2003) unıt root test which allowed structural break. Hatemi-J (2008) Cointegration Test that allow two structural breaks and Hacker-Hatemi-J Bootstrap causality test are used in the analysis. In the results of the Hatemi- J (2008) cointegration test, there is a medium and long-term relationship, with under structural breaks between the number of new cases and the number of new deaths and the exchange rate. According to the results of the analysis, it can be concluded that the number of new cases and the number of new deaths have a significant effect on the exchange rate, causing uncertainty in the economy.

Keywords: Covid-19, exchange rate, time series analysis

JEL Classification: I19, F31, C22

1. INTRODUCTION

The contraction in the global economic volume, which was experienced in the 1929 World Economic Crisis and the 2008 Global Economic Crisis, is being experienced again in 2020 not due to economic reasons other than known ones, but due to a rapidly spreading health problem in the world. The effect of COVID-19 disease, which started in Wuhan city in Hubei province of China in December 2019, spread to almost 180 countries in a short time like 3 months. It was declared as a pandemic by the World Health Organization due to the rapid spread of the disease in a short time and causing the death of thousands of people. It is

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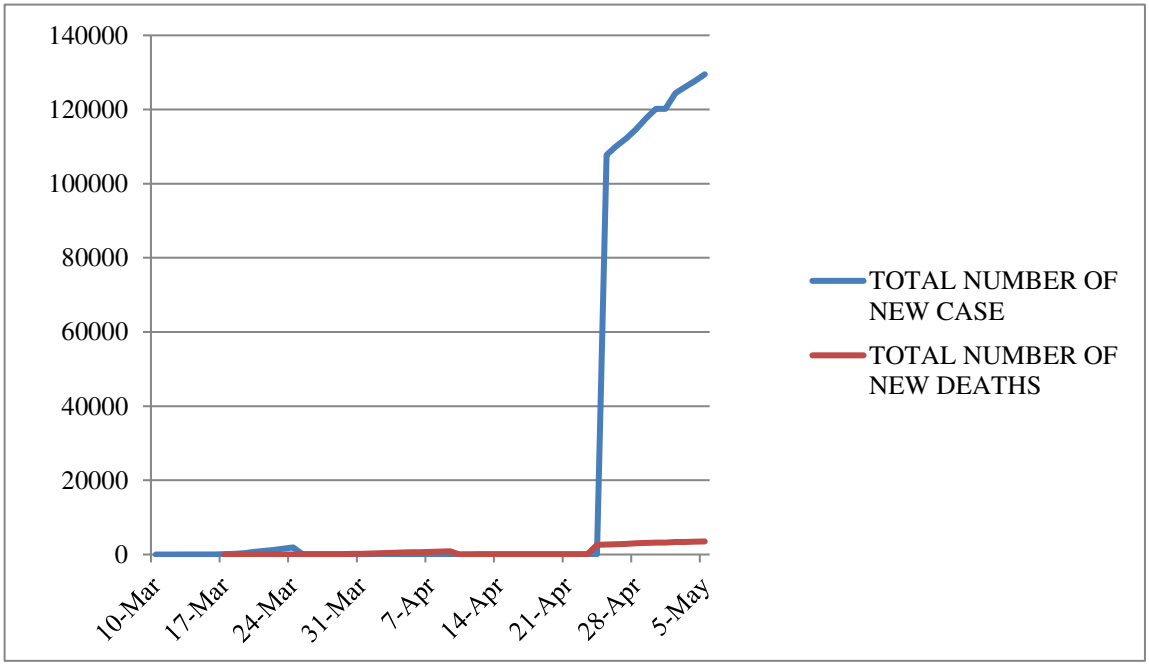
named as "Black Swan" taken from the theory developed by Nassim Nicholas Taleb due to the destructive dimension created by the pandemic in the economy other than the health aspect (Avishai, 2020). Another concept used is "Coronanomics" Eichengreen, 2020). The rapid spread of the Covid-19 pandemic, in other words, its globalization, disrupted countries' goods, capital and the normal flow of workforce, disrupting business and production (Barua, 2020:2). The reason for the volatility and instability in the markets is not economic reasons, but the insecurity and consumer perception caused by global health problems. While countries are seeking solutions to the pace of the global epidemic and the treatment of the disease, on the other hand, they have had to take precautions for the economic effects caused by the global epidemic (Ozatay ve Sak, 2020:1). The fact that the end time of social isolation, which is one of the solutions of the pandemic, is not clear, has further increased the uncertainty about how long these economic effects will continue. Governments have introduced support packages to minimize negative economic impacts in this process. Support packages have revealed higher spending items outside of their normal economic plans.

