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CONSTRUCTION GDP AND TOTAL GDP IN TURKEY:
BEFORE&AFTER THE GLOBAL CRISIS ANALYSIS

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PREFACE

I would like to express my profound gratitude to my advisor Assoc. Prof. Serda Selin Öztürk for her patience, guidance and support. She was always very positive and helpful to me during the making of this thesis. This work could not be realized without her.

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I would also like to thank my mother Fatma Esra Yıldırım, my grandmother Fatma Rezzan Esen and my aunt Ayşe Özlem Esen for their support of me in every milestone of my life. I feel honorable and lucky to have been born into this family.

Lastly, I dedicate this thesis to my late grandfather, Osman Esen, who passed away four years ago. The guiding star of my life, he always supported me for every action I took in my life prior to his passing. Even though he cannot see this work in person, I shall forever hold his memory dearly and strive towards upholding his legacy.

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LIST OF ABBREVIATIONS

GDP: Gross Domestic Product

IMF: International Monetary Fund

VAR: Vector Autoregressive

CBRT: Central Bank of Republic of Turkey

BIST100: The BIST100 Turkish stock market index

XGMYO: REIT companies index in the Turkish stock market

REIT: Real Estate Investment Trust

ADF: Augmented Dickey-Fuller Test

CPI: Consumer Price Index

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ABSTRACT

In this study, the interactions between the share of construction sector in Turkey's GDP, Turkish economic growth, and key expressive factors such as real effective exchange rates, commercial loan rates and consumer price index are examined. The Spillover analysis approach developed by Diebold and Yilmaz is utilized in the study. The period between the start of year 2003 and the end of year 2019 is examined. All data has been taken quarterly, and the mentioned time period has been split into two parts to examine the interactions in three sub-periods: Before the global financial crisis, after the global financial crisis, and during the whole period. It can be inferred from the study that the construction sector has been a major propelling force in Turkey's economic growth in the period leading to the global financial crisis. However, as the crisis subsides, it is evident according to the Spillover analysis approach that the interaction reverses and Turkish economic growth fuels the growth of the construction sector in Turkey.

Keywords: Economic growth, Construction sector, Spillover, Real effective exchange rates, Commercial loan rates, Consumer price index

ÖZET

Bu çalışmada Türkiye'deki inşaat sektörünün GSYİH üzerindeki etkisi ve bu ikisinin birbiriyle etkileşimi reel efektif döviz kuru, ticari kredi oranları ve tüketici fiyat endeksi gibi anahtar açıklayıcı etkenler ışığında incelenmiştir. Diebold ve Yılmaz tarafından geliştirilen Spillover analizi yaklaşımı çalışmada kullanılmıştır. İncelenen zaman periyodu 2003 yılının başı ve 2019 yılının sonu arasıdır. Çalışmada bütün veriler çeyreksel olarak alınmış ve incelenen zaman periyodu 2008 global finansal krizi öncesi ve sonrası olacak şekilde ikiye ayrılmıştır. Bu ayrım ile birlikte hem global kriz öncesi, hem sonrası, hem de tüm zaman periyodu ayrı ayrı incelenmiştir. Çalışma sonucunda global finansal kriz öncesi Türkiye'de inşaat sektörünün ekonomik büyümenin bir lokomotifi olduğu söylenebilirken, global finansal kriz sonrasında inşaat sektörünün ekonomik büyümeyi etkileyenden etkilenen konumuna geçtiği görülmüştür.

Keywords: Ekonomik büyüme, İnşaat sektörü, Spillover, Reel efektif döviz kuru, Ticari kredi oranları, Tüketici fiyat endeksi

INTRODUCTION

Construction sector has been the catalyst to vast improvements in Turkey in the last two decades. The country has seen constructions of mass housing projects, roads, new airports, brand new infrastructure, urban transformation projects, and much more. It can be argued that investments made on the construction sector is the most expeditious way to observe economic growth of a country on a mass scale and because of this nature of the sector and its high impact on the public's lives, it has been perceived as a highly profitable business sector. Perhaps due to these factors, public investment into the construction sector has been somewhat prioritized and private investment has been encouraged in the last two decades of Turkey's stride.

These aspects have also been debated on for some time. Especially the sector's ability to sustain itself and contribute to economic growth in the long term have been questioned. Inherently, the sector is popular in political regard and profitability due to aforementioned reasons, however it has an underlying problem of translating into producing long term added value, which adds to the question of its sustainability. Another question rises regarding the saturation of the sector. As urban transformation projects and mass public projects picked up the pace in the last decade, more construction and real estate investment trust companies emerged, undertaking more ambitious projects. These phenomena ultimately lead to a point which seems like an endless loop: Is the construction sector a stimulator of economic growth, or does economic growth drive the expansion of the construction sector. In light of these, this paper will focus on answering these questions by analyzing the relationship between the construction sector's effect to GDP, economic growth, and three other key factors that impact on the sector: real effective currency rates, commercial credit rates and Turkey's consumer price index. The period starting from year 2003 to the third quarter of 2019 will be analyzed, since the starting date marks a new era in the Turkish economy after the banking sector crisis.

In this study, the analysis will be conducted by the Spillover analysis method developed by Francis X. Diebold and Kamil Yilmaz, which makes forecast error variance decompositions invariant to the variable ordering based on a generalized vector autoregressive framework (VAR). The Spillover analysis makes it possible for an analyst to predict and measure the total and directional spillovers between time series. As most of the studies employ the Granger causality test in order to investigate the relationship between the construction industry and economic growth, the conduction of Spillover analysis is a different and valuable approach to assess the relationship between the construction industry, economic growth and other key aforementioned variables such as the consumer price index in terms of directional spillovers. The spillover effect in macroeconomic terms can be described as the effect of a seemingly unrelated economic phenomenon impacting another outcome.

Observation of Turkey's macroeconomic situation is paramount in tackling the task of unfolding the relationship between the construction industry and Turkey's economic growth. Just before the start of the period to be observed, Turkey has entered into a severe financial crisis at the start of year 2001 following the reaction of the stock market to a bursting political crisis announced by the then prime minister of Turkey, Bülent Ecevit. The already-unstable Turkish Lira heavily depreciated and overnight rates skyrocketed in a matter of days, causing the fragile banking sector of Turkey to collapse, leading the country into an uncharted territory of turmoil and unknown in financial and political terms.

Another particular occasion fueling the economic crisis is the Gölcük earthquake which happened in 17 August 1999. The earthquake alone caused a fiscal fallout of around 4 billion US Dollars, corresponding to roughly 2% of Turkish GDP at the time. While this terrible event damaged Turkey in both financial and intangible manners, it also ironically spearheaded the construction sector in Turkey in the early years of the following decade, in the form of rebuilding the damaged Marmara region and renovations due to newly raised earthquake awareness.

In turn, Turkey turned to the International Monetary Fund (IMF) for financial aid and restructuring, and strict countermeasures were taken to consolidate the country's economy. Under the program dubbed "Transition to a Strong Economy" led by Kemal Derviş, who has previously served as Vice President in the World Bank and newly appointed as the Minister of Economic Affairs. This series of events have restored hope to both Turkish and national investors, and were followed by recuperation of the Turkish economy with decreasing current account deficit, trade deficit and sowing the foundations of a stronger banking sector with tighter regulations coupled with a more robust fiscal policy.

The crisis brought the winds of political change to Turkey as well. Following the early general election decision taken by the Turkish National Assembly, the Justice and Development Party (AKP) emerged victorious, with policies encouraging neoliberalism and privatization in the Turkish economy. Inflation and interest rates swiftly dropped with the perception of long sought stability, and the construction sector heavily benefited from government policies. In the first four years of AKP rule, GDP related to constructional activities increased its share in Turkish GDP by 70%. This can be heavily attributed to the major infrastructural projects followed by urban transformation projects.

The end of 2008 came with a heavy toll not just the Turkey, but to the whole world, as economic foundations of the world shook with the crisis rising from mortgages in the United States. The effect of this crisis was to shrink Turkey's economic growth by 4.7% of its GDP. While this was still less than the previous 2001 economic crisis in which Turkey's GDP lessened by almost 6%, the 2009 global financial crisis is still an important milestone, and thus it marks the partition of two subperiods for this study. While the loss 4.7% in terms of Turkey's GDP was more than the average shrinkage of other emerging economies, Turkey rose from the crisis faster and stronger than her peers. The great recession's effects on Turkey were limited due to various reasons such as the strengthened fundamentals of the Turkish financial sector, fiscal durability and comparably low currency risk. Implementation of smart policies by the Central Bank of the Republic of Turkey

(CBRT) prevented the country from being pulled into a deadlock of rising inflation and interest rates, while also managing to protect fiscal strength. Financial holdings of the Turkish people was also not high at the time of the crisis, which has helped to absorb the negative shock. This is supported by the increase of real investments from the previous crisis, which were well over the 20% mark of the Turkish GDP prior to the 2008 crisis, as opposed to the 16 percents of the year 2000. A presumption can be made regarding the contribution of the construction sector to this situation in the form of the rise of the construction sector and the perception of Turkish people's investments into real estate. According to these phenomena, it can be argued that smart investment and governmental policies helped Turkey to rise relatively less damaged than other emerging economies, and the role of the construction sector in this.

In the wake of the crisis, Turkish economy first showed signs of recovery in the initial years as expected. The construction sector seemingly showed to have been a driving force in this with both major public projects such as the Eurasia tunnel, continuation of infrastructural projects, and urban transformation projects. Analysis of the BIST100 index compared to the XGMYO index which is the compound index of real investment trust companies in Turkey shows that the XGMYO index increased by almost 380% from its last lowest point in the November of 2008 to its highest point in the January of 2011, while the BIST100 index increased by around 250% during the same time period. However, after this massive outperformance, the XGMYO index has not seen the continuation of this trend, while the Turkish stock market marched on with its upward journey. This contrast can be seen as one of the indicators of the construction sector's struggle in the post-crisis period, and contributes to the controversy of construction sector's sustainability which has been an issue of debate for many years. Macroeconomic conditions of Turkey have been deteriorating as well in the past few years, as the Turkish Lira depreciated by almost two-thirds against the US Dollar in the last six years. While the depreciation of the Turkish Lira can be fruitful for businesses with exporting potential, it certainly does not help the construction sector, coupled with the volatility of the Lira which makes

companies have a much greater challenge managing construction costs and hedging.

