**ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY**

# SPILLOVERS BETWEEN TURKISH HOUSE PRICING, STOCK EXCHANGES, GOLD, CDS AND EXCHANGE RATE

**M.Sc. THESIS**

**Eser ŞENTÜRK**

**Department of Real Estate Development**

**Real Estate Development Programme**

**June 2019**

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**Thesis Advisor: Prof. Dr. Bülent GÜLOĞLU**

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**ISTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ**

# TÜRKİYE KONUT FİYATLARI, HİSSE ENDEKSLERİ, ALTIN, CDS VE DÖVİZ KURU ARASINDAKİ YAYILIMLAR

**YÜKSEK LİSANS TEZİ**

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**Haziran 2019**

Eser ŞENTÜRK a M.Sc. student of ITU Graduate School of Science Engineering and Technology student ID 516131005, successfully defended the thesis entitled "SPILLOVERS BETWEEN TURKISH HOUSE PRICING, STOCK EXCHANGES, GOLD, CDS AND EXCHANGE RATE", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

| | | |
|---|---|---|
| **Thesis Advisor :** | **Prof. Dr. Bülent GÜLOĞLU**<br>Istanbul Technical University | ..... |
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**Date of Submission : 3 May 2019**
**Date of Defense : 10 July 2019**

***To my advisor,***

**FOREWORD**

This research originally come from my passion for developing better understanding about economics and econometrics. As the world economy moves further into the digital and global age, there will be a greater need to understand for developments.
In truth, I could not have achieved my level of success without a strong support group. First of all, my parents, who supported me with love and understanding. And secondly, my advisor Prof. Dr. Bülent GÜLOĞLU, who has provided patient advice and guidance throughout the research process. Thank you all for your unwavering support.

May 2019

Eser ŞENTÜRK
Civil Engineer

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## ABBREVIATIONS

| | |
|---|---|
| **AIC** | **:** Akaike Information Criteria |
| **BIST100** | **:** Borsa İstanbul 100 |
| **CBRT** | **:** Central Bank of the Republic of Turkey |
| **CDS** | **:** Credit Default Swaps |
| **GARCH** | **:** Generalized Autoregressive Conditional Heteroskedasticity |
| **MGARCH** | **:** Multivariate Generalized Autoregressive Conditional Heteroskedasticity |
| **REIDIN** | **:** Real Estate Investment & Development Information Network |
| **SP500** | **:** Standard & Poor's 500 |
| **VAR** | **:** Vector Auto Regression |

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## SPILLOVERS BETWEEN TURKISH HOUSE PRICING, STOCK EXCHANGES, GOLD, CDS AND EXCHANGE RATE


### SUMMARY

The bursting of the U.S. housing bubble triggered the 2007-2008 global financial crisis that make global investors to look for new economic markets particularly developing countries such as Turkey. With the contribution of highly young population, housing prices in Turkey went up during this period.

The relations were explored among housing price spillovers, stock prices, exchange rates, gold prices and credit default swaps in Turkey in this thesis.

Understanding the impact and the transmission of these historical data of financial instruments in Turkey has high importance for policy makers, companies and investors for several reasons.

Firstly, they must decide what will be done in the future both policy making and investing topics. They must allow for the relations between variables in economic markets.

Secondly, they must predict the future level of economy by examining these relationships. For this reason, a VAR approach is used to find out the relationships among house prices, exchange rates, gold prices, stock exchange rates, credit default swaps effects each other.

It is important to comprehend the relation dynamics, financial instrument and financial markets for decision makers under the globalized financial market actions, because of the developing dependence and contagion. Particularly, house prices in a country have great effects on the other financial instruments and markets across the country.

There is a large experimental literature on house prices and econometric ways such as vector autoregressions (VAR), Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models or spillover index etc. across financial markets and financial indicators. However, the literature on housing price spillovers and its relation with, stock prices, exchange rates and credit default swaps in Turkey hardly ever exists. Therefore, first of all shortly the literature of the techniques for housing price spillovers were reviewed, and then the literature of the VAR and GARCH models were reviewed by concentrating on the different markets in different countries.

The techniques used for modelling house price spillovers are developed and varied speedily. Felipe and Diranzo (2005) stated that six main methodologies, -cross-correlations, VAR models, Cointegration models, GARCH models, Regime Switching models and Stochastic Volatility models- have been used to assess links between financial markets. For this reason, it is very crucial to model not only averages of the variables but also the variance of the variables in both the short and the long term.

To model interaction between house prices and other financial indicators, Engle (1982) leaded with his paper by establishing Autoregressive conditional heteroscedasticity (ARCH) models.

Studies primarily target on the financial indicators and some economic indicators that can response each other. Author(s) examined different country(ies), region(s) different

periods and relatively varying methodology to understand relations. For this reason the results change among the studies.

An accepted point for the studies, each methodology has own unique asset in its exact area.

In this thesis, there were two goals. Specifically, it was examined how some financial instruments affect each other and it was aimed to uncover the relations between them. To that end, unit root tests were applied in order to check stationary and VAR model was estimated. After this process, Diebold – Yilmaz spillover index was calculated.

Firstly, data from the Central Bank of the Republic of Turkey was looked in this thesis. There were only 96 data points about house price index in CBRT document. This quantity of data was enough to conduct VAR approach but in order reach more robust results, it was necessary to access more available data. Therefore, to access more data a communication was carried out with Reidin company.

Reidin composite Turkey data index contains 189 monthly data points from January 2003 to September 2018. The data of other financial instruments in this thesis were converted from daily data to monthly data.

First the unit roots of six time series were examined in order to establish VAR Model in EViews software. It is well known that in VAR Model time series should be stationary time series. If there is an obvious trend in time series, it can be predicted that they are non-stationary time series. If they are non-stationary time series, they should be made stationary by calculating difference value between each value. In the model time series in level are non-stationary but return series are stationary. The unit root test results show that all series in return except house price index are stationary. House price index return graph has a fast plummeting and going up movements in short period in 2008 and these effects may come from the mortgage crise in the United States. In order to be sure about the stationary level of house price index the Perron unit root test (1989) was carried out for house price index return. The results of Perron test revealed that house price index return is stationary when a structural break is taken into account.

Then a VAR model with 6 lags was estimated after selecting optimal lag according to LR selection criteria. The stability of the VAR model was examined by calculating Ar Roots. It was easily understood that the VAR model is stable as no root lies outside the unit circle. It is noted that the VAR model with 6 lags satisfies the assumption of no serial correlation among residuals.

Since the VAR model passes the all diagnostic tests, impulse response function and Variance Decomposition of VAR model was estimated.

Results suggest that according to VAR Model, 2.43% of the house price index return variable can be explained by BIST100 return variable, 8.66% of it can be explained by gold return, 4.76% of it can be explained by USD/TRY return, 0.16% of it can be explained by SP500 and 1.50% of it can be explained by credit default swaps return after 10 period. Therefore; gold return is the most important variable for house price index return when it is compared with the BIST100 return, SP500 return, USD/TRY return and CDS return.

Diebold-Yilmaz index of spillover base on the forecast error variance decomposition method of VAR model is calculated. For calculation the number of forecast horizon was chosen as “1” and the number of rolling windows were chosen as “12”.

According to the results of the Diebold – Yilmaz spillover index, innovations to BIST100 return are responsible for 0.5%, SP500 return are 0.7% of the error variance in forecasting one month ahead house price index return. It was easily seen that other financial instruments have deeper relationships with each other when it was compared with house price index return because they affect each other very much. It was found that 32.2% of forecast error variance comes from spillover index table refining all of the various financial instrument spillovers. Hence spillovers are crucial for these financial instruments but house prices in Turkey move more separately.

# TÜRKİYE KONUT FİYATLARI, HİSSE ENDEKSLERİ, ALTIN, CDS VE DÖVİZ KURU ARASINDAKİ YAYILIMLAR

## ÖZET

Amerika Birleşik Devletlerinde konut balonunun patlaması, küresel yatırımcıların Türkiye gibi yeni ekonomik pazarlar aramasına sebep olan 2007 – 2008 küresel finansal krizini tetikledi. Bu periyotta kalabalık genç nüfusun katkısıyla ev fiyatları Türkiyede arttı.

Bu tezde Türkiyedeki konut fiyat dağılımlarının, hisse fiyatları, döviz kurları ve kredi temerrüt takası primleri ve altın fiyatları arasındaki ilişkileri araştırıldı.