First, countries have increased their health spending to prevent possible consequences of Covid-19 disease. Innovative solutions have been started to be searched for especially in improving the health system and increasing physical and human capital (www.ey.com). In addition to health expenditures, many costs are incurred for many economic measures. Pandemic caused a decrease in general expenditure items consisting of consumption, investment, public and export and import globally. In this period, the most impact was seen in the increase of public expenditures. Government spending has begun to exceed its normal routines. The volume of trade in the global economy has caused a greater decline than the previous crises since people could not go out due to the effect of the epidemic, consumption expenditures and investment expenditures started to decrease as they had to meet only their basic needs. Trade volumes collapsed very quickly for all products in all countries at the same time (Baldwin and Di Maura, 2020: 17). The global supply chain has deteriorated, only health, food and some partial industrial productions have continued their activities. According to the OECD report, it has caused a sharp drop in consumption and investment spending by more than 20% since April 2020. The decrease in expenditures is compared to the large decreases in consumption and investment expenditures that occurred after the stock market crash in the financial markets in 1929 in the world economic crisis. The fact that the decrease in expenditures caused a great decrease in world economic growth indicates that the economic stagnation will last long.

The spread rate of Covid-19 pandemic and the uncertainty of the treatment time and end time of this pandemic brought along the uncertainty in the global economy. Uncertainty in financial markets caused a collapse in financial markets. Financial collapse is expected to continue with global recession (Petro, 2020). Beck (2020) stated that "a long slowdown or stagnation will put pressure on banks' credit portfolios and solvency". According to Mc Kinsey & Company's report in March 2020, quarantines, travel barriers and social distance measures will cause a sharp drop in consumer and business spending, resulting in stagnation, loss of jobs and increased unemployment. He stated that the result of business investment contracts and corporate bankruptcies would put pressure on the banking and financial system. For example, the European Central bank has lowered interest rates during the pandemic process, and on March 12, Dow Jones faced price drops that have not occurred since 1992. European markets have shrunk by about 12%. With the instability in the stock exchanges, as the number of cases increases, the depreciation against the exchange rate has started to increase especially in countries in the emerging market economies. The first coronavirus case in Turkey was disclosed in March 11. The measures taken within the scope of social isolation since 11 March 2020 caused uncertainty in the economy. Since the date of the coronavirus incident, there has been a continuous increase in the exchange rate. The total number of case and deaths in Turkey since March 11 is located in Figure 1.

Figure 1. Total number of case and deaths in Turkey



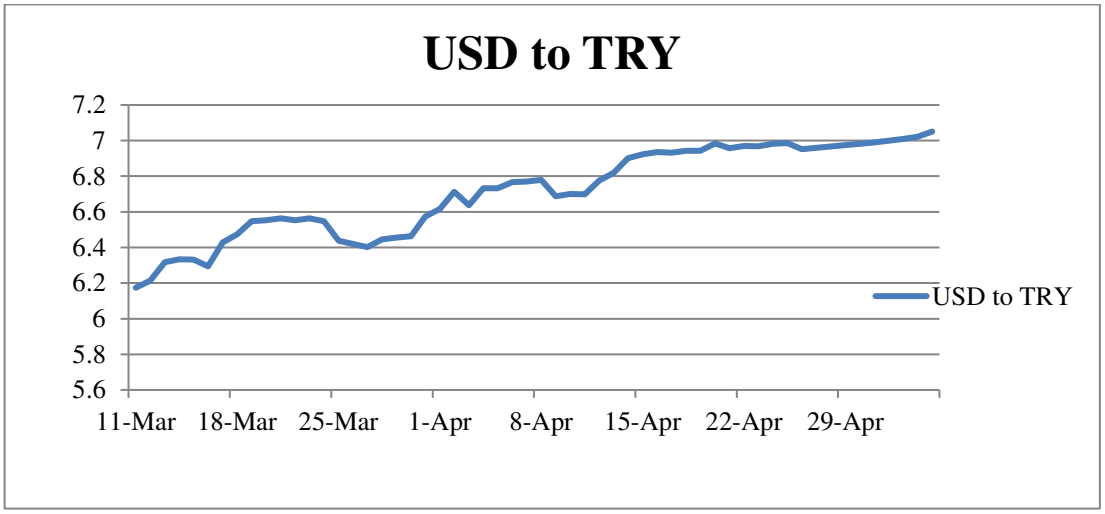
Data Source: www.saglik.gov.tr/

According to the data from the Ministry of Health in Turkey, Covid-19 disease, which started with 1 case number on 10 March 2020, reached 129491 cases on 5 May. The number of new cases,

which started with 3 people on March 17, reached 3520 on May 5. The total number of cases began to increase rapidly after April 21. Turkey has increased health expenditures in this period, as in other countries. In Turkey, during the pandemic prevention, diagnosis and treatment have been given free of charge (www.ttb.org.tr, 2020: 19). Extra fees have also been prevented from hospitalized patients in private hospitals. Turkey has made capital expenditures for the establishment of field hospitals, taking into account the probable conditions.