Graph 1.1: Mean returns of BIST100 and XGMYO index in Turkey
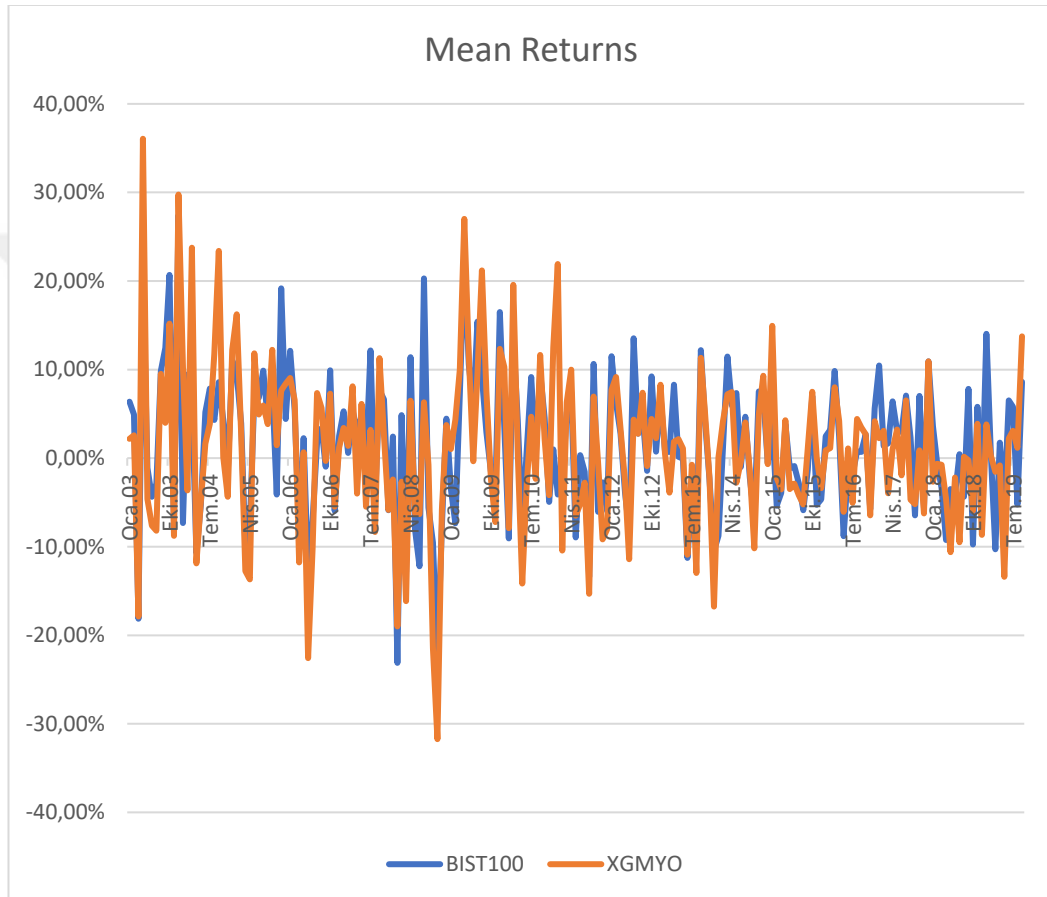
Source: Electronic Data Distribution System (EVDS), Central Bank of Republic of Turkey

Examining monthly mean returns of the BIST100 index and the changes in XGMYO index leads to the following findings:

	Mean return BIST100	Mean return XGMYO
January 2003-June 2009	2,13%	1,54%
July 2009-September 2019	1,06%	0,62%
	Skewness BIST100	Skewness XGMYO
	0,049734299	0,232374021
	Kurtosis BIST100	Kurtosis XGMYO
	0,597595679	1,864971894

Monthly mean returns of the BIST100 index outperform those of the XGMYO index in both periods: before the global crisis and after the global crisis, although the difference is slightly larger after the global crisis. Especially the BIST100 monthly returns seem fairly symmetrical with a skewness of 0.0497, with the XGMYO monthly returns being more positively skewed. Kurtosis values on the other hand indicate that monthly returns for REIT companies have been much more volatile compared to the monthly BIST100 index returns. This correlates to the volatile nature of the construction business. According to these results, while financial returns from REIT companies can be significantly higher than the financial returns from the BIST100 index at given times, however they are more unsustainable and unpredictable.

On the other hand, if the quarterly changes in GDP related to construction and total GDP are investigated, the following table is reached:

Graph 1.2: Changes in Construction GDP and Total GDP in Turkey
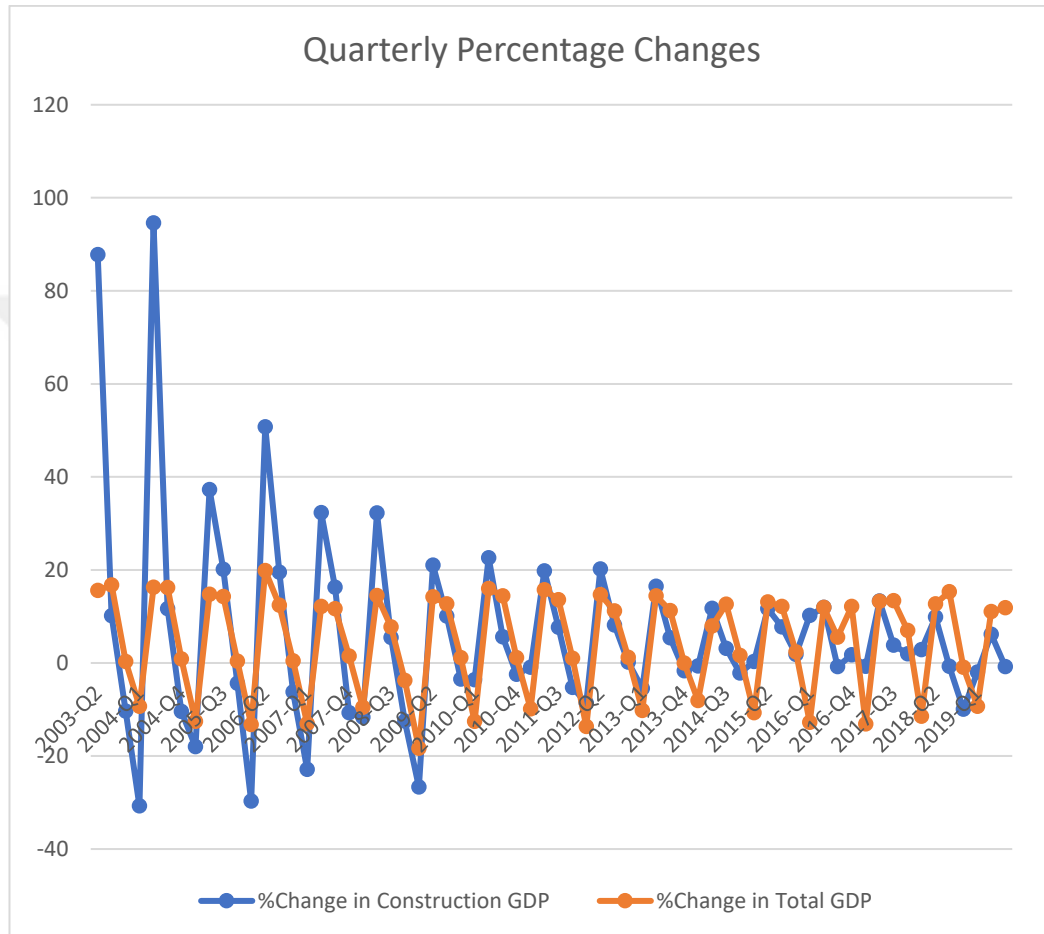
Source: Electronic Data Distribution System (EVDS), Central Bank of Republic of Turkey

Prior to the global crisis, it can be observed that GDP related to constructional activities change in a more volatile manner than the total GDP, and it can be inferred from the graph that the mean of percentage change to GDP related to constructional activities is significantly higher than the mean of percentage change to total Turkish GDP.

GDP related to constructional activities mean between 2003-Q2 and 2009-Q2 (quarterly percentage change): 9.80%

Total GDP mean between 2003-Q2 and 2009-Q2(quarterly percentage change): 4.03%

After the global crisis, it can be seen that the percentage changes in both GDP related to constructional activities and total GDP are much more aligned with each other and have very close means.

GDP related to constructional activities mean between 2009-Q3 and 2019-Q3 (quarterly percentage change): 4.40%

Total GDP mean between 2009-Q3 and 2019-Q3 (quarterly percentage change): 4.38%

Regarding the saturation of the construction industry, it can be hypothesized that the sector has become much more saturated after the global crisis as its quarterly growth means have become very close to the quarterly growth means of Turkish GDP. From the results, it can also be safely presumed that constructional activities made a higher contribution to Turkish economic growth before the global crisis compared to the aftermath of the global crisis.

Considering the information above, several preliminary points can be made. As the Turkish economy recuperated after the 2001 crisis, the construction sector undoubtedly has been a great beneficiary as the sector would be encouraged due to rebuilding efforts from the 1999 earthquake that had struck the Marmara fault. Another benefit to the rise of the construction sector can be observed as policymakers would favor the industry for its merit to make economic growth visible in the short term. The outcome can be clearly seen in the aforementioned point of the construction sector's share in Turkish GDP being increased by 70% from 2003 to 2007.

As later years are examined, a different scenario is faced. After the global economic crisis, drops in both growth of the construction sector and the financial returns of the REIT companies are observed. These decreases heavily suggest two hypotheses. The first is that the construction sector moving close to saturation especially after the global financial crisis, and more importantly, the second would be the industry

transitioning from being a mover of Turkish economic growth to being dependent on Turkish economic growth. Using the Spillover Index, a relatively new concept of approach in examining causality which is yet to be used in analyzing the relationship between economic growth and construction industry, this study will try to shed light on their interaction with each other, added with few other key variables, namely consumer price index, commercial loan rates and real effective exchange rates for Turkey.

In the following parts of the study, selected works finished prior to this study will be reviewed under literature review first, followed by an overview of the construction industry in Turkey which will include how the construction industry fares with the other key variables used in our study. Then, data and methodology to be used will be explained, followed up by the results and conclusion sections.

1. LITERATURE REVIEW

The relationship of the construction sector and economic growth has been examined in several studies in both Turkey and foreign countries. Most of these examined works employ the Granger causality test to investigate the interaction between variables. The Granger causality test is a hypothesis test based on statistics to find the direction and power of causality between different time series. Due to the reliability of this test, it has been utilized widely in econometric studies since its inception. The hypothesis test was proposed by Clive John William Granger, a British economist who has also won the 2003 Nobel Prize on Economics shared with Robert Fry Engle. Augmented Dickey-Fuller unit root tests are also conducted to figure out the stationarity properties of the time series that are to be used. Few other methods such as the Engle-Granger cointegration test, Johansen cointegration test and error correction models are exercised in conjunction with the aforementioned tests.

The Spillover analysis method developed by Francis X. Diebold and Kamil Yılmaz in 2009 is most commonly used in literature to delve into explaining the relationship of different equity assets' time series. While the Spillover analysis method features interaction between equities, the studies done using this method have also accommodated the interaction between economic growth and several different variables such as touristic activities and industrial production.

1.1. Construction Industry and its Role in Turkey

Kargı (2013) examines the relationship between economic growth and the construction industry in Turkey, using quarterly data between 2000's first quarter and 2012's third quarter. After subjecting the data set to correlation analysis, stationarity of the data set is ensured by Augmented Dickey-Fuller test, followed by the conduction of the Granger causality test and formation of regression models. As a result, a strong correlation is found between the construction industry and economic growth and it is suggested that the sector is driven by economic growth.

The correlation between construction industry and inflation is also investigated in the study, leading to the result of weak correlation.

Özkan, Özkan and Gündüz (2011) focus distinctly on the interaction of public and private construction investment and economic growth. Data has been taken monthly between January 1987 and December 2008 in this study. Augmented Dickey-Fuller test was used for data stationarity, followed by the utilization of Engle-Granger cointegration test and Granger causality test. Results of the study indicate that while public construction investment is cointegrated with economic growth, the same cannot be said for the relationship between private construction investment and economic growth. It is also suggested that investment on construction is a vital tool to combat stagnation in developing countries.

Bolkol (2015) investigates the relationship of construction production and economic growth in Turkey between the first quarter of 2005 and the fourth quarter of 2013. Time series used in this study are GDP, non-building production and building production. After the usage of Phillips-Perron unit root test which is a unit root test based on the Augmented Dickey-Fuller test, the stationarized data is checked for cointegration with the Johansen cointegration test. Finally, Granger causality test is applied to find the causality between the time series. As a result, a short run cointegration is revealed between GDP and construction production, while no existence of cointegration in the long run is found. As the Granger causality test is applied in the short run, it is seen that causality runs from GDP to construction production. Another finding of this study is that building production causes non-building (infrastructural) production.