Türkiyedeki finansal enstrümanların bu tarihi verilerin yayılımını ve etkisini anlamak; çeşitli sebeplerden dolayı politika yapıcıları, şirketler ve yatırımcılar için yüksek öneme sahiptir.

İlk olarak politika yapıcılar, şirketler ve yatırımcılar politika yapımı ve yatırım konularında neler yapılacağını hesaba almak zorundadırlar. Politika yapıcılar, şirketler ve yatırımcılar ekonomik piyasalardaki değişkenler arasındaki ilişkileri bilmek zorundadırlar.

İkinci olarak, politika yapıcılar, şirketler ve yatırımcılar bu ilişkileri inceleyerek ekonominin geleceğini tahmin etmek zorundadırlar. Bu nedenle; konut fiyatlarının, döviz kurlarının, altın fiyatlarının, borsa endekslerinin ve kredi temerrüt takasının birbirlerini nasıl etkilediğini bulabilmek için bir VAR yaklaşımı kullanılır.

Gelişen bağımlılık ve yayılmadan dolayı, küreselleşmiş finansal piyasa hareketleri altındaki ilişki dinamiklerini, finansal enstrümanları ve finansal piyasaları kavramak karar vericiler için önemlidir. Özellikle, bir ülkedeki ev fiyatları o ülkedeki diğer finansal enstrümanlar ve piyasalar üzerinde büyük etkiye sahiptir.

Konut fiyatları üzerine geniş deneysel literatür ve finansal piyasalar ve finansal göstergeler arasında; vektör otoregresyon (VAR), genelleştirilmiş otoregresif koşullu değişen varyans modelleri (GARCH) veya yayılma endeksleri vb. ekonometrik yollar bulunmaktadır. Ama Türkiyede konut fiyat yayılımları ve onunla ilgili olan hisse fiyatları, döviz kurları ve kredi temerrüt takası hakkında literatür neredeyse hiç bulunmamaktadır. Bu nedenle ilk olarak konut fiyat yayılımları hakkında literatür incelendi ve sonra farklı piyasalara ve farklı ülkelere konsantre olunarak VAR ve GARCH modelleri incelendi.

Konut fiyat yayılımlarını modellemek için kullanılan teknikler hızlıca gelişti ve çeşitlendi. Felipe ve Diranzo (2005) finansal piyasalar arasındaki bağıntıları değerlendirmek için kullanılan altı ana metodolojiyi belirtti; çapraz korelasyonlar, VAR modeller, eşbütünleşme modelleri, GARCH modelleri, rejim değişim modelleri ve stokastik volatilite modelleri. Bu sebeple, kısa ve uzun dönemde sadece değişkenlerin ortalamalarını modellemek değil aynı zamanda değişkenlerin varyanslarınıda modellemek çok önemlidir.

Konut fiyatları ve diğer finansal göstergeler arasındaki etkileşimi modellemek için Engle (1982) Otoregresif koşullu değişen varyans modelleri kurarak makalesiyle liderlik etmiştir.

Finansal göstergeleri ve ekonomik göstergeleri öncelikle hedefleyen çalışmalar birbirlerine tepki verebilir. İlişkileri anlamak için yazarlar farklı ülkeleri, bölgeleri, periyotları ve nispeten çeşitli metodolojileri incelediler. Bu sebeple çalışmaların sonuçları değişir.

Çalışmalar için kabul edilen bir nokta olarak her bir metodolojinin kendi alanında benzersiz bir varlığı vardır.
Bu tezde, iki hedef vardı. Spesifik olarak, bazı finansal enstrümanların birbirlerini nasıl etkilediği incelendi ve birbirleri arasındaki ilişkilerin açığa çıkarılması amaçlandı. Bu amaçla durağanlıkları test edebilmek için birim kök testleri uygulandı ve VAR modeli tahmin edildi. Daha sonra, Diebold – Yılmaz yayılma indeksi hesaplandı.
İlk olarak, Türkiye Cumhuriyet Merkez Bankası verilerine bakıldı. Bu çalışmayı yaparken TCMB dosyalarında konut fiyat endeksleriyle ilgili sadece 96 adet aylık veri vardı. Bu miktardaki veri VAR yaklaşımını yürütmek için yeterliydi ama daha sağlam sonuçlara ulaşmak için daha fazla veri bulmak gerekliydi. Bu sebeple daha fazla veri için Reidin şirketi ile iletişime geçildi.
Reidin kompozit Türkiye endeksi Ocak 2003 ten Eylül 2018 tarihine kadar 189 aylık veri içermektedir. Bu tezdeki diğer finansal enstrümanlardaki datalar günlük datadan aylık dataya çevirilmiştir.
Eviews yazılımında VAR modelini kurabilmek için altı zaman serisinin birim kökleri incelendi. Çok iyi bilinir ki VAR model zaman serileri durağan zaman seriler olmalıdır. Eğer zaman serisinde açık bir trend var ise, o zaman serisinin durağan olmayan zaman serisi olduğu kolayca tahmin edilebilir. Eğer bu seriler durağan olmayan zaman serileri iseler, seriler durağan hale getirilmelidir. Modelde orijinal fiyat serileri durağan olmayan iken getiri serileri durağandır.
Birim kök test sonuçları konut fiyat endeksi dışındaki tüm getirilerin durağan olduğunu gösterir. Konut fiyat endeks getiri grafiği 2008 yılında kısa bir periyotta hızlıca düşen ve sonra hızlıca artan hareketlere sahiptir ve bu etkiler ABD deki mortgage krizinden kaynaklı olabilir. Konut fiyat endeks getiri zaman serisine Perron birim kök testi (1989) uygulandı. Perron testinin sonuçları; yapısal kırılma dikkate alındığında konut fiyat endeks getiri zaman serisinin durağan olduğunu gösterdi.
Sonra "6" gecikme değeriyle birlikte VAR modeli hesaplandı. LR seçme kriterine göre optimal gecikme değeri seçilmesinden sonra VAR modelinin tutarlılığı Ar kökleri hesaplanarak incelendi. Hiçbir kökün birim çemberin dışında bulunmamasıyla VAR modelinin istikrarlı olduğu anlaşıldı. VAR modeli "6" gecikme değeriyle seri korelasyon olmadığı varsayımına uyduğu not edildi.
VAR modelinin tüm teşhis testlerini geçmesinden dolayı, VAR modelin etki tepki fonksiyonu ve varyansa ayrıştırması hesaplandı.
VAR modeline göre sonuçlar gösteriyor ki, 10 periyot sonra konut fiyat endeks getirisinin % 2,43 ü BIST100 getiri değişkeni, % 8,66 sı altın getiri değişkeni, % 4,76 sı USD/TRY döviz kuru getirisi, % 0,16 sı SP500 getirisi, %1,50 u kredi iflas takası primi tarafından açıklanabiliyor. Bu sebeple, altının BIST100, SP500, USD/TRY ve kredi iflas takası primi ile karşılaştırıldığında Türkiyede uzun vadede konut fiyat endeksi için en etkili değişkendir.
VAR modelinin metodu olan tahminsel hata varyansı ayrıştırmasına dayanan Diebold – Yılmaz yayılma endeksi hesaplandı. Hesaplama için tahmin katmanı "1" olarak, periyodik ilerleyen pencere değeri olarak ta "12" seçildi.
Diebold – Yılmaz dağılma endeksinin sonuçlarına göre; bir ay sonraki konut fiyat endeksi getirisinin tahminindeki hata varyansının BIST100 getirisi %0,5 inden, SP500 getirisi ise %0,7 inden sorumludur. Konut fiyat endeksi getirisiyle karşılaştırdığımzda diğer finansal enstrümanların birbirleriyle daha derin ilişkileri olduğu kolayca anlaşılıyor, çünkü birbirlerini daha çok etkiliyorlar.
Tahmin hata varyansının %32,2 sinin çeşitli finansal enstrümanların yayılımlarından rafine edilerek oluşturulan yayılım tablosundan geldiği bulundu. Bu nedenle

dağılmalar bu finansal enstrümanlar için çok önemlidir ama Türkiyedeki konut fiyatları daha ayrı bir şekilde hareket etmektedir.

# 1. INTRODUCTION

The bursting of the U.S. housing bubble triggered the 2007-2008 global financial crisis that make global investors to look for new economic markets particularly developing countries such as Turkey. With the contribution of highly young population, housing prices in Turkey went up during this period. In this thesis the relations among housing price spillovers, stock prices, exchange rates, and credit default swaps in Turkey were explored.