Pandemic has affected not only public spending but also many macroeconomic indicators such as production, supply chain, trade, consumption, investment, exchange rate and growth. The epidemic process and the uncertainty of the end time of this process have caused the exchange rate to fluctuate. While the number of cases and deaths progressed like this, the fluctuation in exchange rates is given in figure 2.

Figure 2.Exchange Rate Fluctuation 11 March 2020- 5 May 2020



Data Source: www.tcmb.gov.tr.

Nominal exchange rate against the US dollar has shown continuous upward trend since 11 March 2020, when the first case was announced. Among the reasons of the change in exchange rates; along with the number of new cases brought by the outbreak, decrease in country exports due to the increase in foreign trade volume in the global economy, increase of bankrupt companies, reduce in employment, increased unemployment fund insurance due to unemployment payments, increased credit volume and high risk of non-repayment of loans, decrease in tourism revenues might be considered. Turkey's increasing external debts can also be considered among the reasons. The extent of the problem in external debt payments can be observed with capital outflows. In the report of May 2020 of The Central Bank of the Republic of Turkey, it is stated that uncertainty in the global economy, tightening in financial

conditions and a decrease in risk appetite have led to portfolio outflows in Turkey and there is an increase in risk premium and options in the same rate as the exchange rates.

Until the week of April 24, people residing abroad sold $ 2.7 billion of shares and $ 5.5 billion of bonds. The decline in risk appetite in foreign markets and tourism revenues included in important export items have confronted Turkey with a serious problem (Demiralp, 2020). The increase in the tourist numbers especially in summer was to contribute to the increased trade in the country and to the reduction of current account deficit rates in Turkey that has high current account deficit. The decline in tourism revenues in the country that normally has increasing tourism mobility as from April has greatly disrupted the tourism sector and affected the related sectors directly and indirectly. In their study for 28 countries, Ali and Çobanoğlu(2020) stated that the travel industry will shrink by 50% in 2020 compared to 2019, which will result in significant job and income losses. In case of a failure to control the outbreak in Turkey, In May, June and July, an average of 30 billion dollars will be lost since the outbreak started (Bahar ve İlal, 2020: 130). Turkey's public expenditure has been increasing, although it’s already at risk due to external debt. Apart from reviving the economy during the recession like other countries, it had to increase health expenditures and health investments to protect human health. Public expenditures have increased while public revenues have decreased due to the tax policies applied in this period.

In order to provide liquidity in the market and support companies, Turkey has put the expansionary monetary and fiscal policies into operation during this period. She has reduced the Central Bank's interest rates to the lowest level. The Ministry of Finance has postponed withholding tax declarations and Value- added tax declarations for 6 months within three months of the pandemic in certain sectors. Value- added tax rates have been reduced to 1% in airline transportation. Accommodation tax has been reduced until November 2020. She has allowed companies to postpone their loan payments and provide additional financing to companies.

In the first months of 2019 until March 2020, the USD currency in Turkey was among 5.50-6.00 TL band. Since the first occurrence of corona virus cases in Turkey in March 11, 2020, USD has reached the level of 7.00 TL. The reason for this rapid change in currency rate is the number of cases or is it the economic risks that may occur due to circumstances brought about by the possible health risks in Turkey? Exchange rates are affected by many factors, especially in developing countries. In the exchange rate balance where trust is at the forefront, all kinds of developments in the country are effective. Within this scope in this study, the

relationship between Covid-19 virus and exchange rate is analysed on daily data of 16.03.2020-06.05.2020 periods. In the following part of the study, literature research is carried out and the findings obtained by econometric analysis are interpreted.

2. LITERATURE REVIEW

The rapid spread of the Covid-19 outbreak caused not only health scientists but all scientists to work in this field due to the effects of the epidemic in the world. In this part of the study, the studies on the economic effects of the pandemic are mentioned. Global stagnation is experienced due to COVID-19 outbreak. Most of the work done is about sectors. The difference that distinguishes this study from other studies is that an econometric study on the exchange rate has not been done yet.