Erol and Ünal (2015) shed light onto the role of the construction industry on Turkey's economic growth in their study. With using GDP growth, construction growth and interest rate data for Turkey between the first quarter of 1998 and the fourth quarter of 2014, the authors subject the data to Augmented Dickey-Fuller test for stationarity of the time series. This is followed by testing the data for structural breaks and utilization of the Granger causality test. Results of the study indicate that over the constructional growth lags behind economic growth by two

to four quarters. While this is the case for the whole time period, when the period is fragmented into sub-periods, it is suggested that this scenario can vary with different sub-periods having the construction industry as the driver of economic growth. Another result indicates that Turkish construction industry prospers better in times of higher economic growth, but suffers worse than other sectors in times of economic stagnation. Finally, the study's findings indicate to bidirectional causality between interest rates and construction industry's growth.

Lopes, Ruddock and Ribeiro (2002) analyze the construction investments in developing countries in their study by collecting data from 15 African countries between years 1980 and 1992. Construction value added and GDP are chosen as the main indicators of constructional activity. The study tackles whether a minimum construction value added over GDP per capita ratio exists in order to achieve long term sustainable economic growth via hypothesis testing. According to the results, GDP and construction investment are dependent to each other in the long term for the analyzed African countries. Also, a critical value of the aforementioned ratio is found as between four and five percent, whose drop directly corresponds to decreasing economic growth, while the increase of this ratio does not necessarily result in increasing economic growth.

Wilhelmsson and Wigren (2011) challenge the problem of the robustness of the interaction of construction investment and economic growth in fourteen Western European countries between the years 1980 and 2004. In this study, construction variables are broken down to three parts: building, infrastructural, and other construction. Using a panel data set, the authors use the Augmented Dickey-Fuller test to establish stationarity of the data series, followed by Engle and Granger's error correction model and Granger causality test. Findings of the study are that bidirectional Granger causality exists between construction and economic growth, such as building constructions affecting growth in both short and the long run, with the reverse standing true as well. There are also multidirectional existing causality runs between different types of construction. For example, it is established that building constructions cause infrastructural improvements in the long run. Finally,

it is said that a 1% increase in construction flows can result in up to 0.15% increase in economic growth, an effect which diminishes with increasing housing stock.

According to Chung and Nieh (2004) who studied the causal interaction between construction activity and economic growth in Taiwan, unidirectional causality exists between construction and economic growth in both short and the long run, with constructional activity being the driving force. The Taiwanese construction investment, GDP data are taken quarterly alongside public and private expenditure data between the first quarter of 1979 and the fourth quarter of 1999. The authors use the Augmented Dickey-Fuller and KPSS unit root tests, Johanssen cointegration test, Granger causality test and the error correction model proposed by Engle and Granger.

Asomanin-Anaman and Amponsah (2007) focus on the relationship between the construction industry and economic growth in Ghana. The study analyzes GDP and construction activities related GDP for Ghana between the years 1968 and 2004. The analysis is made with Augmented Dickey-Fuller test to accomplish data stationarity, Engle-Granger cointegration test and Granger causality test to achieve conclusive results about causality between time series. Conclusions of this study are that construction related GDP precedes economic growth by three years, implying that construction Granger causes economic growth. Another interesting outcome is that higher GDP levels are achieved two years after drops in construction production, which can be attributed to the finishes of major infrastructural projects.

Tiwari (2011) investigates the linkage between construction flows and economic growth in India, using construction related GDP and GDP growth data between 1950 and 2009. The data is taken yearly in this study. Tiwari uses unit root analysis on the data set to enforce stationarity, followed by performing Johansen cointegration test and Granger causality test. The author also constructs impulse response functions and variance decomposition analysis in order to explore the dynamic properties of the data set. The results of this study are conclusive that construction production contributes to economic growth in the short term for India,

with this effect reversing in the long term. This suggests that India should gradually cut down on her efforts on construction in a gradual manner to benefit economic growth.

In Dlamini's (2012) study, interaction of the construction sector with economic growth is examined for two countries: United Kingdom and South Africa. Three models are utilized, namely Harrod-Domar model, Solow growth model and endogenous growth model. Construction output and GDP time series used in this study are taken yearly between 1986 and 2010 for South Africa and between 1955 and 2010 for United Kingdom. The study's findings are that South Africa has a stronger correlation between construction activities and GDP than United Kingdom and grand events such as the 2010 FIFA World Cup held in South Africa can lead to unsustainable constructional growth. Finally, it is inferred that constructional activity does not necessarily pave the way to economic growth in South Africa and United Kingdom.

1.2. Spillover Analyses

The Spillover analysis was developed and proposed by Francis X. Diebold and Kamil Yilmaz (2009) in their 2009 study, where the authors analyzed the effect of spillovers in return and volatility terms between nineteen global stock markets based on daily stock market data between January 1992 and November 2007. In order to do so, a Spillover index rooted in vector autoregressive framework was constructed, which illustrated the spillover impact of each market onto others and their total spillovers. Results of their work indicated that return spillovers exhibit a soft upward trend while spillovers attributed to volatility exhibit at times of crises instead of an existing trend.

The Spillover analysis however had its shortcomings in its first application. In their next study, Diebold and Yılmaz (2012) enhanced the Spillover analysis such that contrary to their previous work, the analysis would now be able to operate without the boundaries of variable ordering and more importantly, the analysis' results would also include net directional spillovers among observed series, in contrast to

their previous work whose results only included total spillovers. With data taken between January 1999 and January 2010 for US stock, bond, commodities markets and foreign exchange markets, the authors demonstrated both the total spillover between these asset markets and directional spillovers between specific assets in terms of volatility. The study builds upon its predecessor study of 2009, as no specific trend is observed in cross-market volatility spillovers. However, as the Great Recession of 2008 ensues, US stock market emerges as the greatest source of net volatility spillovers, and the foreign exchange market comes out as the net receiver. Again, volatility spillovers display shocks instead of visible trends.

In literature, the Spillover analysis has been mostly used as a way to observe spillovers among financial asset classes, equity markets as well as spillovers between economic growth and several other variables such as tourism income.

Dragouni, Filis and Antonakakis (2013) investigate the connectedness of touristic activities and economic growth using the Spillover analysis for various European countries including Spain, Portugal, Italy, Germany, Greece, Netherlands, Cyprus, Austria, United Kingdom and Sweden. The data is taken monthly between 1995 and 2012 in varying periods. It is seen in the study that the economies of Mediterranean countries such as Spain, Portugal, Greece and Italy suffer way harder than others, due to the heavy-weighing of tourism on these countries' economies. Also, the relationship of tourism and economic growth changes differently over time in different economies. For example, net directional spillovers start off weak in Greece leading up to year 2006. Then, between 2006 and 2009, touristic activities take over as the emitter of directional spillovers towards economic growth, until this pattern reverses after the year 2009.

Antonakakis, Breitenlechner and Scharler (2015) examine the spillovers between credit growth and GDP growth for the G7 countries using quarterly data between 1957's first quarter and 2014's fourth quarter. The authors use Spillover analysis inside a vector autoregressive framework in order to work out the relationship between financial and business cycles. The analysis is split to two parts: spillovers within countries and spillovers across countries. Results reveal that within the

majority of G7 countries, credit growth is seen as the transmitter of spillover bursts in the beginning of most major crises, with the real sector assuming the mantle of being the source later on. When inter-G7 country relations are examined, the scenario is such that the United States transforms from being a net receiver to a net sender of credit growth spillover in the beginning of the first decade of the 21st century. This situation in turn transforms into the United States also being a transmitter of GDP growth spillovers. It is concordantly inferred that United States' credit growth may well be one of the underlying reasons of the Great Recession. Last but not least, it is highlighted in the study that magnitude and direction of spillover effects inside countries differ. For example, United States, Germany and Japan display higher connectedness with well over twenty percents of total spillover, while United Kingdom and Canada display around seven percent of total spillover over the observed time period.

Sugimoto, Matsuki and Yoshida (2014) discuss the impact of spillovers from global stock markets, regional stock markets, commodity markets and currency markets. The effects of seven African stock markets (South Africa, Namibia, Zambia, Morocco, Mauritius, Tunisia and Egypt) are investigated with relation to global leading stock markets, commodities such as gold and petroleum, and effective exchange rates based on US dollar and Euro. Daily data between September 2004 and March 2013 is used in this analysis. Spillover analysis within vector autoregressive framework conducted on the data shows that the leading spillovers onto African stock markets among the four time series were transmitted from global stock markets, followed by regional spillovers. The effect of spillovers from commodity markets and exchange rates were shown to be of smaller-scale than the effects of regional and global stock markets. The study also compares the impact of the Great Recession and the following Eurozone debt crisis, and finds the latter to be more detrimental according to the Spillover analysis. Finally, the effects of regional spillovers within Africa onto African stock markets are found to be somewhat independent from global stock market spillovers.

Karğın, Kayalıdere, Güleç and Erer's study (2018) delves into the relationship between Turkey's BIST100 index and three global leading stock market indices: CAC 40, S&P 500 and DAX 30 in the time period of Jamuary 2004 and February 2017. The study examines the volatility spillovers caused between these three market indices and the BIST100 index. Spillover analysis is employed in this research, with Augmented Dickey-Fuller test for data stationarity and E-GARCH model for variance modelling purposes. The findings put forth that volatility spillovers from these three markets are positively correlated with the global risk levels, and the S&P 500 index is the most impactful stock index on BIST100 in terms of volatility spillovers among the three stock indexes.

Yılmaz (2010) explores spillovers of return and volatility among East Asian markets in his study using the Spillover analysis. Stock market indices for ten East Asian countries are taken as weekly time series between January 1992 and April 2009. A secondary analysis is also made with the inclusion of Chinese and Indian stock market indices, although the secondary analysis starts in the December of 1994 due to data availability. According to the constructed Spillover indices, the increasing trend of return spillovers show dependencies of East Asian markets becoming higher over the investigated time period, while volatility spillovers display upward shocks coinciding with occurring crises. Another conclusion of this study is that the spillovers from Chinese and Indian stock markets start to become prominent only after 2001, driving the all-inclusive spillover index higher by close to 10 percent. This phenomenon can be explained by the broadening of investment interest on the Chinese and Indian markets starting from the beginning of the 21st century. Another interesting note of this study is that the Hong Kong stock market is the highest provider of spillovers among these twelve countries, imitating a similar scenario from Diebold and Yilmaz's (2009) previous work which is aforementioned in this study. In the study, Hong Kong is the third highest provider of return spillovers behind the United States and United Kingdom stock markets, and the second highest provider of volatility spillovers, only behind the United States.

Arora and Vamvakidis (2010) focus on Chinese economic growth's effect on the world in both short and long term using Chinese growth and import-export data between 1960 and 2007. The authors study the data set within a vector autoregressive framework and use error correction model in conjunction with the framework. Results of the study indicate that China's growth has transmitted growth spillovers to other countries for both short and the long term. The spillover effects start off regional especially in 1978 and onwards with the start of expedited Chinese growth, and rapidly erodes distance boundaries. The period between 1990 and 2007 suggests that China's 1% economic growth translates into 0.5% economic growth in other countries.