Understanding the impact and the transmission of these historical data of financial instruments in Turkey has high importance for policy makers, companies and investors for several reasons. Firstly, they must decide what will be done in the future both policy making and investing topics. Policy makers, companies and investors must know the relations between variables in economic markets. Secondly, policy makers, companies and investors must predict the future of economy by examining these variables. For this reason, VAR approach is applied to find how housing prices, exchange rates, stock prices, gold and credit default swaps interact.

Firstly, the data from the Central Bank of the Republic of Turkey were examined. During the preparation of this thesis, there were only 96 monthly data points in CBRT document. These data come from valuation reports of houses. This quantity of data was enough to conduct VAR approach but in order reach more robust results, it was needed to access more available data. Therefore, to access more data a communication was carried out with Reidin company. Reidin composite Turkey data index contains 189 monthly data points from January 2003 to September 2018. These data come from asking price of houses in web researches.

In this thesis, there are two goals. Specifically, it is examined how these financial variables affect each other and it is aimed to uncover the relations between them. To that end, unit root tests are applied firstly in order to check stationary and as a second VAR model is estimated. After this process, Diebold – Yilmaz spillover index is calculated.

Results suggest that according to variance decompositions of VAR Model, 8.66% of the house price index return variable can be explained by gold return variable after 10 period. Therefore, it can be said that gold is most effective variable for house price index in the long run in Turkey when it compared with other financial instruments. According to the results of the Diebold – Yilmaz spillover index, innovations to BIST100 return are responsible for 0.5%, SP500 return are 0.7% of the error variance in forecasting one month ahead house price index return. It is seen that other financial instruments have deeper relationships with each other when they are compared with house price index return because they affect each other very much. It is found that 32.2% of forecast error variance comes from spillovers. Hence spillovers are crucial for these financial variables but house prices in Turkey behave more separately.

The thesis is organized as follows: after the introduction, section 2 reviews the related literature. The model and data are presented in Section 3, before the concluding remarks in Section 4.

## 2. LITERATURE REVIEW

It is important to comprehend the relation dynamics, financial instrument and financial markets for decision makers under the globalized financial market actions, because of the developing dependence and contagion. Particularly, house prices in a country have great effects on the other financial instruments and markets across the country. There is a large literature on house prices and econometric ways such as vector autoregressions (VAR), Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models or spillover index etc. across financial markets and financial indicators. However, to the best of the knowledge, the literature on estimating the interactions among housing price spillovers, stock prices, exchange rates and credit default swaps in Turkey hardly ever exists. The literature of the techniques for housing price spillovers and VAR and GARCH models are reviewed by concentrating on the different markets in different countries.

The techniques used for modelling house price spillovers developed and varied rapidly. Felipe and Diranzo (2005) stated that six main methodologies, -cross-correlations, VAR models, Cointegration models, GARCH models, Regime Switching models and Stochastic Volatility models- have been used to assess links between financial markets. For this reason, it is very crucial to model not only averages of the variables but also the variance of the variables in both the short and the long term. To model interaction between house prices and other financial indicators, Engle (1982) leaded with his paper by establishing Autoregressive conditional heteroscedasticity (ARCH) models. Bollerslev (1986) broadened the ARCH models into Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models by allowing the conditional variance to be an ARMA process in ARCH models. Bollerslev, Engle and Wooldridge (1988) clarified the diagonal VECH multivariate generalized autoregressive conditional heteroskedasticity (DVECH MGARCH) models, the familiar half-vec (vech) form (see Engle and Sheppard, 2001), which points to use for assessing the volatility spillover across the financial markets. The literature studied the

connectedness across the financial indicators and markets covering country-specific, regional and global level mainly targets on the volatility spillovers among the asset prices, stock market returns, commodity prices, exchange rates, and bond returns in the spot and future markets resulted from economic crises, monetary shocks, the news effects, increasing risks and investor preferences and economic fundamentals by evaluating different spillover way in the light of the theories of international economics and finance and by using different techniques.

Table 2.1 illusrates chosen empirical applications using GARCH, VAR, Spillover Index techniques for figuring out spillovers and creating models. Studies primarily target on the financial indicators and some economic indicators that can response each other. Author(s) examined different country(ies), region(s) different periods and relatively varying methodology to understand relations. For this reason the results change among the studies. An accepted point for the studies, each methodology has own unique asset in its exact area.

**Table 2.1 :** Empirical Literature on the Price Spillovers, Vector Autoregressions and House Prices.

| Author(s) | Year | Method | Data | Variables | Findings |
|---|---|---|---|---|---|
| Diebold and Yilmaz | 2009 | Spillover Index | 1992 – 2007, Daily | Local currency stock market indexes | Striking evidence of divergent behaviour in the dynamics of return spillovers vs. volatility spillovers: return spillovers display a gently increasing trend but no bursts, whereas volatility spillovers display no trend but clear bursts. |
| Diebold and Yilmaz | 2012 | VAR model, Spillover Index | 1999 – 2010, Daily | US stock, bond, foreign exchange and commodities | Despite volatility fluctuations, cross-market volatility spillovers were quite limited until the global financial crisis, which began in 2007. As the crisis intensified, so too did the volatility spillovers, with particularly important spillovers from the stock market to other markets taking place after the collapse of the Lehman Brothers in September 2008. |
| Bai et al | 2013 | OLS estimation, HCW (2012) | 1998-2012 Monthly | House prices of 31 cities in China | Showing discriminative taxation based on property types can drive up home prices instead, possibly by causing a spillover effect from high-end to low-end properties. |

**Table 2.1 (continued) :** Empirical Literature on the Price Spillovers, Vector Autoregressions and House Prices.

| Author(s) | Year | Method | Data | Variables | Findings |
|---|---|---|---|---|---|
| Coulson and Tang | 2013 | Regression Model | 2011 | An Extended Survey among4338 Homeowners in China | Urban and rural residency status of people plays a significant role in housing market. |
| Mensi et al | 2014 | VAR, BEKK – DCC, GARCH, | 2000-2013 Daily | Brent oil, WTI, gasoline, New York Harbor No.2 heating oil | The cut decisions of OPEC have a much larger effect on both types of commodity markets than the decisions to increase and to maintain the current production |
| Antonakakis et al | 2014 | VAR model, Spillover Index | 1997-2013 Monthly | Economic Policy Uncertainty Indices for different countries | For almost all countries, economic policy uncertainty is net transmitter throughout the period up until the end of the Great Recession of 2007-2009. In the post 2009 period economic policy uncertainty assumes a net receiving role. |
| Jouini and Harrathi. | 2014 | MGARCH-BEKK | 2005 – 2011, Daily | GCC Stock Markets and oil markets | Evidence of shock and volatility linkages among GCC stock and oil markets |
| Kumar. | 2014 | VAR-ADCC-BVGARCH | 2004-2012 Daily | Gold and Indian industrial sectors | Unidirectional significant return spillover from gold to stock sectors. Stock-gold portfolio provides better diversification benefits than stock portfolios. |
| Chan et al | 2015 | DAG, SVAR | 2005, 2007, 2010 Input – Output Tables | Data from construction sector and different sectors in China | Shocks to the property market could have much larger impact on the Chinese economy than suggested by headline figures. |
| Arouri et al. | 2015 | VAR– GARCH | 2004 – 2011, Daily | World Gold Prices And Stock Market For China | Significant volatility transmission between the Chinese stock market and the world gold market. |
| Alotaibi and Mishra. | 2015 | EGARCH, CCC, DCC, BEKK | 2005-2013 | MSCI Stock Market Indices For GCC Countries | Significant return spillover effects from Saudi Arabia and US to GCC markets. |
| Wu and Deng | 2015 | Granger Causality Test | 2006-2011 | Google Searches about house prices in China | A bubble in Beijing may generate misleading signals to market participants in other cities and quickly spread around the country |
| Gong et al | 2016 | Augmented Dicky Fuller Test, Granger Causality Test, | 2005-2015 Monthly | Price Indices of Newly Constructed Residential Buildings from 70 cities in China | Housing price change of a city can be influenced by its own lagged price changes, the spillovers from neighbouring cities, or the long-run forces from the cointegrated counterparts. |