The studies in the literature are primarily examined as the effects of epidemic diseases on the economy, and then the studies on COVID-19 are included. In their study, Bloom and Mahal (1997) examined the relationship between AIDS epidemic and economic growth for 51 developing and industrial countries. In the study, it was determined that AIDS epidemic had an insignificant effect on income per capita. Kauffman and Weerepana (2009) studied the effect of the AIDS epidemic on the exchange rate in South Africa. They concluded that the AIDS epidemic negatively affected macroeconomics in Sub-Saharan African countries. Chen et al. (2007) found that the SARS outbreak in Taiwan weakened the Taiwan economy and the tourism industry stock prices decreased. Keogh-Brown and Smith (2008) examined the effect of SARS outbreak on macroeconomics. In their study, they state that economies affected by the SARS epidemic are less affected by media reports and model estimates. Hoffman et al. (2020) stated in their study that the Covid-19 epidemic increased and complicated the markets of emerging market economies, especially in developing countries. In his study, Kouam (2020) found that the capital flow dynamics during the pandemic increased the negative effects of high credit margins on domestic exchange rates. Fernandes (2020) examined the impact of the COVID-19 crisis on industry and countries. In his study, he stated that in case of normalization in May, the economic impact of the crisis will vary between 3.5% and 6% depending on the country and this effect will change according to the weight of tourism and dependence of countries on foreign trade (Fernandes, 2020: 20). Odhiambo et al. (2020) In their work with Discrete-time Markov Chain analysis, they determined that COVID-19 affected all sectors, including agriculture, in agriculture, followed by the tourism sector, infrastructure and construction sector. The least affected sector is the manufacturing sector. Bhuiyan et al. (2020) stated that Bangladesh will experience a great economic shock due to

COVID-19. He stated that the production and supply was disrupted in the Bangladesh economy, and that they lost money in the export of ready-made clothing and leather, and that large-scale project investments by China were lost and the income distribution inequality increased. In his study, Atay (2020) stated that the destinations whose economy depends on tourism will be affected more by the impact of the epidemic's economic and social effects compared to other destinations. Kılıç (2020), in his study, determined that the decline in world indices also occurred in Market İstanbul sector indices. In his study, which he examined with the event study method, he observed that there have been great decreases in the tourism and textile sector since the beginning of the pandemic, and it has increased in the trade sector due to the demand for market and food. Güven (2020), mentioned that during the outbreak in Turkey e-commerce volume increased compared to previous years, especially in health, cleaning and personal care products the volume of e-commerce has decreased. He also stated that demand in clothing, accessories and luxury goods decreased in this period.

The aspect that distinguishes this study from other studies is the examination of the relationship between the number of cases and deaths resulting from the outbreak and the exchange rate. As the subject of the research is a new field, different approaches and methods could not be reached in the literature. For this reason, the study is unique and it is thought that it will make important contributions to the literature. Especially when structural fractures are taken into account, policy suggestions about the effect of epidemic diseases on exchange rates bring more realistic results.

3. Data and Model

In this section, the hypothesis “there is a medium and long term relationship between Covid-19 virus and exchange rate.” is tested by the econometric methods with structural breaks in Turkey's economy. In today's age, the dynamics of the country's economy change depending on global developments. In this study, the effect of Covid-19 outbreak on the economy in general is discussed. In the analysis, the effect of Covid-19 outbreak on economy is tested on exchange rate, because a positive or negative development in macroeconomic variables finds a response in foreign exchange markets. On the other hand, changes in the exchange rate cause changes in the parameters of the country's economy. In this context, the policy proposals are made by analyzing the medium and long term relationship between Covid-19 and the exchange rate.

The study's data set consists of daily data covering the period 16.03.2020-06.05.2020 for Turkey's economy. The exchange rate used in the analysis (USD) is included as dependent

variable, while the new cases (New Cases - NC) and new deaths (New Deaths - ND) are included as independent variables. The databases where the dataset is obtained are given in the table below.

Table 1. Variables and Database

Variables		***Database***
USD	Dollar exchange rate	TCMB
NC	Number of new cases	Republic of Turkey Ministry of Health
ND	Number of new death	Republic of Turkey Ministry of Health

The formulation of the model used in the analyzes under the determined hypothesis is as follows:

$$USD = \beta_0 + \beta_1 NC_t + \beta_2 ND_t + \varepsilon_t$$

In the first stage of the study, the stationarity of the series was tested with unit root tests, Lee and Strazicich (2003), which allowed two structural breaks. After the stationary test, Hatemi-J (2008) Cointegration Test, which allows structural breaks, was conducted to check whether there is a long-term relationship between the variables or not. In the last stage of the analysis, the direction of the relationship between the variables is demonstrated by Hacker-Hatemi-J (2006) Bootstrap Causality analysis.

4. METHODOLOGY AND ANALYSIS RESULTS

In this study, the relationship between the number of new cases and the number of deaths with the exchange rate is analyzed by using the time series method unit root test with structural breaks and cointegration test. In the first stage of the study, in order to test the stability of the series, Lee-Strazicich unit root test is used, which allowed two structural breaks. The reason for using the Lee-Strazicich unit root test is that the specified daily data range is short and it is thought that there are no more breaks than events occurring within the specified date range. Following the unit root test, Hatemi-J (2008) multiple structural breaks cointegration test is used to test the existence of long-term relationship between variables. In order to determine the direction of the relationship, Hacker and Hatemi-J Bootstrap Causality test is applied. Findings from the analysis are interpreted and policy proposals are included.