List of studies examined:

Study Title	Author(s)	Year Published	Methods	Results
Interaction Between The Economic Growth and the Construction Industry: A Time Series Analysis	Bilal Kargı	2014	-Correlation analysis -Augmented Dickey-Fuller test -Granger causality test	-Strong correlation between construction industry and economic growth,

on Turkey (2000-2012)				growth supports construction industry -Weak correlation between construction industry and inflation
Causal relationship between construction investment policy and economic growth in Turkey	Filiz Özkan Ömer Özkan Murat Gündüz	2011	-Engle-Granger cointegration -Error correction model -Granger causality test	-Construction industry vital to get rid of stagnation -Cointegration for public construction investments and GDP -No cointegration for private construction

				investments and GDP
Causal relationship between construction production and GDP in Turkey	Hakkı Kutay Bolkol	2015	-PP Unit root test -Johansen cointegration test -Granger causality test	-Short run causality from GDP to construction production -No long run cointegration -Building constructions Granger cause non-building constructions
Role of Construction Sector in Economic Growth: New Evidence from Turkey (1998Q1-2014Q4)	Işıl Erol Umut Ünal	2015	-Augmented Dickey-Fuller test -Structural break test -Granger causality test	-Three time series: Real GDP, real constructional activities, real interest rates -Constructiona

				l activity follows growth, lagging by 2-4 quarters -Construction grows faster in times of better growth, but it is damaged harder by stagnation -Bidirectional interaction between interest rates and construction sector
Investment in Construction and Economic Growth in	Jorge Lopes Les Ruddock F.L. Ribeiro	2002	-Hypothesis testing -Hypothesis: Minimum level of	-Construction investment and GDP are interdependent in long term

Developing Countries			construction value added over GDP ratio is required to reach sustainable and long term growth in economy	-A critical level of construction value added over GDP ratio exists in developing countries (4-5%) -A drop of the ratio directly leads to decreasing economic growth. The converse is invalid.
The robustness of the causal and economic relationship between construction flows and economic	Mats Wilhelmsson Rune Wigren	2011	-Panel data set -Augmented Dickey-Fuller test -Error correction model	-GDP is Granger caused by residential construction in both short and long run.

			-Granger causality test	-Low unemployment periods lead to positive outcome on economic growth
growth: Evidence from Western Europe				-1% increase in construction flows can affect growth by up to 0.15%, effect decreases with increasing housing stock.
A note on testing the causal link between construction activity and economic growth in Taiwan	Tsangyao Chang Chien-Chung Nieh	2004	-Four variable VAR model (GDP, construction investment, gov. expenditure,	- Unidirectional causality exists from constructional activity to economic growth in

			private expenditure) -Cointegration -Augmented Dickey-Fuller test	both short and long run
Analysis of the causality links between the growth of the construction industry and the growth of macro-economy in Ghana	Kwabena Asomanin-Anaman Charity Osei-Amponsah	2007	-Augmented Dickey-Fuller test -Granger Causality test -Engle-Granger cointegration	-GDP growth lags behind construction related GDP by three years -This implies that constructional growth Granger causes GDP growth in Ghana -Higher GDP levels actually follow a decline in construction production by

				two years, possibly caused by successful installments major public construction projects
A Causal Analysis Between Construction Flows and Economic Growth: Evidence from India	Aviral Kumar Tiwari	2011	-Unit root analysis -Granger causality test -Impulse response function -Cointegration (Johansen test) -Granger causality test -Variance decomposition analysis	-Changes in constructional GDP have correlating contribution to national GDP in India in the short term, however in the long run, construction production's effect on national GDP reverses

				-Study suggests that the country should decrease spending on construction industry as time progresses
Relationship of Construction Sector to Economic Growth	Sitsabo Dlamini	2012	-Harrod-Domar model -Solow growth model -Endogenous growth model	-Interaction between construction and economic growth investigated for UK and South Africa -Stronger correlation between construction and growth for South

				Africa than for the UK -Events such as the 2010 FIFA World Cup can lead up to manifestation of unsustainable increasing trends -Inferred that construction industry does not necessarily lead to growth
Better to give than to receive: Predictive directional measurement of volatility spillovers	Francis X. Diebold Kamil Yılmaz	2012	-Vector Autoregressive (VAR) Framework -Spillover Analysis	-Low cross market spillovers before the global financial crisis

			-Analysis of interaction between US stock, bond, foreign exchange and commodity markets	-Spillovers increase from stock market to other markets as crisis escalates -Specifically, stock market is the biggest net transmitter among these four market types in terms of volatility spillovers, while the foreign exchange market is the net receiver
Time Varying Interdependencies of Tourism and Economic	Mina Dragouni George Filis	2013	-Vector Autoregressive (VAR) Framework	-Nature of the interaction between tourism and

Growth: Evidence from European Countries	Nikolaos Antonakakis		-Spillover Analysis	growth changes as time progresses in terms of spillovers -Mediterranean countries such as Portugal, Spain and Greece were the hardest damaged ones by the interaction between tourism and economic growth during times of crises
Business Cycle and Financial Cycle Spillovers	Nikolaos Antonakakis	2015	-Vector Autoregressive (VAR) Framework	-Spillovers in the G7 countries are not

in the G7 Countries	Max Breitenlechner Johann Scharler		-Spillover Analysis	homogenous for different countries between financial and real sectors -Economic crises impact heavily on the magnitude of spillovers, causing dramatic increase -Assuming the roles of giving and receiving ends of spillovers change over time between credit growth and GDP growth

The global financial crisis: An analysis of the spillover effects on African stock markets	Kumiko Sugimoto Takashi Matsuki Yushi Yoshida	2014	-Vector Autoregressive (VAR) Framework -Spillover Analysis	-Regional spillovers in Africa are independent from global spillovers affecting Africa -Most impact is caused from global stock markets, followed by comparatively limited impact by commodity and currency markets
Spillovers of Stock Return Volatility to Turkish Equity Markets from Germany,	Sibel Karğın Koray Kayalıdere Tuna Can Güleç Deniz Erer	2018	-E-GARCH model -Spillover analysis -Threshold VAR model	-Global risk levels are influential on the volatility spillovers that the BIST100 index

France, and America				experiences from other stock markets -BIST100 index is affected the most by the S&P index among investigated stock indexes both in periods of low and high global risk
Return and volatility spillovers among the East Asian Equity Markets	Kamil Yılmaz	2010	-Vector Autoregressive (VAR) Framework -Variance decomposition -Spillover Analysis	-Increasing synthesis among East Asian markets -Volatility spillover shocks among markets occur in unison with economic and

				financial crises
Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets	Francis X. Diebold Kamil Yılmaz	2009	-Vector Autoregressive (VAR) Framework -Variance decomposition -Spillover Analysis	-Soft increasing trend for global return spillovers -Shocks related to global economic and financial events observed for volatility spillovers instead of trends -Chinese and Indian markets start to become more prominent for

				investors in 2001
China's Economic Growth: International Spillovers	Vivek Arora Athanasios Vamvakidis	2010	-Vector Autoregressive (VAR) Framework -Error correction model	

2. DATA

The data set used in this study includes five different quarterly time series between the first quarter of 2003 and the third quarter of 2019. These series are:

-Turkish Gross Domestic Product (GDP)

-Gross Domestic Product (GDP) generated related to constructional activities in Turkey

-Turkish Consumer Price Index (CPI)

-Commercial loan rates

-Real effective exchange rates for the Turkish Lira

The purpose of utilizing quarterly data is to have more precision in this study since the available GDP data is announced quarterly. As the aim of this study is to investigate the relationship between economic growth and the construction industry in Turkey, Turkish GDP data and GDP generated related to constructional activities are taken as time series. CPI, commercial loan rates and real effective exchange rates are also included in this research due to their explanatory nature of the Turkish macroeconomic conditions and the construction industry. Natural logarithms of aforementioned time series are displayed as well to be used in the analysis, since all data taken except for the commercial loan rates is used in their natural logarithmic forms.

3. METHODOLOGY

In this exploration of the relationship between the construction industry and economic growth, two main methods are used. These methods are the Augmented Dickey-Fuller test and the Spillover analysis.

Ensuring stationarity in time series is paramount in tackling econometric problems. Time series with existing unit roots are dubbed as nonstationary time series. Stationarity in time series is sought after in time series in econometric evaluations since stationary time series' important characteristics such as mean and variance are constant over time. As such, working with stationary time series yields precision in results. The most common method of transforming nonstationary time series into stationary ones is the differencing method. Via taking the difference between the values of each data point in a time series, the series can be made stationary, losing one data point in the process. Stationarity in time series is checked by using unit root tests, such as Augmented Dickey-Fuller test and the Phillips-Perron test. As mentioned, the Augmented Dickey-Fuller test will be used in this study. After checking the five time series utilized in the study, appropriate differencing will be applied to them in order to work with stationary data.

After obtaining appropriate data sets, the Spillover analysis method will be conducted. The Spillover analysis method measures spillovers between time series in a vector autoregressive framework. With utilization of this analysis, a Spillover index is constructed, which provides information on both aggregate and directional spillovers between time series. The aggregate results indicate total affectedness of the time series by the spillovers from other time series, while directional results indicate the effect of one time series to another specific time series, leading to an alternative and effective approach to examine the relationship between financial and econometric data.

3.1. Augmented Dickey-Fuller Test

It is assumed that x_t is a random walk process, therefore $x_t = \eta x_{t-1} + \varepsilon_t$

When x_{t-1} is subtracted from both sides of the equation, the restricted Augmented Dickey-Fuller model is reached, which is:

$\Delta x_t = \mu x_{t-1} + \varepsilon_t$ where $\mu = 1 - \eta$

$$(4.1)$$

While the null hypothesis of the Augmented Dickey Fuller test always dictates the assumption of random walk to be present in the time series, conduction of the test differs in three possible scenarios, depending on the alternative hypotheses:

-Alternative hypothesis one: Time series is stationary

-Alternative hypothesis two: Time series is driven by a deterministic trend

-Alternative hypothesis three: Time series is driven by a quadratic trend

In order for less restriction in the model equation, a constant α is added to the equation. Thus, the model to be used in conducting the Augmented Dickey-Fuller test is:

$\Delta x_t = \alpha + \mu x_{t-1} + \varepsilon_t$

$$(4.2)$$

If autocorrelation is present in the time series, then the Augmented Dickey-Fuller test model becomes:

$\Delta x_t = \alpha + \mu x_{t-1} + \sum_{i=1}^{k} \psi_i \Delta x_{t-1} + \varepsilon_t$

(4.3)

ε_t error term is a normally and independently distributed time series.

Null hypothesis of the Augmented Dickey-Fuller test is:

$x_t = x_{t-1} + \varepsilon_t$, which leads to the null and alternative hypotheses of:

$H_0 : \mu = 0$ and $H_A = \mu < 0$

Rejection of the null hypothesis for a designated time series leads to the establishment stationarity of the time series on the tested level.

3.2. Spillover Analysis

The Spillover analysis is based on a vector autoregressive approach. To construct the Spillover index, a variance decomposition analysis is conducted on an N-variable VAR. For each time series, the spillover shocks coming from other time series are found and added to each other and finalized.

In order for a simplified start, we take a covariance stationary first order VAR with two variables.

$$x_t = \Phi x_{t-1} + \varepsilon_t$$
(4.4)

$$x_t = (x_{1t}, x_{2t}), \Phi \text{ is a 2x2 matrix}$$
(4.5)

Moving average representation:

$$x_t = \Theta(L)\varepsilon_t \text{ where } \Theta(L) = (I - \Phi L)^{-1}$$
(4.6)

By rearrangement: $x_t = A(L)u_t$

$A(L) = \Theta(L)Q_t^{-1}$, $u_t = Q_t\varepsilon_t$, $E(u_t, u_t') = I$, Q_t^{-1} is the unique lower-triangular Cholesky factor of the covariance matrix of ε_t

One-step ahead forecasting:

$$x_{t+1,t} = \Phi x_t$$
(4.7)

Error vector of forecast:

$$e_{t+1,t} = x_{t+1} - x_{t+1,t} = A_0 u_{t+1} = \begin{bmatrix} a_{0,11} & a_{0,12} \\ a_{0,21} & a_{0,22} \end{bmatrix} \begin{bmatrix} u_{1,t+1} \\ u_{2,t+1} \end{bmatrix}$$
(4.8)

Covariance matrix of error vector:

$$E\left(e_{t+1,t}, e'_{t+1,t}\right) = A_0 A'_0$$

Therefore, variance of the one step ahead errors are $a_{0,11}^2 + a_{0,12}^2$ for x_{1t} and $a_{0,21}^2 + a_{0,22}^2$ for x_{2t}. Concordantly, spillover shocks from one time series to another can be classified such as $a_{0,21}^2$ which denotes the shocks transmitted from x_1 to x_2. Similarly, $a_{0,12}^2$ denotes shocks transmitted from x_2 to x_1. Thus:

$a_{0,ij}^2$ denotes shocks transmitted from time series j to i where $i, j = 1,2, i \neq j$.