**Table 2.1 (continued) :** Empirical Literature on the Price Spillovers, Vector Autoregressions and House Prices.

| Author(s) | Year | Method | Data | Variables | Findings |
|---|---|---|---|---|---|
| Korobilis | 2016 | Monte Carlo simulations, PVAR | 1999-2012, Monthly | 10 year bond yields, total industrial production, for some European countries | Monte Carlo simulations and an empirical forecasting exercise have more importance than VAR. |
| Lütkepohl and Netsunajev | 2017 | VAR, SVAR | 1970-2007, Monthly | In US, Industrial production index, Consumer price index, Commodity price index, S&P 500 | In SVAR model, monetary policy shock is related with the supply side. Clearly identified stock market shock was not found. |
| Mensi et al | 2017 | DECO-FIAPARCH, Spillover Index | 1998-2015 Monthly | Crude oil, Gold, Dow Jones Islamic Index | Gold offers better diversification benefits than oil. Gold is helpful for investors dealing with the technology sector. |
| Yang et al | 2018 | VAR model, Spillover Index | 2005-2015 Monthly | House Prices for 69 cities in China | City-level monthly housing prices in China are highly interactive with each other. A higher administrative status, population, city GDP and secondary education are important issues. |
| BenSaida et al | 2018 | VAR, Spillover Index | 2001-2017 Daily | VIX, VFTSE, VCAC, VDAX, VAEX, VSMI, VHSI, JNIV | Volatility indices show that total and directional spillovers are more intense during turbulent periods than tranquility periods. |
| Yun et al | 2018 | VAR, GARCH, BEKK | 2007-2017 Daily | WTI, Brent oil, Dubai oil | Volatility spillover effect between the crude oil price and airlines' stock price is more significant than the return spillover effect and smaller airlines of South Korea and China are relatively more sensitive to the change in oil price. |

## 3. DATA AND MODEL

Monthly data are used for house price index for Turkey that was prepared by Reidin data company from January 2003 to September 2018. This data contains house prices of 7 big cities (Istanbul, Ankara, Izmır, Bursa, Antalya, Adana, Kocaeli in Figure 3.1) of Turkey. Besides, credit default swaps data, BIST100 (Istanbul Stock Exchange Index) data, SP500 (Standard & Poor's) data, gold data and USD/TRY currency rates that was taken from internet for same period between January 2003 and September 2018 are used. These data come from asking price of houses in web researches. In the end 6 different time series (house price index, BIST100 stock exchange, SP500 stock exchange, USD/TRY currency rate, gold price, CDS) with 189 monthly observation that was converted from daily data points from January 2003 to September 2018 are obtained in order to see effects of different economic situations in that long period. In order to have more robust analysis more historical data are needed but house price data for Turkey before 2000's is not available. Here are the graphs of the time series in Figure 3.2. Descriptive Statistics of original time series can be seen in Table 3.1.


**Figure 3.1 :** 7 Big cities (Istanbul, Ankara, Izmır, Bursa, Antalya, Adana, Kocaeli) in Turkey.

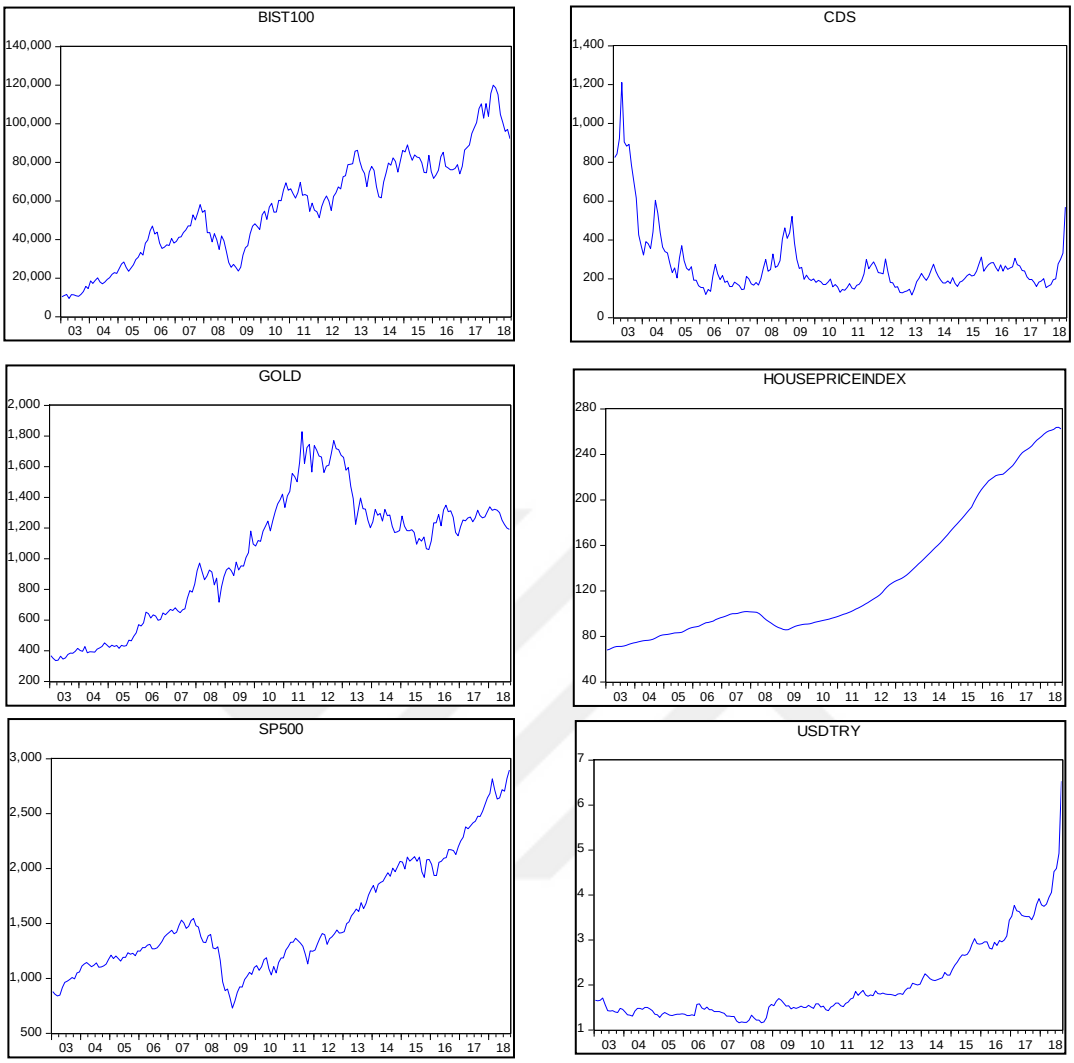


**Figure 3.2 :** Graphs of original time series (House price index, SP500 index, BIST100 index, CDS, gold, USD/TRY) between January 2003 and September 2018.

**Table 3.1 :** Table of Descriptive Statistics of non - stationary time series.

| DESCRIPTIVE STATISTICS | BIST100 | CDS | GOLD | HOUSE PRICE INDEX | SP500 | USD/TRY |
|---|---|---|---|---|---|---|
| **Mean** | 56854.84 | 268.5487 | 1026.290 | 131.6886 | 1536.518 | 2.002063 |
| **Median** | 57079.66 | 216.7100 | 1170.800 | 101.2000 | 1365.900 | 1.600000 |
| **Maximum** | 120016.0 | 1211.250 | 1828.500 | 263.8000 | 2896.960 | 6.530000 |
| **Minimum** | 9475.090 | 116.9400 | 335.9000 | 68.04000 | 729.5700 | 1.160000 |
| **Std. Dev.** | 26814.59 | 166.9777 | 411.3033 | 59.11524 | 512.4116 | 0.881204 |
| **Skewness** | 0.113235 | 2.894308 | -0.184095 | 0.990143 | 0.827134 | 1.800203 |
| **Kurtosis** | 2.253620 | 12.41862 | 1.933236 | 2.555318 | 2.728434 | 6.726365 |
| **Jarque-Bera** | 4.790935 | 962.4700 | 10.02920 | 32.43930 | 22.13152 | 211.4337 |
| **Probability** | 0.091130 | 0.000000 | 0.006640 | 0.000000 | 0.000016 | 0.000000 |
| **Observations** | 189 | 189 | 189 | 189 | 189 | 189 |

### 3.1 VAR Model

Vector autoregression (VAR) is a stochastic model developed to understand the linear relations among multiple time series. VAR models generalize the univariate autoregressive model by allowing for more than one changing variable. All variables in a VAR are used in the model in the same way: each variable has an equation showing its change based on its own lagged values, the lagged values of the other model variables, and an error term. The aim of this thesis is to find the percentages of the effects of financial instruments on house price index with VAR Model.