4.1. Unit root test results

Time series can be stationary around different deterministic trends in different periods. These differences may arise from structural breaks occurring in the constant term and/or

slope. These breaks can be caused by war, natural disasters, peace, policy changes, terrorist events and economic crises. Unit root analysis without taking into account these structural breaks can give misleading results, and as a result of the tests carried out, the series that are actually stationary may emerge as they are not stationary (Yıldırım et al., 2013:83). In the study, Lee- Strazicich (2003) unit root test results with two fractions are given. The Lee-Strazicich (2003) unit root test developed by Schmidt and Phillips (1992) is a more advanced version of the structural breaks LM test developed by Lee and Strazicich (1999) (Strazicich and Lee, 2003: 2). In the unit root test, Lee-Strazicich (2003), Model A investigates the existence of two structural breaks in the average of the series, while Model C investigates the existence of two structural breaks in the average and trend of the series. If the absolute value of the obtained test statistics is greater than critical values, the structural root unit hypothesis with refraction is rejected, and if it is smaller, the basic hypothesis is not rejected. In equations (1) and (2), the formulation for Model A and Model C, respectively, is as follows:

Model A

$$\Delta y_t = K + \emptyset y_{t-1} + \beta t + \theta_1 DU1_t + \theta_1 DU2_t + \sum_{j=1}^{k} dj\, \Delta y_{t-j} + \varepsilon_t \quad (1)$$

Model C

$$\Delta y_t = K + \emptyset y_{t-1} + \beta t + \theta_1 DU1_t + \theta_2 DT1_t + \theta_2 DU2_t + \gamma DT_t + \sum_{j=1}^{k} dj\, \Delta y_{t-j} + \varepsilon_t \quad (2)$$

$$\boldsymbol{DU_t = \begin{pmatrix} 1 \rightarrow t > TB \\ 0 \rightarrow Diğer \end{pmatrix} \rightarrow (3)} \qquad \boldsymbol{DT_t = \begin{pmatrix} t - TB \rightarrow t > TB \\ 0 \rightarrow Diğer \end{pmatrix} \rightarrow (3)}$$

Here, Δ represents the first difference operator, ε_t is the White Noise with σ^2 variance term and $t = 1.....T$ indicates the time. The term Δy_{t-j} ensures that the error term is white noisy and not consecutively dependent. DU_t is the dummy variable. The hypotheses of Lee and Strazicich (2003) unit root testing that allow two structural fractions are as follows:

H_o: There is a unit root under structural breaks.

H_1: There is no unit root under structural breaks.

The reason for using the Lee-Strazicich unit root test is that the specified daily data range is short and it is thought that there are no more breaks than events occurring within the specified date range. Lee- Strazicich unit root test results are given in Table 2.

Table 2. Lee-Strazicich Unit Root Results

Variables	Model A			Model C		
	t-statistics	**First Breaks**	**Second Breaks**	**t-statistics**	**First Breaks**	**Second Breaks**
USD	-3.97 (7)**	22.04.2020	24.04.2020	-5.28 (7)	04.04.2020	15.04.2020
NC	-3.01 (9)	01.04.2020	22.04.2020	-4.94 (1)	28.03.2020	11.04.2020
ND	-2.38 (7)	27.03.2020	19.04.2020	-6.45 (2)**	31.03.2020	21.04.2020
Critical Values	**Model A Critical Values**			**Model C Critical Values**		
	-4,07(%1)			-6.93 (%1)		
	-3,56(%5)			-6.17 (%5)		
	-3.29 (%10)			-5.85 (%10)		

Note: Values in parentheses show the length of the lag. *, ** and *** show significance levels of 1%, 5% and 10%, respectively. The critical values are taken from Lee and Strazizich 2003:1084 Table 2.

While the exchange rate, which is included in Table 2, is stable with 5% structural breaks in model A, the number of new deaths is determined stable as 5% in model C. Other variables are unit rooted in level values in both models. In order to determine the cointegration relationship, all variables must be equally stable. The most frequently used method in the literature to stabilize the unit rooted series is to subtract the series from first degree. In this context, the stationary analysis was made again by the series from first difference.

Table 3. Lee-Strazicich Unit Root Test Results (First Difference)

Variables	Model A			Model C		
	t-statistics	**First Break**	**Second Break**	**t-statistics**	**First Break**	**Second Break**
USD	-5.39 (1)*	26.03.2020	11.04.2020	-6.27 (7)***	30.03.2020	09.04.2020
NC	-6.96 (1)*	10.04.2020	12.04.2020	-7.83 (1)*	30.03.2020	10.04.2020
ND	-6.45 (0)*	26.03.2020	28.03.2020	-6.40(2)**	30.03.2020	04.03.2020
Critical Values	**Model A Critical Values**			**Model C Critical Values**		
	-4,07(%1)			-7.19 (%1)		
	-3,56(%5)			-6.31 (%5)		
	-3.29 (%10)			-5.89 (%10)		

Note: Values in parentheses show the length of the lag. *, ** and *** show significance levels of 1%, 5% and 10%, respectively. The critical values are taken from Lee and Strazizich 2003:1084 Table 2.