Thus, total spillover between two time series is $a_{0,12}^2 + a_{0,21}^2$, and total forecast error is $a_{0,11}^2 + a_{0,12}^2 + a_{0,21}^2 + a_{0,22}^2 = trace(A_0 A'_0)$. The Spillover index is derived from the ratio of these variables and shown as a percentage value.

$$S = \frac{a_{0,12}^2 + a_{0,21}^2}{a_{0,11}^2 + a_{0,12}^2 + a_{0,21}^2 + a_{0,22}^2} * 100$$

$$(4.9)$$

With this basis, generalization of the Spillover index for a N-variable VAR with one-step ahead forecasting is:

$$S = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} a_{0,ij}^2}{trace\left(A_0 A'_0\right)} * 100$$

$$(4.10)$$

For H-step ahead forecasts the generalized Spillover index becomes:

$$S = \frac{\sum_{H=0}^{H-1} \sum_{\substack{i,j=1 \\ i \neq j}}^{N} a_{0,ij}^2}{\sum_{H=0}^{H-1} trace\left(A_0 A'_0\right)} * 100$$

$$(4.11)$$

While proposing a model and equations to construct a Spillover index, Diebold and Yılmaz's 2009 study was enbroadened in their 2012 study, in which the authors took their study further by improving the Spillover analysis in such a way that it includes net directional spillovers between time series. The measurement of net directional and net pairwise spillovers is instrumental in this study in order to delve

into the relationship between economic growth and construction sector in Turkey. The equations that formulate net directional and net pairwise spillovers are:

Total Spillover Index:

The previous equation (4.11) is set as: $S = \dfrac{\sum_{H=0}^{H-1}\sum_{\substack{i,j=1 \\ i \neq j}}^{N} a_{0,ij}^2}{\sum_{H=0}^{H-1} trace(A_0 A_0')} * 100 = \dfrac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} \Theta'^{g}_{ij}(H)}{\sum_{i,j=1}^{N} \Theta'^{g}_{ij}(H)} *$

$100 = \dfrac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} \Theta'^{g}_{ij}(H)}{N} * 100$ where each entry of the variance decomposition matrix is normalized as:

$\Theta'^{g}_{ij}(H) = \dfrac{\Theta^{g}_{ij}(H)}{\sum_{j=1}^{N} \Theta^{g}_{ij}(H)}$

(4.12)

By construction, $\sum_{j=1}^{N} \Theta'^{g}_{ij}(H) = 1$ and $\sum_{i,j=1}^{N} \Theta'^{g}_{ij}(H) = N$

Directional Spillovers:

Directional spillovers received by time series i from all other time series j is measured by:

$S_{i.}{}^{g}(H) = \dfrac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \Theta'^{g}_{ij}(H)}{\sum_{i,j=1}^{N} \Theta'^{g}_{ij}(H)} * 100 = \dfrac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \Theta'^{g}_{ij}(H)}{N} * 100$

(4.13)

Similarly, directional spillovers transmitted by time series i to all other time series j becomes:

$S_{.i}{}^{g}(H) = \dfrac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \Theta'^{g}_{ji}(H)}{\sum_{i,j=1}^{N} \Theta'^{g}_{ji}(H)} * 100 = \dfrac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \Theta'^{g}_{ji}(H)}{N} * 100$

(4.14)

Net Spillovers:

Building upon the two previous equations 4.13 and 4.14, net spillovers from time series i to all other time series j is:

$$S_i{}^g(H) = S_{.i}{}^g(H) - S_{i.}{}^g(H)$$

(4.15)

Net Pairwise Spillovers:

$$S_{ij}^g(H) = \left(\frac{\Theta'^g_{ji}(H)}{N} - \frac{\Theta'^g_{ij}(H)}{N}\right) * 100$$

(4.16)

4. RESULTS AND ANALYSIS

4.1. Augmented Dickey-Fuller Test and Data Stationarity

In order to obtain data stationarity, Augmented Dickey-Fuller test at 95% confidence interval has been implemented on the data set using the Eviews program. P-values less than 0.05 lead to the rejection of the null hypothesis. Results of the test are as follows:

Time series	Level		First Difference	
	t-statistic	p-value	t-statistic	p-value
Construction GDP	-0.385	0.904	-2.276	0.183
GDP	0.053	0.956	-2.911	0.049
CPI	1.761	1	-8.021	0
Real effective exchange rate	-1.449	0.553	-9.741	0
Commercial loan rate	-4.253	0.001	-	-

According to the Augmented Dickey-Fuller test results, the null hypothesis proposing that the time series have unit roots can be rejected on the following levels:

-Construction GDP: Second difference

-Total GDP: First difference

-Consumer Price Index: First difference

-Real Effective Exchange Rate: First difference

-Commercial Loan Rate: Level

This means that the construction GDP time series is stationary at the second difference level, while the total GDP, CPI, and real effective exchange rate time series are stationary at the first difference level and the commercial loan rate time

series is already stationary. Since the data sets should have the same starting and ending dates, the period between the third quarter of 2003 and third quarter of 2019 (due to GDP data availability) is taken as the analysis period. All data series are used at their corresponding stationarity levels.

Using the final data set, Spillover indices for the total time period and two sub-periods (before and after the global financial crisis) are constructed using the Eviews program. Concordantly, the Spillover analysis leads to the following Spillover indices:

4.2. Pre-Great Recession Spillover Analysis

Table 5.2.1.: Before the global crisis (2003Q3-2009Q2)

Spillover (Connectedness) Table

	ConsGDPGDP	GDP	CPI	Loan rates	Real eff. currency	From Others
ConsGDP	68.4	13.1	2.1	8.4	8.0	31.6
GDP	32.9	31.5	3.8	20.0	11.7	68.5
CPI	36.4	7.3	6.9	27.9	21.6	93.1
Loan rates	46.3	7.6	12.3	31.5	2.3	68.5
Real eff. currency	23.2	3.7	2.1	4.4	66.5	33.5
Contribution to others	138.8	31.6	20.4	60.7	43.7	295.2
Contribution including own	207.2	63.2	27.3	92.1	110.2	59.0%

The construction sector is a major transmitter of spillovers to the other parameters. The sector contributes 47% of the total spillovers between the five time series. The sector contributed 68.4% of the spillovers to itself, indicating a spillover contribution of 31.6% from other time series.

GDP's main contributor across the variables was the construction sector, transmitting 32.9% of the spillovers received by GDP. The second highest contributor to the GDP series was GDP itself, with 31.5%.

When net connectedness between the construction sector and GDP is observed, Turkish GDP transmitted 13.1% of the spillovers received by the construction sector, whereas the converse result is 32.9%. This leads to a net directional spillover of 19.8% between the two time series, with construction output being the transmitter.

Real effective exchange rate time series has received the least amount of spillovers from the other time series after the construction sector.

Commercial loan rate is the second greatest transmitter of spillovers after construction output, being a net transmitter to all other series but construction output itself. When the interaction between these two time series are considered, it can be seen that commercial loan rate is the net receiver.

Consumer Price Index contributed the least amount of spillovers to the other time series, while having been affected considerably by all of them except Turkish GDP.

Construction output and GDP are the greatest contributors to each other across all of the time series.

The total connectedness between the data set is 59%, indicating fairly high integration among observed parameters.

Thus, the analysis of the period before the global financial crisis of 2008 infers that the construction sector is a driver of Turkish economic growth, being a net transmitter of spillovers not only to Turkish GDP, but to all of the other variables as well.

4.3. Post-Great Recession Spillover Analysis:

Table 5.3.1.: After the global crisis (2009Q3-2019Q3)

Spillover (Connectedness) Table

	ConsGDP	GDP	CPI	Loan rates	Real eff. currency	From Others
ConsGDP	41.0	46.0	5.2	4.9	2.9	59.0
GDP	13.2	74.2	4.0	5.5	3.2	25.8
CPI	9.4	11.6	44.1	14.4	20.5	55.9
Loan rates	2.6	5.4	32.1	39.7	20.2	60.3
Real eff. currency	1.8	13.4	21.4	26.6	36.8	63.2
Contribution to others	27.0	76.3	62.7	51.4	46.8	264.2
Contribution including own	68.0	150.5	106.8	91.0	83.6	52.8%

Turkish GDP takes over as the greatest spillover transmitter. In the period after the global financial crisis, GDP leads spillover transmission to other variables with %28.9. Moreover, 74.2% of the spillovers GDP received was transmitted by GDP itself, making the spillover contribution from other time series 25.8%.

GDP's biggest contributor across the other time series is the construction sector with 13.2% of the spillovers received by GDP.

Net connectedness between the construction sector and GDP reveals that Turkish GDP transmitted 46% of the spillovers received by the construction sector, while the converse case was 13.2%. Net directional spillover between the two time series is 32.8%, with GDP being the net transmitter.

Spillover effects of Consumer Price Index increase more than threefold, as the spillover shocks transmitted from the CPI time series become apparent on the commercial loan rate and real effective exchange rate.

Least amount of spillover transmission was made by the construction sector, with 10.2%.

Construction sector and GDP remain as the greatest contributors to each other in terms of spillovers.

Total connectedness of the data set is 52.8% in the Post-Great Recession era.

4.4. Comparison of sub-periods:

Comparison of the sub-periods before and after the 2008 financial crisis leads to indicate that the construction sector transforms from being a driver of Turkish economic growth to being affected by it. Net directional spillovers between construction output and GDP show net spillover transmission from construction output to GDP before the Great Recession, while the converse appears to be true after the Great Recession. Moreover, while construction output is the greatest contributor of spillovers among the five time series before the Great Recession (causing 47% of cross-variable spillovers), it is the lowest contributor in the post-Recession era (causing 10.2% cross-variable spillovers). This further strengthens the idea of construction sector becoming a follower of Turkish economic growth rather than a driver, since the sector output's transmission of spillovers to other time series decreases dramatically overall.

Time series pair	Before the Great Recession	After the Great Recession
Construction output-GDP	Construction output is the net transmitter (19.8%)	GDP is the net transmitter (32.8%)

Turkish economic growth appears to be less affected by all other four time series in the post-Recession period, as the sector's spillover contribution from others decreases from 68.5% to 25.8%. The same cannot be said for construction output, as the same metric increases from 31.6% to 59%. Therefore, it can be inferred from

the data that construction sector becomes more vulnerable to external spillover shocks, and economic growth becomes less vulnerable to them.

Among the CPI, real effective exchange rate and the commercial loan rate time series, CPI changes from being a net receiver to a net transmitter. Real effective exchange rate conversely changes from being a net transmitter to a net receiver, and commercial loan rate remains as a net receiver for both sub-periods. When net directional connectedness between them and construction output-GDP series is observed, the following results are reached:

Time series pair	Before the Great Recession	After the Great Recession
Construction output-CPI	Construction output is the net transmitter (34.3%)	Construction output is the net transmitter (4.2%)
Construction output-Real effective exchange rate	Construction output is the net transmitter (15.2%)	Real effective exchange rate is the net transmitter (1.1%)
Construction output-Commercial loan rate	Construction output is the net transmitter (37.9%)	Commercial loan rate is the net transmitter (2.3%)
GDP-CPI	GDP is the net transmitter (3.5%)	GDP is the net transmitter (7.6%)
GDP-Real effective exchange rate	Real effective exchange rate is the net transmitter (8%)	GDP is the net transmitter (10.5%)
GDP-Commercial loan rate	Commercial loan rate is the net transmitter (12.4%)	Neutral (0.1%)

When tables 5.1 and 5.2 are examined, results reveal that while construction output assumes the role of transmitter in the first sub-period, GDP takes over in the second sub-period. Further investigation suggests that construction output provides more spillovers to the other variables in the first sub-period (47% of total spillovers) than GDP does in the second sub-period (28.9% of total spillovers), while the prime net receiver of spillovers provided by GDP is the construction output time series in the second sub-period. These findings, combined with Graph 1.2., which exhibits the quarterly changes in construction output and GDP in Turkey, strengthen the argument of construction industry reaching saturation towards the year 2009, therefore becoming dependent on economic growth rather than being a driver of economic growth.