### 3.2 Estimation

The unit roots of six time series are examined in order to estimate VAR Model. Since in VAR Model time series should be stationary time series. If there is an obvious trend in time series, it can be predicted that they are non-stationary time series easily. If they are non-stationary time series, they should be made stationary by taking difference. Time series have unit roots, if ADF test value is higher than critical test values.

In order to obtain stationary time series logarithmic difference was calculated. After that unit root tests carried out again. As seen all time series became stationary except house price index. Augmented Dickey Fuller Tests results for variables in level and return are illustrated in Table 3.2 and Table 3.3 respectively. Test results indicate that series are not stationary in level but the returns are significant at 1% level of significance except for house price return. More tests are needed for house price index return as it is not significant at intended level.

A rapid going up and down movements occurred in short period in 2008 for house price index return as it can be seen in Figure 3.4. These effects may be the outcomes of the mortgage crisis in the United States.

The structural break test by Perron (1989) is conducted for house price index return. The result shows that house price index return is stationary when a structural break is taken into.

VAR model is estimated with the usage of stationary return time series (house price index return, BIST100 stock exchange return, SP500 stock exchange return,

USD/TRY currency rate return, gold price return, CDS return) to find out interaction. Results can be seen in Appendix A.

The stability of the VAR model should be checked and this is examined by estimating ar roots. According to results VAR model is stable as no root lies outside the unit circle. It can bee seen in Figure 3.3.

According to lag order selection criteria "6" is the optimal lag value. It is noted that the VAR model with 6 lags satisfies the assumption of no serial correlation among residuals. The results can be seen in Appendix B.

Descriptive Statistics of the return time series can be seen in Table 3.5.

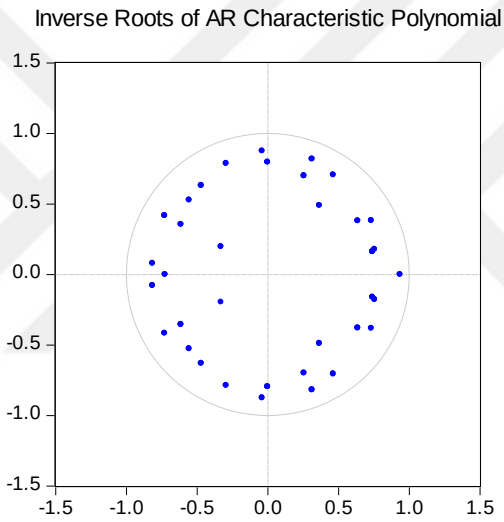


**Figure 3.3** : AR roots graph.

**Table 3.2 :** Augmented Dickey – Fuller unit root test results for series in level.

| SERIES | ADF statistics (Intercept) | ADF statistics (Intercept + Trend) |
|---|---|---|
| BIST100 | -1.347 | -3.213 |
| HOUSE PRICE INDEX | -0.247 | -1.801 |
| SP500 | 1.261 | -0.356 |
| GOLD | -1.588 | -1.171 |
| CDS | -3.252 | -2.627 |
| USD/TRY | 4.068 | 3.226 |

*** indicates that series are significant at 1% level of significance.

**Table 3.3 :** Augmented Dickey – Fuller unit root test results for returns.

| SERIES | ADF statistics (Intercept) | ADF statistics (Intercept + Trend) |
|---|---|---|
| BIST100 RETURN | -13.715*** | -13.827*** |
| HOUSE PRICE INDEX RETURN | -2.532 | -2.466 |
| SP500 RETURN | -11.521*** | -11.501*** |
| GOLD RETURN | -15.617*** | -15.900*** |
| CDS RETURN | -12.818*** | -12.993*** |
| USD/TRY RETURN | -9.647*** | -10.230*** |

*** indicates that series are significant at 1% level of significance.

**Table 3.4 :** Augmented Dickey – Fuller unit root test results with structural break test for house price index time series

| SERIES | ADF statistics (Intercept) | ADF statistics (Intercept + Trend) |
|---|---|---|
| HOUSE PRICE INDEX RETURN | -5.02*** | -4.95** |

*** indicates that series are significant at 1% level of significance.

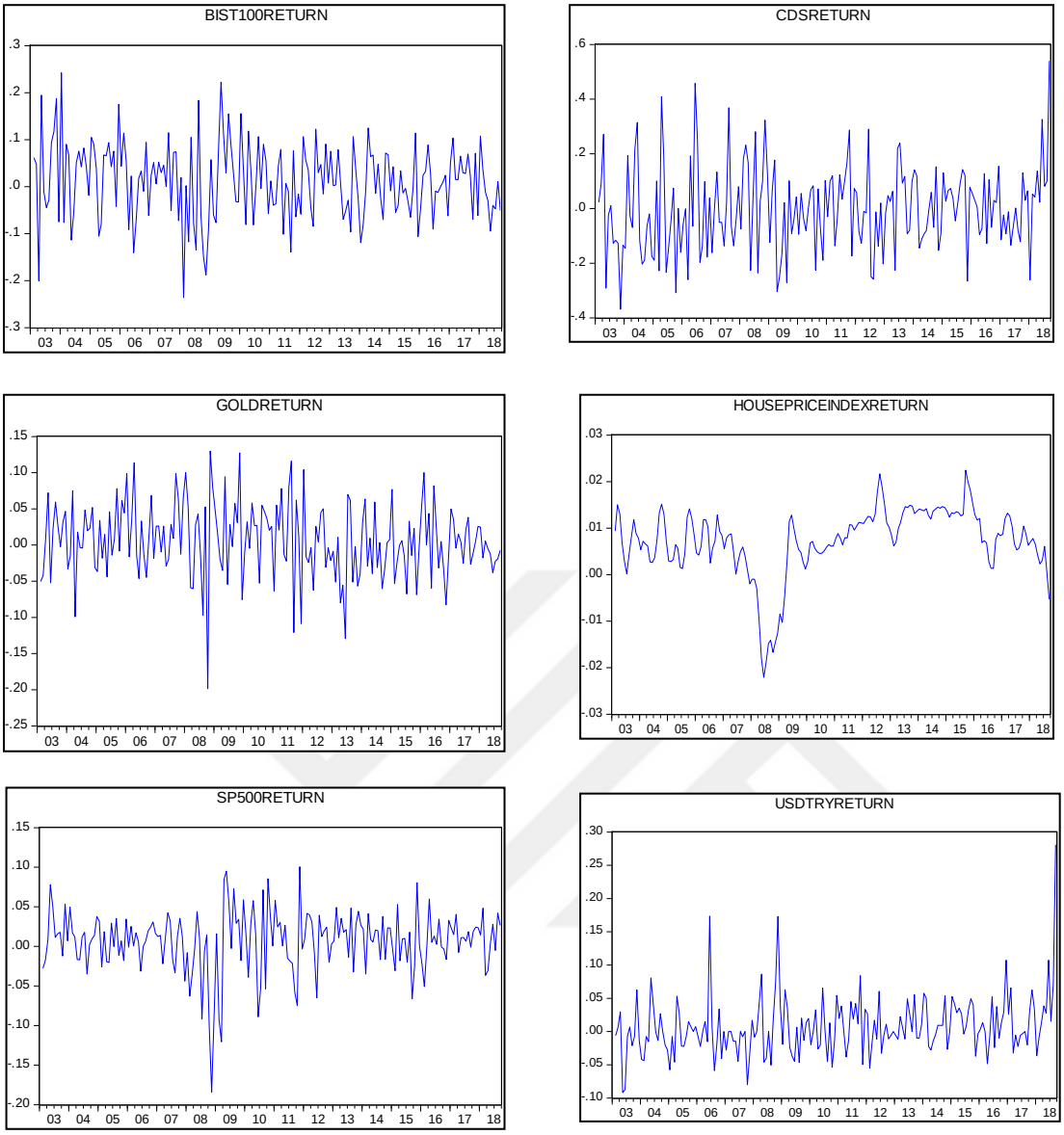


**Figure 3.4 :** Time plot of series in return (House price index, SP500 index, BIST100 index, CDS, gold, USD/TRY) between January 2003 and September 2018