In Table 3, when the subtraction of the series from first degree is taken into account, it is seen that the test statistic values of all variables are at 1% significance level in Model A in absolute value, in Model C the exchange rate and the number of new deaths are 5% and the number of new cases is greater than the critical values with 1%, therefore It was concluded that the series were stationary with the structural breaks. During the breaks, it is observed that significant breaks occurred in the specified dates. The developments experienced on these dates can be summarized as follows;

The highest number of cases since March 11 was recorded on the date 26.03.2020. On 30.03.2020, "We Are Enough For Us" aid and solidarity campaign was launched. A two-day curfew was declared on 10.04.2020. After examining the stationarity test of the series and breaking dates, Hatemi-J (2008) cointegration test is used to test the existence of long-term relationship between variables.

4.2. Hatemi-J Cointegration Test

In unit root tests, it is concluded that if the series contains unit root, it is not stationary, and if the non-stationary series do not have a co-integration relationship, it would be wrong to talk about the existence of a meaningful economic relationship between the variables (Harris and Sollis, 2003: 41). The Hatemi-J Cointegration Test, which allows structural breaks, is used to analyse whether variables act together in the long term. (Hatemi-J (2008) in his cointegration test, previously developed by Gregory and Hansen (1996) allowing single structural break, applied the test in a way that allows two structural breaks. Hatemi –J (2008), the formulation of two structural breaks equations that take into account both constant and slope coefficients are as follows:

$$y_t = \alpha_0 + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \beta'_0 x_t + \beta'_1 D_{1t} x_t + \beta'_2 D_{2t} x_t + u_t \qquad (4)$$

While α_0 in the equation shows the constant term before structural changes, α_1 indicates the first structural change, α_2 indicates the change in constant term due to the second structural fraction; while β_0 indicates the slope parameter before structural changes, β_1 indicates the effect of the first structural change on the slope, and the parameter β_2 indicates the effect of the second structural change. y_t is the dependent variable and x_t is the independent variable vector.

In the model, if $t > [n\tau_1]$ then $D_{1t} = 1$, if not, then $D_{1t} = 0$; if $t > [n\tau_2]$ then $D_{2t} = 1$, if not, then $D_{2t} = 0$ defined as dummy variables. The terms τ_1 and τ_2 refer to unknown indicators, whose values range from 0 to 1, and that indicate structural fraction periods. "$\tau 1 \in (0,1)$and $\tau 2 \in (0,1)$ signifying the relative timing of the regime change point and the bracket denotes the integer part, with unknown parameters" (Hatemi- J, 2008: 499). In the Hatemi-J test, ADF*, Z_t and Z_α test statistics are used to test the basic hypothesis showing that there is no cointegration relationship between variables (Yılancı and Öztürk: 2010: 267). The findings obtained from Hatemi-J cointegration test are given in Table 4.

Table 4. Hatemi-J Cointegration Test Results

ADF*		Z_t		Z_a	
Test Statistics	**Time Breaks**	**Test Statistics**	**Time Breaks**	**Test Statistics**	**Time Breaks**
-6.46(0)**	25.03.2020 10.04.2020	-6.53	26.03.2020 10.04.2020	-45.30	26.03.2020 10.04.2020
Critical Values		**Critical Values**		**Critical Values**	
1%	5%	1%	5%	1%	5%
-6.92	-6.45	-7.88	-7.35	-99.45	-83.64

Note: Critical values are taken from Hatemi-J (2008) study. Values in the parenthesis indicate the lag length. The number of lags of the model was calculated as 10 according to the formula of Schwert (1989).

As in the unit root tests, Hatemi-J Cointegration test, which allows two structural breaks, is used considering the short intervals of the analysis and the number of breaks in the specified dates. According to the results of Hatemi-J structural breaks cointegration test results, it can be seen that the ADF test statistic is higher than the Hatemi-J (2008) critical values at 5% significance level as seen in Table 4. However, in the Z_t and Z_a test statistics, the existence of a cointegration relationship could not be revealed. According to the ADF test statistics, the hypothesis that medium and long-term cointegration exist between the Covid-19 Virus and the exchange rate in Turkey is accepted.

- According to ADF test statistics, when the periods during which the breaks occurred are examined, it corresponds to the period when many important economic statistics for the markets were announced on 25.03.2020. These statistics include CBRT's economic orientation statistics for March, real sector confidence index, capacity utilization rate of manufacturing industry for March, electricity and natural gas price statistics for July-December 2019 and sectoral confidence indices for March. It is estimated that the changes in all these economic data will cause significant breaks in the markets.
- 10.04.2020 is the first time that the curfew was declared since 11 March 2020, when the Covid-19 virus was detected, and it can be interpreted as an important breaking date in terms of both the fight against the virus and the confidence perception of the markets.