Similarities exist between the sub-periods as well. Construction output and GDP are the time series that affect each other the most in terms of spillovers in both sub-periods. Spillovers received by construction output from other time series except GDP appear quite limited for both sub-periods, with construction output receiving 18.5% of the total spillovers from CPI, real effective exchange rate and commercial loan rate before the global crisis and 13% of the spillovers from the same time series after the global crisis. The real effective exchange rate and commercial loan rate time series are fairly consistent in terms of their contributions to other time series in both sub-periods, real effective exchange rate contributing 14.80% and 17.71% respectively and commercial loan rate contributing 20.56% and 19.45% respectively.

4.5. Whole period analysis:

Table 5.5.1.: Whole period (2003Q3-2019Q3)

Spillover (Connectedness) Table

	ConsGDP	GDP	CPI	Loan rates	Real eff. currency	From Others
ConsGDP	63.4	20.6	12.6	1.8	1.6	36.6
GDP	19.5	65.9	8.5	1.2	5.0	34.1
CPI	15.5	9.7	51.9	2.7	20.2	48.1
Loan rates	7.1	1.5	46.5	36.1	8.8	63.9
Real eff. currency	8.1	3.7	4.8	18.1	65.3	34.7
Contribution to others	50.1	35.6	72.4	23.8	35.6	217.4
Contribution including own	113.5	101.5	124.3	59.9	100.8	43.5%

Construction output and GDP are the highest spillover contributors to each other, with construction output transmitting 19.5% of the spillovers received by GDP and GDP transmitting 20.6% of the spillovers received by construction output.

Net pairwise spillovers between construction output and GDP almost indicate neutrality, GDP being the net transmitter of spillovers slightly by 1.1%.

Both construction output and GDP are net spillovers transmitters across all variables.

CPI is the highest net contributor of spillovers having contributed 33.30% of the inter-series spillovers.

Commercial loan rate transmits the lowest amount of spillovers to other series with 10.95% of the inter-series spillovers.

Spillover effects from commercial loan rate and real effective exchange rate going towards construction output and GDP are very limited. Total of 3.4% of the spillovers received by construction output and total of 6.2% spillovers received by GDP were provided by these two series.

While CPI is the highest net contributor of spillovers, CPI does not have much spillover effect on construction output and GDP either, with 12.6% and 8.5% of spillovers received by construction output and GDP respectively.

Results of the three spillover indices indicate that construction output and GDP remain the highest contributors to each other across all examined time periods. While the interaction between construction output and GDP remains fairly neutral in terms of spillovers for the whole period, the pre-Great Recession period exhibits construction output as the net spillover transmitter between construction output and GDP while the converse appears to be true for the post-Great Recession period. These findings suggest cyclical behavior of spillovers and thus cyclical behavior of causality between the two variables.

CONCLUSION

Construction sector is a valuable and popular industry in Turkey. The focus on construction industry has been regularly argued in Turkey especially in the last decade, questioning the sustainability of the industry and the role of the industry in its relationship with economic growth in Turkey. This thesis study focuses on shedding light on these questions.

Popularity of the construction sector rises from both profitability and political reasons in Turkey. Due to its nature, construction industry is innately popular in synchronization with political policies, since it is often the most expeditious way to make economic growth apparent in the short term. Having come out of a plethora of economic crises up to the year 2001, Turkey's focus on construction increased rapidly in the aftermath of 2001. The 1999 earthquake in Gölcük also raised high demand for the industry in order to rebuild the shattered Marmara region. Thus, construction industry became more lucrative and popular, for both private and public investments.

As the construction sector kept flourishing in the decade with its share in Turkish GDP increasing, this came to a halt with the global financial crisis of 2008, as Turkish economy was damaged alongside the global financial system. Growth of the construction sector in Turkey stabilized after the crisis. Growth rate of the sector which was two to three times higher than the growth rate of total Turkish economic growth stabilized towards being roughly the same as the GDP growth rate of Turkey in the aftermath of the crisis.

The reasons of this convergence towards similar growth rates for the construction industry and Turkish GDP can mostly be seen natural, since the sector was lagging behind in the aftermath of several economic crises in Turkey which raised funding issues for the sector, as cash liquidity is a very fundamental catalyst for the sector to keep its constructions functioning, especially when private ventures are considered. As Turkey entered a relative period of financial stability at the start of the first decade of the 21st century, both funding and keeping the projects well-

funded were facilitated, as profitability of the sector encouraged investors and businesspeople to focus more on the sector, as the stable Turkish economy of the time expedited their efforts. Public construction efforts have also flourished due to infrastructural improvements and road building, followed by grand projects such as Marmaray, the Eurasia tunnel and Osmangazi Bridge in the following decade. As such, growth of the construction industry caught up to Turkish economic growth rapidly in the period leading to the Great Recession, followed by a stabilization of the construction industry's growth rate towards being roughly equal to Turkish economic growth has led this study to investigate the interaction between the construction industry and Turkish economic growth using a Spillover analysis.

With consideration of the aforementioned phenomena, Spillover analysis of the period between 2003 and 2019 and the two sub-periods yield to the following conclusions:

When the first sub-period is examined, it is revealed that construction output dominates the transmission of spillovers to all of the other time series. Such one-sided domination cannot be observed in the second-time period which is the post-Recession era. While GDP is the greatest provider of spillovers, it is evident that construction output affects other aforementioned variables in the first sub-period more than GDP does in the second sub-period. Coupled with the quarterly growth of the construction industry dropping towards being roughly the same as the growth of Turkish GDP starting from the third quarter of 2009 as seen on Graph 1.2., this suggests that construction industry reaches saturation in the second sub-period, which encompasses the aftermath of the global financial crisis of 2008. Another important note is that such a reversion of the interaction of spillovers between construction output and economic growth suggests cyclical behavior of causality between construction output and economic growth in Turkey, a phenomenon which is to be double-checked and confirmed in the examination of the whole time period between 2003 and 2019.

When the whole period of 2003-2019 is examined while considering the sub-periods, it can be inferred that the spillover causality between the Turkish

construction industry and economic growth is cyclical, as construction output is the net spillover transmitter between construction output and GDP growth in Turkey in the first sub-period, while the converse appears to be true in the second sub-period. In the whole period, the spillovers running between the time series are almost equal (20.6% from GDP to construction output and 19.5% from construction output to GDP). According to the following results, cyclicality between construction output and GDP growth in Turkey can be reached, as bidirectional causality seems to exist between construction output and economic growth in Turkey.

As this study does not differentiate between public and private investments, further studies can be made on this matter in order to compare and account for this distinction and their specific relationship with economic growth and among each other. One other possible further study can delve into the relationship of Turkey's constructional growth and other variables such as gross fixed capital formation.

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APPENDIX

Data sets

Date	Construction GDP	Total GDP	Natural Logarithm Construction GDP	Natural Logarithm GDP
2003-Q1	1126473,42	96288944,70	13,93	18,38
2003-Q2	2115277,71	111329662,39	14,56	18,53
2003-Q3	2330057,69	129995984,40	14,66	18,68
2003-Q4	2088115,75	130400554,89	14,55	18,69
2004-Q1	1445992,89	118274223,96	14,18	18,59
2004-Q2	2813496,67	137567375,75	14,85	18,74
2004-Q3	3141676,89	159874958,76	14,96	18,89
2004-Q4	2814969,14	161306938,83	14,85	18,90
2005-Q1	2307902,60	141042563,35	14,65	18,76
2005-Q2	3168455,11	161871869,54	14,97	18,90
2005-Q3	3805688,97	185021847,57	15,15	19,04
2005-Q4	3639090,05	185766662,29	15,11	19,04
2006-Q1	2559171,86	161135992,52	14,76	18,90
2006-Q2	3858665,45	193081372,66	15,17	19,08
2006-Q3	4610550,55	217039426,46	15,34	19,20
2006-Q4	4324823,86	217970763,48	15,28	19,20
2007-Q1	3335364,15	189593408,03	15,02	19,06
2007-Q2	4412003,44	212565694,63	15,30	19,17
2007-Q3	5130678,61	237359324,52	15,45	19,29
2007-Q4	4580737,46	240942451,97	15,34	19,30
2008-Q1	4047696,28	217948233,82	15,21	19,20
2008-Q2	5353766,61	249483189,18	15,49	19,33
2008-Q3	5647097,52	268726652,43	15,55	19,41
2008-Q4	4939971,15	258624782,99	15,41	19,37
2009-Q1	3621360,99	211255559,34	15,10	19,17
2009-Q2	4381623,11	241220604,55	15,29	19,30
2009-Q3	4823756,71	271840902,50	15,39	19,42
2009-Q4	4655859,46	274874781,66	15,35	19,43
2010-Q1	4487074,38	240272871,66	15,32	19,30
2010-Q2	5502984,83	278647853,11	15,52	19,45
2010-Q3	5811586,62	318732806,05	15,58	19,58
2010-Q4	5670583,24	322360447,43	15,55	19,59
2011-Q1	5617725,08	290610290,52	15,54	19,49
2011-Q2	6727917,90	336234139,95	15,72	19,63
2011-Q3	7243319,94	381898595,37	15,80	19,76
2011-Q4	6861114,90	385734139,69	15,74	19,77
2012-Q1	6269770,31	333164005,46	15,65	19,62

Date				
2012-Q2	7537662,57	382070001,70	15,84	19,76
2012-Q3	8151199,85	424705390,32	15,91	19,87
2012-Q4	8162711,70	429732717,44	15,92	19,88
2013-Q1	7718204,87	385824643,40	15,86	19,77
2013-Q2	8991579,51	441539542,87	16,01	19,91
2013-Q3	9479869,65	491263793,92	16,06	20,01
2013-Q4	9321564,81	491085106,51	16,05	20,01
2014-Q1	9262983,65	451269184,24	16,04	19,93
2014-Q2	10349396,33	487151068,27	16,15	20,00
2014-Q3	10676865,67	548625834,71	16,18	20,12
2014-Q4	10447777,34	557419788,61	16,16	20,14
2015-Q1	10481754,11	497687043,16	16,17	20,03
2015-Q2	11701167,30	562947770,73	16,28	20,15
2015-Q3	12608064,99	631512354,71	16,35	20,26
2015-Q4	12834645,68	646500325,08	16,37	20,29
2016-Q1	14145881,60	563890602,00	16,46	20,15
2016-Q2	15834321,15	631232693,23	16,58	20,26
2016-Q3	15705305,65	666176429,47	16,57	20,32
2016-Q4	15976781,59	747226024,63	16,59	20,43
2017-Q1	15863294,60	649434601,86	16,58	20,29
2017-Q2	17973678,56	735280547,65	16,70	20,42
2017-Q3	18655235,15	833706740,87	16,74	20,54
2017-Q4	19015596,19	892228264,53	16,76	20,61
2018-Q1	19557254,66	790113059,53	16,79	20,49
2018-Q2	21484682,26	890435944,67	16,88	20,61
2018-Q3	21334953,59	1026648922,65	16,88	20,75
2018-Q4	19209665,80	1017190008,72	16,77	20,74
2019-Q1	18828522,03	922029155,99	16,75	20,64
2019-Q2	19992146,43	1023855087,17	16,81	20,75
2019-Q3	19833314,90	1145099354,34	16,80	20,86

Consumer Price Index Data for Turkey:

Date	CPI	Natural Logarithm CPI
2003-Q1	96,37	4,57
2003-Q2	99,75	4,60
2003-Q3	100,49	4,61
2003-Q4	103,39	4,64
2004-Q1	105,51	4,66
2004-Q2	107,15	4,67

2004-Q3	108,61	4,69
2004-Q4	113,13	4,73
2005-Q1	114,60	4,74
2005-Q2	116,38	4,76
2005-Q3	117,20	4,76
2005-Q4	121,75	4,80
2006-Q1	123,86	4,82
2006-Q2	127,56	4,85
2006-Q3	129,89	4,87
2006-Q4	133,71	4,90
2007-Q1	136,64	4,92
2007-Q2	139,68	4,94
2007-Q3	139,17	4,94
2007-Q4	144,63	4,97
2008-Q1	148,68	5,00
2008-Q2	154,12	5,04
2008-Q3	155,38	5,05
2008-Q4	160,44	5,08
2009-Q1	161,12	5,08
2009-Q2	162,90	5,09
2009-Q3	163,67	5,10
2009-Q4	169,60	5,13
2010-Q1	176,09	5,17
2010-Q2	177,92	5,18
2010-Q3	177,39	5,18
2010-Q4	182,20	5,21
2011-Q1	183,74	5,21
2011-Q2	188,40	5,24
2011-Q3	188,69	5,24
2011-Q4	198,95	5,29
2012-Q1	203,02	5,31
2012-Q2	206,14	5,33
2012-Q3	205,76	5,33
2012-Q4	212,42	5,36
2013-Q1	217,65	5,38
2013-Q2	220,52	5,40
2013-Q3	222,85	5,41
2013-Q4	228,30	5,43
2014-Q1	235,09	5,46
2014-Q2	241,25	5,49
2014-Q3	243,44	5,49
2014-Q4	248,30	5,51

2015-Q1	252,64	5,53
2015-Q2	259,92	5,56
2015-Q3	261,21	5,57
2015-Q4	268,57	5,59
2016-Q1	274,36	5,61
2016-Q2	277,92	5,63
2016-Q3	282,20	5,64
2016-Q4	288,89	5,67
2017-Q1	302,38	5,71
2017-Q2	309,87	5,74
2017-Q3	311,99	5,74
2017-Q4	324,33	5,78
2018-Q1	333,47	5,81
2018-Q2	349,52	5,86
2018-Q3	372,64	5,92
2018-Q4	396,88	5,98
2019-Q1	399,86	5,99
2019-Q2	412,26	6,02
2019-Q3	423,04	6,05

Commercial Loan rates data for Turkey:

Date	Commercial Loan rates
2003-Q1	44,61
2003-Q2	44,34
2003-Q3	38,09
2003-Q4	33,25
2004-Q1	29,45
2004-Q2	26,68
2004-Q3	25,81
2004-Q4	24,77
2005-Q1	23,93
2005-Q2	20,74
2005-Q3	19,09
2005-Q4	18,54
2006-Q1	18,22
2006-Q2	16,84
2006-Q3	19,85
2006-Q4	20,22
2007-Q1	19,43
2007-Q2	19,19

2007-Q3	18,45
2007-Q4	17,64
2008-Q1	17,04
2008-Q2	17,65
2008-Q3	18,50
2008-Q4	21,67
2009-Q1	19,87
2009-Q2	14,32
2009-Q3	12,19
2009-Q4	9,98
2010-Q1	8,96
2010-Q2	9,15
2010-Q3	8,91
2010-Q4	8,61
2011-Q1	8,54
2011-Q2	9,64
2011-Q3	11,48
2011-Q4	13,39
2012-Q1	14,74
2012-Q2	14,19
2012-Q3	14,79
2012-Q4	12,23
2013-Q1	11,58
2013-Q2	9,78
2013-Q3	10,97
2013-Q4	11,02
2014-Q1	14,79
2014-Q2	14,23
2014-Q3	12,19
2014-Q4	12,79
2015-Q1	12,77
2015-Q2	13,35
2015-Q3	14,59
2015-Q4	15,67
2016-Q1	16,00
2016-Q2	15,62
2016-Q3	14,78
2016-Q4	14,35
2017-Q1	14,71
2017-Q2	15,85
2017-Q3	16,58
2017-Q4	16,68

Date	
2018-Q1	17,49
2018-Q2	19,50
2018-Q3	28,66
2018-Q4	30,39
2019-Q1	24,18
2019-Q2	26,40
2019-Q3	20,64

Real Effective Exchange Rates Based on CPI:

Date	Real Effective Exchange Rates	Natural Logarithm of Real Effective Exchange Rates
2003-Q1	91,62	4,51765
2003-Q2	103,25	4,637153
2003-Q3	110,27	4,702932
2003-Q4	101,23	4,617395
2004-Q1	111,03	4,7098
2004-Q2	98,68	4,591882
2004-Q3	99,14	4,596533
2004-Q4	102,28	4,627714
2005-Q1	109,74	4,698114
2005-Q2	112,69	4,724641
2005-Q3	113,95	4,73576
2005-Q4	119,46	4,782982
2006-Q1	119,94	4,786992
2006-Q2	99,16	4,596735
2006-Q3	107,58	4,678235
2006-Q4	109,85	4,699116
2007-Q1	113,08	4,728096
2007-Q2	119,55	4,783735
2007-Q3	120,41	4,790903
2007-Q4	127,72	4,84984
2008-Q1	117,73	4,768394
2008-Q2	118,83	4,777694
2008-Q3	124,92	4,827674
2008-Q4	111,15	4,710881
2009-Q1	105,80	4,661551
2009-Q2	110,78	4,707546
2009-Q3	111,96	4,718142

2009-Q4	113,67	4,7333
2010-Q1	118,86	4,777946
2010-Q2	121,60	4,800737
2010-Q3	123,20	4,813809
2010-Q4	120,22	4,789323
2011-Q1	111,68	4,715638
2011-Q2	109,16	4,692815
2011-Q3	99,89	4,60407
2011-Q4	103,56	4,640151
2012-Q1	108,30	4,684905
2012-Q2	110,11	4,70148
2012-Q3	109,74	4,698114
2012-Q4	111,16	4,710971
2013-Q1	112,87	4,726237
2013-Q2	108,10	4,683057
2013-Q3	102,87	4,633466
2013-Q4	101,09	4,616011
2014-Q1	97,43	4,579134
2014-Q2	104,62	4,650335
2014-Q3	103,61	4,640634
2014-Q4	105,86	4,662117
2015-Q1	104,74	4,651481
2015-Q2	99,20	4,597138
2015-Q3	91,95	4,521245
2015-Q4	99,16	4,596735
2016-Q1	102,62	4,631033
2016-Q2	101,88	4,623796
2016-Q3	101,53	4,620354
2016-Q4	93,58	4,538817
2017-Q1	90,87	4,50943
2017-Q2	92,89	4,531416
2017-Q3	91,68	4,518304
2017-Q4	86,33	4,458177
2018-Q1	85,06	4,443357
2018-Q2	78,14	4,358502
2018-Q3	62,50	4,135167
2018-Q4	76,37	4,33559
2019-Q1	75,33	4,321878
2019-Q2	72,32	4,281101
2019-Q3	76,84	4,341725

ADF Test results

-Construction GDP ADF Level Test:

Augmented Dickey-Fuller Unit Root Test on _N_AAT_GSY_H

Null Hypothesis: _N_AAT_GSY_H has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.384783	0.9045
Test critical values:	1% level	-3.548208	
	5% level	-2.912631	
	10% level	-2.594027	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(_N_AAT_GSY_H)
Method: Least Squares
Date: 01/17/20   Time: 17:39
Sample (adjusted): 2005Q2 2019Q3
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_N_AAT_GSY_H(-1)	-0.005228	0.013586	-0.384783	0.7021
D(_N_AAT_GSY_H(-1	-0.042414	0.126768	-0.334582	0.7394
D(_N_AAT_GSY_H(-2	-0.148011	0.123288	-1.200534	0.2358
D(_N_AAT_GSY_H(-3	-0.067660	0.126088	-0.536611	0.5940
D(_N_AAT_GSY_H(-4	0.140245	0.120167	1.167082	0.2489
D(_N_AAT_GSY_H(-5	-0.081292	0.113814	-0.714258	0.4785
D(_N_AAT_GSY_H(-6	-0.102554	0.111921	-0.916312	0.3641
D(_N_AAT_GSY_H(-7	-0.112279	0.109918	-1.021474	0.3122
D(_N_AAT_GSY_H(-8	0.376859	0.108167	3.484034	0.0011
C	0.114780	0.216158	0.531000	0.5979

R-squared	0.831573	Mean dependent var		0.037087
Adjusted R-squared	0.799993	S.D. dependent var		0.137982
S.E. of regression	0.061708	Akaike info criterion		-2.577208
Sum squared resid	0.182780	Schwarz criterion		-2.221959
Log likelihood	84.73903	Hannan-Quinn criter.		-2.438831
F-statistic	26.33223	Durbin-Watson stat		1.690042
Prob(F-statistic)	0.000000			

-Construction GDP ADF First Difference Test:

Augmented Dickey-Fuller Unit Root Test on D(_N_AAT_GSY_H)

Null Hypothesis: D(_N_AAT_GSY_H) has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.276241	0.1830
Test critical values:	1% level	-3.548208	
	5% level	-2.912631	
	10% level	-2.594027	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(_N_AAT_GSY_H,2)
Method: Least Squares
Date: 01/17/20   Time: 17:40
Sample (adjusted): 2005Q2 2019Q3
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(_N_AAT_GSY_H(-1))	-1.039992	0.456890	-2.276241	0.0272
D(_N_AAT_GSY_H(-1),	-0.003361	0.411519	-0.008168	0.9935
D(_N_AAT_GSY_H(-2),	-0.152054	0.375336	-0.405113	0.6872
D(_N_AAT_GSY_H(-3),	-0.220812	0.339335	-0.650721	0.5183
D(_N_AAT_GSY_H(-4),	-0.080024	0.309155	-0.258846	0.7968
D(_N_AAT_GSY_H(-5),	-0.162890	0.243870	-0.667938	0.5073
D(_N_AAT_GSY_H(-6),	-0.266201	0.177162	-1.502587	0.1394
D(_N_AAT_GSY_H(-7),	-0.378215	0.107166	-3.529244	0.0009
C	0.031943	0.019270	1.657654	0.1038

R-squared	0.927619	Mean dependent var	0.003287
Adjusted R-squared	0.915802	S.D. dependent var	0.210807
S.E. of regression	0.061170	Akaike info criterion	-2.608611
Sum squared resid	0.183344	Schwarz criterion	-2.288887
Log likelihood	84.64972	Hannan-Quinn criter.	-2.484072
F-statistic	78.49704	Durbin-Watson stat	1.690532
Prob(F-statistic)	0.000000		

-Total GDP ADF Level Test:

Augmented Dickey-Fuller Unit Root Test on TOTAL_GSY_H

Null Hypothesis: TOTAL_GSY_H has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.053496	0.9595
Test critical values:	1% level	-3.540198	
	5% level	-2.909206	
	10% level	-2.592215	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TOTAL_GSY_H)
Method: Least Squares
Date: 01/17/20   Time: 17:40
Sample (adjusted): 2004Q2 2019Q3
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TOTAL_GSY_H(-1)	0.000398	0.007440	0.053496	0.9575
D(TOTAL_GSY_H(-1))	-0.223873	0.091650	-2.442695	0.0178
D(TOTAL_GSY_H(-2))	-0.244861	0.091279	-2.682566	0.0096
D(TOTAL_GSY_H(-3))	-0.219978	0.090930	-2.419198	0.0188
D(TOTAL_GSY_H(-4))	0.715286	0.090039	7.944152	0.0000
C	0.024496	0.146541	0.167159	0.8678