**Table 3.5 :** Descriptive Statistics of return time series.

| DESCRIPTIVE STATISTICS | BIST100 RETURN | CDS RETURN | GOLD RETURN | HOUSE PRICE INDEX RETURN | SP500 RETURN | USD/TRY RETURN |
|---|---|---|---|---|---|---|
| **Mean** | 0.011628 | -0.001970 | 0.006245 | 0.007180 | 0.006339 | 0.007285 |
| **Median** | 0.016233 | -0.000276 | 0.004883 | 0.007809 | 0.011281 | 0.000000 |
| **Maximum** | 0.242284 | 0.539912 | 0.129863 | 0.022461 | 0.100655 | 0.281068 |
| **Minimum** | -0.236049 | -0.368711 | -0.198512 | -0.022090 | -0.183840 | -0.091808 |
| **Std. Dev.** | 0.079638 | 0.155988 | 0.050985 | 0.007321 | 0.038838 | 0.043820 |
| **Skewness** | -0.061930 | 0.402609 | -0.292926 | -1.480086 | -1.045017 | 1.879986 |
| **Kurtosis** | 3.254874 | 3.419700 | 3.883775 | 6.235816 | 6.295333 | 11.72544 |
| **Jarque-Bera** | 0.629032 | 6.458778 | 8.806862 | 150.6595 | 119.2817 | 707.1211 |
| **Probability** | 0.730142 | 0.039582 | 0.012235 | 0.000000 | 0.000000 | 0.000000 |
| **Observations** | 188 | 188 | 188 | 188 | 188 | 188 |

Impulse response function of VAR Model is estimated. The estimation results of impulse response functions of VAR Model can be seen in Appendix C. Variance Decomposition of VAR Model is estimated and the result of house price index return can be seen below in Table 3.6. The results of other financial instruments can be seen in Appendix D.

As it can be seen from Table 3.6 variance decompositions of VAR Model, 2.43% of the house price index return variable can be explained by BIST100 return variable, 8.66% of it can be explained by gold return, 4.76% of it can be explained by USD/TRY return, 0.16% of it can be explained by SP500 and 1.50% of it can be explained by credit default swaps return after 10 period. Therefore; gold returns are the most important variable for house price index return when it is compared it with BIST100 return, SP500 return, gold return and CDS return.

**Table 3.6 :** Variance Decomposition of House Price Index Return.

| VARIANCE DECOMPOSITION OF HOUSE PRICE INDEX RETURN | | | | | | |
|---|---|---|---|---|---|---|
| **PERIOD** | **HOUSE PRICE INDEX RETURN** | **GOLD RETURN** | **USD/TRY RETURN** | **BIST100 RETURN** | **SP500 RETURN** | **CDS RETURN** |
| 1 | 99.79957 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 98.20361 | 0.00000 | 0.00000 | 0.00000 | 0.02099 | 1.22256 |
| 3 | 97.39766 | 0.00000 | 0.00000 | 0.00000 | 0.04592 | 1.30799 |
| 4 | 95.46217 | 1.23091 | 0.00000 | 1.20546 | 0.12015 | 1.18328 |
| 5 | 93.78757 | 2.15138 | 1.46987 | 1.19757 | 0.13167 | 1.26193 |
| 6 | 91.90743 | 3.33328 | 1.79098 | 1.16992 | 0.12605 | 1.67233 |
| 7 | 89.63198 | 4.48625 | 2.25984 | 1.79975 | 0.14058 | 1.68160 |
| 8 | 87.33206 | 5.91996 | 2.84983 | 2.21738 | 0.13085 | 1.54992 |
| 9 | 84.69918 | 7.42747 | 3.85555 | 2.39250 | 0.15430 | 1.47101 |
| **10** | **82.45589** | **8.66362** | **4.76867** | **2.43714** | **0.16761** | **1.50708** |

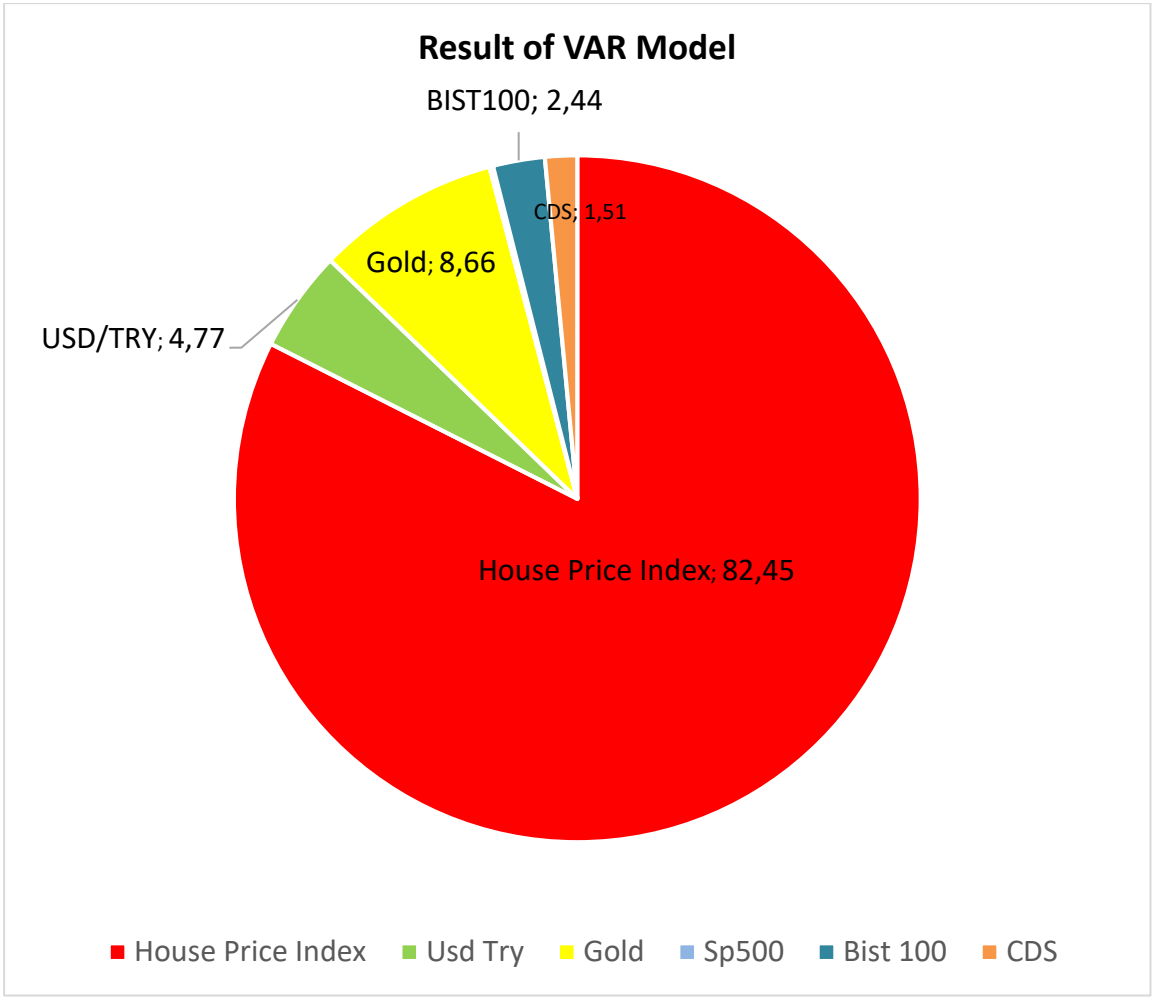


**Figure 3.5 :** The result of VAR Model for House Price Index

### 3.3 Diebold – Yilmaz Spillover Index

Diebold – Yilmaz spillover index is calculated for six time series (house price index, BIST100, SP500, USD/TRY, gold, CDS). Diebold-Yilmaz index of spillover base on the forecast error variance decomposition method of VAR model is calculated. It is considered that first the simple example of a covariance stationary, N-variable VAR (1):

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

The moving average representation is given by

$$x_t = \Theta(L)\varepsilon_t$$

The structural moving average representation form is given by

$$x_t = A(L)u_t$$

where $A(L)=\Theta(L)Q^{-1}$, $u_t=Q\varepsilon_t$, $E(u_t u_t')=I$, and $Q^{-1}$ is the unique lower-triangular Cholesky factor of the covariance matrix of $\varepsilon t$. The spillover index (S) is estimated as the following H-step-ahead forecast relative total forecast error variation:

$$S = \frac{\sum_{h=0}^{H-1}\sum_{i,j=1}^{N} a_{h,ij(i\neq j)}^{2}}{\sum_{h=0}^{H-1} trace(A_h A_h')} \times 100.$$

For calculation the number of forecast horizon was chosen as “1” and the number of rolling windows were chosen as “12”. Generalized index and 6 lags are choosen. Spillover index result table can be seen below in Table 3.7.