4.3. Hacker and Hatemi-J Bootstrap Causality Test

In Hacker and Hatemi-J (2006) Granger causality test, Toda-Yamamoto causality test (1995) is applied to determine causality between variables, however, in case the risk that errors are not normally distributed, critical values are obtained with bootstrap. However, the shortcoming of this model is that it cannot distinguish between positive and negative shocks. In this context, the equation can be written as following:

$$y_t = v + A_1\, y_{t-1} + \cdots \dots \dots + A_p\, y_{t-p} + \cdots \dots \dots \dots \dots A_{p+d}\, y_{t-p-d} + \varepsilon_t \quad (5)$$

According the formulation the terms refer to the following: p of the process is assumed to be known and d is equal to the maximum order of integration of the variables. The VAR (p+d) model can be written compactly as:

$$Y = \breve{D}Z + \tilde{\delta} \qquad (6)$$

Where

Y: $= (Y_{1,} \dots \dots, Y_T)$ (n x T) matrix

D: $= (\upsilon, A_{1,} \dots \dots, A_P, \dots \dots .. A_{P+d})$ (n x (1+n (p+d))) matrix

$$Z=\begin{bmatrix} 1 \\ y_t \\ y_{t-1} \\ \cdot \\ \cdot \\ \cdot \\ y_{t-p-d+1} \end{bmatrix}$$ ((1+n (p+d) x 1) matrix for t=1,…., T

Z= ($Z_o \ldots\ldots, Z_{T-1}$) ((1+n(p+d) xT)) matrix, and

δ=($\varepsilon_o \ldots\ldots, \varepsilon_{T-1}$) (nxT) matrix

The modified Wald (MWALD) test statistic for testing non-Granger causality of one variable in yt on another variable in yt, suggested by Toda and Yamamoto (1995), can be then written as:

$$MWALD= (C\tilde{\beta})'[C(Z'Z)^{-1}\oplus S_u\, C']^{-1}\,(C\tilde{\beta}) \quad (7)$$

where $\otimes$ is the Kronecker product, and C is a *p×n(1+n(p+d)) matrix*, $\tilde{\beta}$= *vec(D)*

The null hypothesis for non-Granger causality is expressed as follow:

$$Ho: C\beta = 0 \quad (8)$$

The MWALD test statistic is asymptotically $\chi 2$ distributed with the number of degrees of freedom equal top.

Table 5. Hacker and Hatemi-J Bootstrap Causality Test

Basic Hypothesis	Test Statistics	Critical Values		
		1%	5%	10%
DUSD≠>DNC	13.441	27.412	21.020	17.570
DNC≠>DUSD	8.473	31.435	21.705	17.342
DUSD≠>DND	18.651***	30.639	21.447	18.017
DND≠>DUSD	19.291	35.637	24.169	20.226

According to Table 5, where the results of the Hacker and Hatemi-J Bootstrap Causality test results, no causal relationship was found between the number of new cases and the number of new deaths and the exchange rate. There is a one-way causality relationship from exchange rate to death rates at the level of 10% significance. This result is interpreted except expectations and beyonds contradicts theory. In this case, we can mention that the fluctuations in the exchange rate in Turkey is due to other variables caused by the pandemic.

5. Conclusion and Policy Recommendations

Covid-19 epidemic started in China and soon affected the whole world. Turkey has been faced with the first new case on March 11, 2020, and to minimize the impact of the epidemic has begun to take both health and economic measures. One of the first measures taken by Turkey against the pandemic is social distance measures and isolation. This measure has impacts not only on health, but also on social and economic life.

In this study, the impacts of the pandemic on Turkey's economy and the relationship between the Covid-19 outbreak and the exchange rate have been discussed by using the daily data from 11.03.2020, when the first Covid-19 case was seen according to the records, to 06.05.2020. In this context, as dependant variables, the effect of the number of cases and the number of deaths on the exchange rate has been discussed. In the first phase of the analysis, Lee-Strazicich unit root test, which allowed two structural breaks, was performed. As a result of unit root test, it was concluded that the series are stationary at I (1) level. The existence of a long-term relationship between variables was examined with Hatemi-J Cointegration test, which allows two structural breakages. According to the results of the analysis, it was determined that there is a long-term relationship between the variables. After the cointegration test, no causal relationship has been found between the number of new cases and new deaths and the exchange rate by using the Hacker-Hatemi J Bootstrap Causality analysis.