R-squared	0.907245	Mean dependent var	0.036617
Adjusted R-squared	0.898963	S.D. dependent var	0.106440
S.E. of regression	0.033833	Akaike info criterion	-3.842975
Sum squared resid	0.064103	Schwarz criterion	-3.637124
Log likelihood	125.1322	Hannan-Quinn criter.	-3.762153
F-statistic	109.5480	Durbin-Watson stat	1.835854
Prob(F-statistic)	0.000000		

-Total GDP ADF First Difference Test:

Augmented Dickey-Fuller Unit Root Test on D(TOTAL_GSY_H)

Null Hypothesis: D(TOTAL_GSY_H) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.911095	0.0498
Test critical values:	1% level	-3.540198	
	5% level	-2.909206	
	10% level	-2.592215	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TOTAL_GSY_H,2)
Method: Least Squares
Date: 01/17/20   Time: 17:41
Sample (adjusted): 2004Q2 2019Q3
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TOTAL_GSY_H(-1))	-0.972440	0.334046	-2.911095	0.0051
D(TOTAL_GSY_H(-1),)	-0.251013	0.252170	-0.995413	0.3237
D(TOTAL_GSY_H(-2),)	-0.495593	0.168976	-2.932929	0.0048
D(TOTAL_GSY_H(-3),)	-0.715356	0.089239	-8.016186	0.0000
C	0.032307	0.012337	2.618715	0.0113

R-squared	0.959886	Mean dependent var	0.003379
Adjusted R-squared	0.957071	S.D. dependent var	0.161860
S.E. of regression	0.033536	Akaike info criterion	-3.875182
Sum squared resid	0.064106	Schwarz criterion	-3.703639
Log likelihood	125.1307	Hannan-Quinn criter.	-3.807830
F-statistic	340.9916	Durbin-Watson stat	1.835754
Prob(F-statistic)	0.000000		

-CPI ADF Level Test:

Augmented Dickey-Fuller Unit Root Test on TUFE_CEYREKSEL

Null Hypothesis: TUFE_CEYREKSEL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.761200	0.9997
Test critical values: 1% level	-3.531592	
5% level	-2.905519	
10% level	-2.590262	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TUFE_CEYREKSEL)
Method: Least Squares
Date: 01/27/20   Time: 20:59
Sample (adjusted): 2 68
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TUFE_CEYREKSEL(-	0.007610	0.004321	1.761200	0.0829
C	-0.017394	0.022770	-0.763933	0.4477

R-squared	0.045547	Mean dependent var		0.022589
Adjusted R-squared	0.030863	S.D. dependent var		0.014517
S.E. of regression	0.014291	Akaike info criterion		-5.629014
Sum squared resid	0.013275	Schwarz criterion		-5.563203
Log likelihood	190.5720	Hannan-Quinn criter.		-5.602972
F-statistic	3.101827	Durbin-Watson stat		2.095349
Prob(F-statistic)	0.082908			

-CPI ADF First Difference Test:

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Augmented Dickey-Fuller Unit Root Test on D(TUFE_CEYREKSEL)

Null Hypothesis: D(TUFE_CEYREKSEL) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.020630	0.0000
Test critical values:	1% level	-3.533204	
	5% level	-2.906210	
	10% level	-2.590628	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TUFE_CEYREKSEL,2)
Method: Least Squares
Date: 01/27/20   Time: 21:00
Sample (adjusted): 3 68
Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TUFE_CEYREKSEL(-1	-1.002413	0.124979	-8.020630	0.0000
C	0.022464	0.003332	6.740979	0.0000

R-squared	0.501288	Mean dependent var	-2.84E-06
Adjusted R-squared	0.493495	S.D. dependent var	0.020607
S.E. of regression	0.014666	Akaike info criterion	-5.576760
Sum squared resid	0.013766	Schwarz criterion	-5.510407
Log likelihood	186.0331	Hannan-Quinn criter.	-5.550541
F-statistic	64.33050	Durbin-Watson stat	1.946823
Prob(F-statistic)	0.000000		

-Real Effective Exchange Rate ADF Level Test:

Augmented Dickey-Fuller Unit Root Test on LN_REEL_EFEKTIF_DOVIZ_KURU

Null Hypothesis: LN_REEL_EFEKTIF_DOVIZ_KURU has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.448691	0.5533
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_REEL_EFEKTIF_DOVIZ_KURU)
Method: Least Squares
Date: 01/27/20   Time: 20:56
Sample (adjusted): 2 68
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_REEL_EFEKTIF_DOVIZ_KURU(-	-0.084371	0.058240	-1.448691	0.1522
C	0.388370	0.270109	1.437826	0.1553

R-squared	0.031278	Mean dependent var	-0.002756
Adjusted R-squared	0.016374	S.D. dependent var	0.067274
S.E. of regression	0.066721	Akaike info criterion	-2.547209
Sum squared resid	0.289357	Schwarz criterion	-2.481397
Log likelihood	87.33150	Hannan-Quinn criter.	-2.521167
F-statistic	2.098705	Durbin-Watson stat	2.164829
Prob(F-statistic)	0.152231		

-Real Effective Exchange Rate ADF First Difference Test:

Augmented Dickey-Fuller Unit Root Test on D(LN_REEL_EFEKTIF_DOVIZ_KURU)

Null Hypothesis: D(LN_REEL_EFEKTIF_DOVIZ_KURU) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.741498	0.0000
Test critical values:	1% level	-3.533204	
	5% level	-2.906210	
	10% level	-2.590628	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_REEL_EFEKTIF_DOVIZ_KURU,2)
Method: Least Squares
Date: 01/27/20   Time: 20:57
Sample (adjusted): 3 68
Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_REEL_EFEKTIF_DOVIZ_KURU(-	-1.168542	0.119955	-9.741498	0.0000
C	-0.005058	0.008076	-0.626342	0.5333

R-squared	0.597223	Mean dependent var	-0.001943
Adjusted R-squared	0.590929	S.D. dependent var	0.102497
S.E. of regression	0.065556	Akaike info criterion	-2.582005
Sum squared resid	0.275042	Schwarz criterion	-2.515652
Log likelihood	87.20616	Hannan-Quinn criter.	-2.555786
F-statistic	94.89678	Durbin-Watson stat	2.102334
Prob(F-statistic)	0.000000		

-Commercial Loan Rate ADF Level Test:

Augmented Dickey-Fuller Unit Root Test on TICARI_KREDI

Null Hypothesis: TICARI_KREDI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.253229	0.0011
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TICARI_KREDI)
Method: Least Squares
Date: 01/18/20   Time: 01:05
Sample (adjusted): 2003Q3 2020Q1
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TICARI_KREDI(-1)	-0.158515	0.037269	-4.253229	0.0001
D(TICARI_KREDI(-1))	0.281841	0.105061	2.682649	0.0093
C	2.443772	0.701277	3.484745	0.0009

R-squared	0.309527	Mean dependent var	-0.475631
Adjusted R-squared	0.287950	S.D. dependent var	2.498012
S.E. of regression	2.107899	Akaike info criterion	4.373003
Sum squared resid	284.3673	Schwarz criterion	4.471721
Log likelihood	-143.4956	Hannan-Quinn criter.	4.412066
F-statistic	14.34505	Durbin-Watson stat	1.934341
Prob(F-statistic)	0.000007		

Final data set

Tarih	Construction GDP	Total GDP	CPI	Real Effective Exchange Rate	Commercial Loan Rate
2003-Q3	-0,53	0,16	0,01	0,07	38,09
2003-Q4	-0,21	0	0,03	-0,09	33,25
2004-Q1	-0,26	-0,1	0,02	0,09	29,45
2004-Q2	1,03	0,15	0,02	-0,12	26,68
2004-Q3	-0,56	0,15	0,01	0,00	25,81
2004-Q4	-0,22	0,01	0,04	0,03	24,77
2005-Q1	-0,09	-0,13	0,01	0,07	23,93
2005-Q2	0,52	0,14	0,02	0,03	20,74
2005-Q3	-0,13	0,13	0,01	0,01	19,09
2005-Q4	-0,23	0	0,04	0,05	18,54
2006-Q1	-0,31	-0,14	0,02	0,00	18,22
2006-Q2	0,76	0,18	0,03	-0,19	16,84
2006-Q3	-0,23	0,12	0,02	0,08	19,85
2006-Q4	-0,24	0	0,03	0,02	20,22
2007-Q1	-0,2	-0,14	0,02	0,03	19,43
2007-Q2	0,54	0,11	0,02	0,06	19,19
2007-Q3	-0,13	0,11	0,00	0,01	18,45
2007-Q4	-0,26	0,01	0,04	0,06	17,64
2008-Q1	-0,01	-0,1	0,03	-0,08	17,04
2008-Q2	0,4	0,14	0,04	0,01	17,65
2008-Q3	-0,23	0,07	0,01	0,05	18,50
2008-Q4	-0,19	-0,04	0,03	-0,12	21,67
2009-Q1	-0,18	-0,2	0,00	-0,05	19,87
2009-Q2	0,5	0,13	0,01	0,05	14,32
2009-Q3	-0,09	0,12	0,00	0,01	12,19
2009-Q4	-0,13	0,01	0,04	0,02	9,98
2010-Q1	0	-0,13	0,04	0,04	8,96
2010-Q2	0,24	0,15	0,01	0,02	9,15
2010-Q3	-0,15	0,13	0,00	0,01	8,91
2010-Q4	-0,08	0,01	0,03	-0,02	8,61
2011-Q1	0,02	-0,1	0,01	-0,07	8,54
2011-Q2	0,19	0,15	0,03	-0,02	9,64
2011-Q3	-0,11	0,13	0,00	-0,09	11,48
2011-Q4	-0,13	0,01	0,05	0,04	13,39
2012-Q1	-0,04	-0,15	0,02	0,04	14,74
2012-Q2	0,27	0,14	0,02	0,02	14,19
2012-Q3	-0,11	0,11	0,00	0,00	14,79

2012-Q4	-0,08	0,01	0,03	0,01	12,23
2013-Q1	-0,06	-0,11	0,02	0,02	11,58
2013-Q2	0,21	0,13	0,01	-0,04	9,78
2013-Q3	-0,1	0,11	0,01	-0,05	10,97
2013-Q4	-0,07	0	0,02	-0,02	11,02
2014-Q1	0,01	-0,08	0,03	-0,04	14,79
2014-Q2	0,12	0,08	0,03	0,07	14,23
2014-Q3	-0,08	0,12	0,01	-0,01	12,19
2014-Q4	-0,05	0,02	0,02	0,02	12,79
2015-Q1	0,02	-0,11	0,02	-0,01	12,77
2015-Q2	0,11	0,12	0,03	-0,05	13,35
2015-Q3	-0,04	0,11	0,00	-0,08	14,59
2015-Q4	-0,06	0,02	0,03	0,08	15,67
2016-Q1	0,08	-0,14	0,02	0,03	16,00
2016-Q2	0,02	0,11	0,01	-0,01	15,62
2016-Q3	-0,12	0,05	0,02	0,00	14,78
2016-Q4	0,03	0,11	0,02	-0,08	14,35
2017-Q1	-0,02	-0,14	0,05	-0,03	14,71
2017-Q2	0,13	0,12	0,02	0,02	15,85
2017-Q3	-0,09	0,13	0,01	-0,01	16,58
2017-Q4	-0,02	0,07	0,04	-0,06	16,68
2018-Q1	0,01	-0,12	0,03	-0,01	17,49
2018-Q2	0,07	0,12	0,05	-0,08	19,50
2018-Q3	-0,1	0,14	0,06	-0,22	28,66
2018-Q4	-0,1	-0,01	0,06	0,20	30,39
2019-Q1	0,08	-0,1	0,01	-0,01	24,18
2019-Q2	0,08	0,1	0,03	-0,04	26,40
2019-Q3	-0,07	0,11	0,03	0,06	20,64