From Diebold – Yilmaz spillover index in Table 3.7, that innovations to BIST100 return are responsible for 0.5%, SP500 return are 0.7% of the error variance in forecasting 1 month ahead house price index return. That is, return spillovers from BIST100 return to CDS return are much larger than BIST100 return to house price index return. It can be seen that other financial instruments have deeper relationships with each other when it is compared with house price index return because they affect each other very much. The key summary result to emerge from spillover index table in Table 3.7 is that, refining all of the various financial instrument spillovers into a single Spillover Index for the full 2003-2018 data sample, it is found that 32.2% of

forecast error variance comes from spillovers. Hence spillovers are crucial for these financial instruments, but house prices behave separately.

**Table 3.7 :** The result of spillover index of Diebold – Yilmaz.

| SPILLOVER (CONNECTEDNESS) TABLE | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **HOUSE PRICE INDEX RETURN** | **BIST100 RETURN** | **CDS RETURN** | **GOLD RETURN** | **SP500 RETURN** | **USD/TRY RETURN** | **FROM OTHERS** |
| **HOUSE PRICE INDEX RETURN** | 98.7 | 0.5 | 0.0 | 0.1 | 0.7 | 0.0 | 1.3 |
| **BIST100 RETURN** | 0.2 | 51.0 | 22.9 | 0.3 | 12.2 | 13.3 | 49.0 |
| **CDS RETURN** | 0.0 | 20.9 | 46.6 | 0.3 | 10.8 | 21.3 | 53.4 |
| **GOLD RETURN** | 0.1 | 0.7 | 0.6 | 97.8 | 0.1 | 0.7 | 2.2 |
| **SP500 RETURN** | 0.4 | 14.4 | 13.9 | 0.1 | 60.1 | 11.0 | 39.9 |
| **USD/TRY RETURN** | 0.0 | 13.6 | 24.0 | 0.4 | 9.6 | 52.4 | 47.6 |
| **CONTRIBUTION TO OTHERS** | 0.7 | 50.1 | 61.4 | 1.2 | 33.5 | 46.4 | 193.2 |
| **CONTRIBUTION INCLUDING OWN** | 99.5 | 101.1 | 108.0 | 99.0 | 93.6 | 98.8 | **32.2%** |

## 4. CONCLUSION

Real estates are not only an important investment method but also basic need for people. Houses are the most vital part of the real estate industry. In literature, there are lots of researches about house prices but there are only a few researches for Turkey. This thesis explores housing prices and its statistical relationships with 5 different financial instruments (BIST100, SP500, USD/TRY, gold and CDS) in Turkey via VAR model approach and Diebold – Yilmaz spillover index. There are only 189 available monthly data points that come from asking prices of houses for house price index that was prepared by Reidin company for 7 big cities (Istanbul, Ankara, Izmır, Bursa, Antalya, Adana, Kocaeli) in Turkey from 2003:01 to 2018:09. The number of the CBRT (Central Bank of Republic of Turkey) data are fewer than Reidin company data. In VAR model, time series must be stationary. Therefore, time series are made stationary by calculating log differences. According to LR information criteria, lag value is found "6". With this information VAR model (6) is created and is found that the model is stable. According to variance decompositions of VAR Model, 8.66% of the house price index return variable can be explained by gold return variable after 10 period. Therefore, it can be said that gold is most effective variable for house price index in the long run in Turkey when it compared with other financial instruments. According to the results of the Diebold – Yilmaz spillover index in Table 3.7, that innovations to BIST100 return are responsible for 0.5%, SP500 return are 0.7% of the error variance in forecasting 1 month ahead house price index return. Other financial instruments have deeper relationships with each other when they are compared with house price index return because they affect each other very much. According to results 32.2% of forecast error variance comes from spillovers. Hence spillovers are crucial for these financial instruments but house prices in Turkey behave more separately.

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# 6. APPENDICES

## **APPENDIX A :** VAR Model Result.

| | | | |
|---|---|---|---|
| Vector Autoregression Estimates | | Determinant resid covariance (dof adj.) | 1.11E-18 |
| Date: 04/08/19 Time: 23:17 | | Determinant resid covariance | 7.20E-19 |
| Sample (adjusted): 2003M04 2018M09 | | Log likelihood | 2.301.485 |
| Included observations: 186 after adjustments | | Akaike information criterion | -2.390.844 |
| Standard errors in ( ) & t-statistics in [ ] | | Schwarz criterion | -2.255.571 |

| | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEINDEXRETURN | SP500RETURN | USDTRYRETURN |
|---|---|---|---|---|---|---|
| BIST100RETURN(-1) | -0.207806 | -0.376436 | 0.028407 | -0.001511 | 0.102747 | -0.039456 |
| | -0.10794 | -0.20993 | -0.07153 | -0.00357 | -0.05034 | -0.05717 |
| | [-1.92523] | [-1.79311] | [ 0.39710] | [-0.42371] | [ 2.04107] | [-0.69021] |
| BIST100RETURN(-2) | -0.051753 | -0.167081 | 0.033536 | -0.004954 | 0.011421 | 0.002597 |
| | -0.10816 | -0.21037 | -0.07168 | -0.00357 | -0.05044 | -0.05728 |
| | [-0.47847] | [-0.79422] | [ 0.46784] | [-1.38643] | [ 0.22641] | [ 0.04534] |
| CDSRETURN(-1) | -0.033623 | -0.213974 | -0.028299 | -0.003301 | 0.04301 | -0.058366 |
| | -0.06152 | -0.11965 | -0.04077 | -0.00203 | -0.02869 | -0.03258 |
| | [-0.54653] | [-1.78829] | [-0.69410] | [-1.62421] | [ 1.49908] | [-1.79138] |
| CDSRETURN(-2) | -0.124277 | 0.027294 | 0.017633 | -0.002023 | -0.005196 | 0.03349 |
| | -0.06193 | -0.12046 | -0.04105 | -0.00205 | -0.02888 | -0.0328 |
| | [-2.00663] | [ 0.22658] | [ 0.42960] | [-0.98873] | [-0.17990] | [ 1.02102] |
| GOLDRETURN(-1) | 0.17247 | -0.595493 | -0.14938 | -0.001877 | 0.035504 | -0.249593 |
| | -0.11542 | -0.22448 | -0.07649 | -0.00381 | -0.05383 | -0.06113 |
| | [ 1.49432] | [-2.65277] | [-1.95292] | [-0.49228] | [ 0.65959] | [-4.08328] |
| GOLDRETURN(-2) | -0.024661 | 0.080273 | -0.019984 | -0.008608 | -0.100812 | 0.066715 |
| | -0.12247 | -0.2382 | -0.08117 | -0.00405 | -0.05712 | -0.06486 |
| | [-0.20136] | [ 0.33699] | [-0.24621] | [-2.12775] | [-1.76500] | [ 1.02857] |
| HOUSEPRICEINDEXRETURN(-1) | 3.530.686 | -4.124.976 | 0.235709 | 1.315.760 | 1.111.939 | 0.643669 |
| | -210.064 | -408.564 | -139.217 | -0.06939 | -0.97968 | -111.252 |
| | [ 1.68077] | [-1.00963] | [ 0.16931] | [ 18.9608] | [ 1.13500] | [ 0.57857] |
| HOUSEPRICEINDEXRETURN(-2) | -1.889.103 | 1.371.825 | -0.401113 | -0.418054 | 0.5961 | -1.353.716 |
| | -215.328 | -418.803 | -142.706 | -0.07113 | -100.423 | -114.040 |
| | [-0.87731] | [ 0.32756] | [-0.28108] | [-5.87709] | [ 0.59359] | [-1.18706] |
| SP500RETURN(-1) | 0.024927 | 0.163851 | -0.071974 | -0.007305 | 0.041643 | -0.011232 |
| | -0.19744 | -0.384 | -0.13085 | -0.00652 | -0.09208 | -0.10456 |
| | [ 0.12625] | [ 0.42669] | [-0.55005] | [-1.11999] | [ 0.45225] | [-0.10742] |
| SP500RETURN(-2) | -0.092791 | 0.534426 | -0.007825 | 0.006093 | -0.121507 | 0.16134 |
| | -0.19539 | -0.38002 | -0.12949 | -0.00645 | -0.09112 | -0.10348 |
| | [-0.47491] | [ 1.40631] | [-0.06043] | [ 0.94404] | [-1.33342] | [ 1.55915] |
| USDTRYRETURN(-1) | -0.472348 | 0.695392 | 0.156762 | -0.00762 | -0.100411 | 0.363335 |
| | -0.22532 | -0.43824 | -0.14933 | -0.00744 | -0.10508 | -0.11933 |
| | [-2.09632] | [ 1.58678] | [ 1.04977] | [-1.02378] | [-0.95552] | [ 3.04472] |
| USDTRYRETURN(-2) | 0.427238 | -0.537136 | -0.026775 | 0.008435 | 0.115352 | -0.058886 |
| | -0.21924 | -0.4264 | -0.1453 | -0.00724 | -0.10225 | -0.11611 |
| | [ 1.94875] | [-1.25969] | [-0.18428] | [ 1.16460] | [ 1.12818] | [-0.50716] |
| C | 0.001444 | 0.020726 | 0.008095 | 0.000777 | -0.006046 | 0.011389 |
| | -0.0085 | -0.01653 | -0.00563 | -0.00028 | -0.00396 | -0.0045 |
| | [ 0.16981] | [ 1.25350] | [ 1.43673] | [ 2.76712] | [-1.52504] | [ 2.52967] |
| | | | | | | |
| R-squared | 0.106167 | 0.119808 | 0.034263 | 0.884182 | 0.18021 | 0.174248 |
| Adj. R-squared | 0.044167 | 0.058754 | -0.032725 | 0.876149 | 0.123346 | 0.116971 |
| Sum sq. resids | 1.056.604 | 3.996.953 | 0.46408 | 0.001153 | 0.229816 | 0.296361 |
| S.E. equation | 0.078151 | 0.151999 | 0.051793 | 0.002582 | 0.036447 | 0.041389 |
| F-statistic | 1.712.379 | 1.962.340 | 0.511482 | 1.100.607 | 3.169.136 | 3.042.174 |
| Log likelihood | 2.169.513 | 9.321.737 | 2.934.679 | 8.512.484 | 3.588.263 | 3.351.763 |
| Akaike AIC | -2.193.024 | -0.862552 | -3.015.784 | -9.013.424 | -3.718.563 | -3.464.261 |
| Schwarz SC | -1.967.569 | -0.637097 | -2.790.329 | -8.787.969 | -3.493.107 | -3.238.805 |
| Mean dependent | 0.011162 | -0.002597 | 0.006807 | 0.007126 | 0.006649 | 0.007363 |
| S.D. dependent | 0.079936 | 0.156671 | 0.050966 | 0.007336 | 0.038927 | 0.044045 |