We can say that the reason for the increase in the exchange rate in Turkey from the date of first Covid-19 case is the possibility of the negative consequences of the policies of the country's economy during the pandemic and the economic uncertainity. Turkey has increased its spending on healt care during this breakout in order to reduce the number of new cases and the number of deaths. With the increase in budget expenditures, postponement of tax revenues, decrease in revenues with decreasing production, decrease in tourism revenues, shrinkage in trade volume, etc. changes occurring in many economic variables cause the exchange rate to rise in Turkey. In addition, the increase in the exchange rate affects expectations negatively.

When the results obtained from the analysis are compared with the literature, it is supported that, as in many studies, COVİD- 19 cause important results on the economy due to the global effects. For this reason, it can be said that economic managers and private sector should constantly develop an alternative plan in the face of major developments such as the global epidemic. During these periods, reserves should be kept strong against foreign currency risk. The study analysed the relationship between COVID-19 virus and exchange rate, and it is suggested that future researchers analyse the effects of both COVID-19 and different global outbreaks on the economy with different macroeconomic variables. In addition, work has only been carried out in Turkey's economy. It is thought that new researchers will also analyse the effects of the COVID-19 virus and develop solutions by conducting analysis through different country groups.

Availability of data and materials

The data are from

The data are from Electronic Data Delivery System of the Central Bank of Turkey https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Statistics/Exchange+Rates/ and https://www.saglik.gov.tr/?_Dil=2 /that requires neither license nor permission of acquisition.

The model is developed and executed with the GAUSS. The author would provide the data and the code, if it is requested.

Competing interests

The author whose name is listed immediately below certifies that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Funding

The study is conducted without any financial support. There is no role of any funding body in the design of the study and collection, analysis, and interpretation of data.

Authors' contribution

ED and İÇ contributed to the research, analysis, and manuscript. The authos read and approved the final manuscript.

Acknowledgements

Not applicable.

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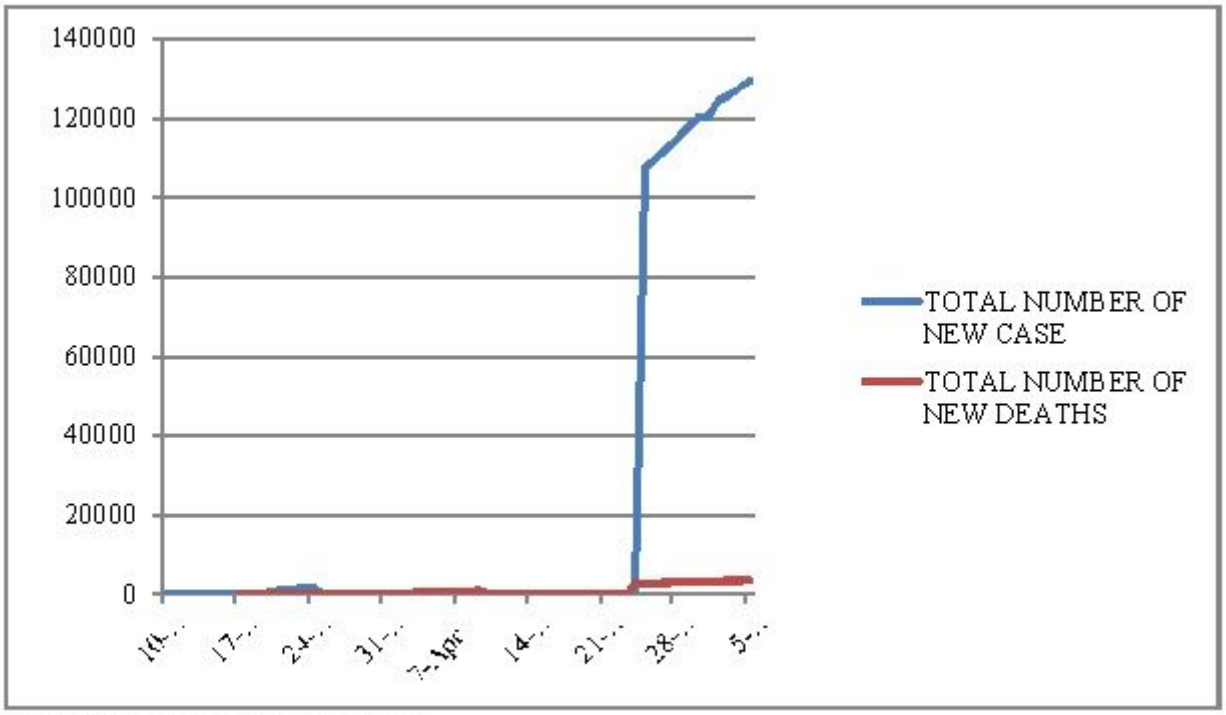
Figures



Data Source: www.saglik.gov.tr/

Figure 1

Total number of case and deaths in Turkey

Data Source: www.tcmb.gov.tr.

Figure 2

Exchange Rate Fluctuation 11 March 2020- 5 May 2020

Supplementary Files

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- supplement4.pdf