**APPENDIX B :** VAR Model Result with lag "6".

| Vector Autoregression Estimates | | | Determinant resid covariance (dof adj.) | | | 7.04E-19 |
|---|---|---|---|---|---|---|
| Date: 04/09/19 Time: 23:43 | | | Determinant resid covariance | | | 1.80E-19 |
| Sample (adjusted): 2003M08 2018M09 | | | Log likelihood | | | 2.378.146 |
| Included observations: 182 after adjustments | | | Akaike information criterion | | | -2.369.391 |
| Standard errors in ( ) & t-statistics in [ ] | | | Schwarz criterion | | | -1.978.572 |
| | | | | | | |
| | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEINDEXRETURN | SP500RETURN | USDTRYRETURN |
| BIST100RETURN(-1) | -0.152114 | -0.485526 | 0.051179 | -0.000126 | 0.188796 | -0.078444 |
| | -0.11898 | -0.23776 | -0.07678 | -0.00387 | -0.05668 | -0.06522 |
| | [-1.27853] | [-2.04210] | [ 0.66655] | [-0.03244] | [ 3.33065] | [-1.20285] |
| BIST100RETURN(-2) | -0.057807 | -0.058588 | 0.116305 | -0.00034 | 0.059185 | -0.026506 |
| | -0.12854 | -0.25686 | -0.08295 | -0.00419 | -0.06124 | -0.07046 |
| | [-0.44973] | [-0.22809] | [ 1.40207] | [-0.08129] | [ 0.96644] | [-0.37621] |
| BIST100RETURN(-3) | -0.215801 | 0.241178 | 0.112171 | 0.006649 | 0.053809 | 0.051239 |
| | -0.12483 | -0.24946 | -0.08056 | -0.00407 | -0.05947 | -0.06842 |
| | [-1.72875] | [ 0.96680] | [ 1.39238] | [ 1.63558] | [ 0.90474] | [ 0.74883] |
| BIST100RETURN(-4) | -0.210568 | 0.482632 | 0.181942 | 0.000798 | -0.031792 | 0.04601 |
| | -0.12492 | -0.24963 | -0.08062 | -0.00407 | -0.05951 | -0.06847 |
| | [-1.68568] | [ 1.93340] | [ 2.25691] | [ 0.19625] | [-0.53419] | [ 0.67196] |
| BIST100RETURN(-5) | -0.032716 | 0.267782 | 0.108385 | 0.001126 | -0.058224 | 0.039024 |
| | -0.12182 | -0.24345 | -0.07862 | -0.00397 | -0.05804 | -0.06678 |
| | [-0.26855] | [ 1.09997] | [ 1.37861] | [ 0.28391] | [-1.00316] | [ 0.58441] |
| BIST100RETURN(-6) | -0.078623 | 0.126144 | 0.159245 | -0.000768 | -0.02957 | 0.06416 |
| | -0.11092 | -0.22166 | -0.07158 | -0.00361 | -0.05285 | -0.0608 |
| | [-0.70884] | [ 0.56910] | [ 2.22465] | [-0.21262] | [-0.55955] | [ 1.05529] |
| CDSRETURN(-1) | -0.005424 | -0.255471 | -0.057147 | -0.003167 | 0.066587 | -0.058675 |
| | -0.06522 | -0.13033 | -0.04209 | -0.00212 | -0.03107 | -0.03575 |
| | [-0.08318] | [-1.96021] | [-1.35778] | [-1.49123] | [ 2.14301] | [-1.64134] |
| CDSRETURN(-2) | -0.098482 | -0.019121 | 0.051324 | -0.000773 | 0.018417 | 0.014522 |
| | -0.06811 | -0.13611 | -0.04396 | -0.00222 | -0.03245 | -0.03734 |
| | [-1.44588] | [-0.14048] | [ 1.16761] | [-0.34833] | [ 0.56753] | [ 0.38895] |
| CDSRETURN(-3) | -0.061652 | -0.044929 | -0.023178 | 0.000743 | 0.055305 | -0.017402 |
| | -0.06725 | -0.13439 | -0.0434 | -0.00219 | -0.03204 | -0.03686 |
| | [-0.91675] | [-0.33432] | [-0.53405] | [ 0.33942] | [ 1.72608] | [-0.47207] |
| CDSRETURN(-4) | -0.101815 | 0.16698 | 0.090207 | 0.002319 | 0.000972 | 0.040491 |
| | -0.06928 | -0.13846 | -0.04471 | -0.00226 | -0.03301 | -0.03798 |
| | [-1.46951] | [ 1.20600] | [ 2.01743] | [ 1.02773] | [ 0.02943] | [ 1.06617] |
| CDSRETURN(-5) | -0.072703 | 0.276739 | 0.142862 | 0.002069 | -0.022627 | 0.042084 |
| | -0.06798 | -0.13585 | -0.04387 | -0.00221 | -0.03239 | -0.03726 |
| | [-1.06947] | [ 2.03708] | [ 3.25634] | [ 0.93449] | [-0.69861] | [ 1.12938] |
| CDSRETURN(-6) | -0.114465 | -0.046691 | 0.13434 | -0.000623 | -0.04442 | 0.002376 |
| | -0.06816 | -0.13621 | -0.04399 | -0.00222 | -0.03248 | -0.03736 |
| | [-1.67929] | [-0.34278] | [ 3.05392] | [-0.28079] | [-1.36782] | [ 0.06359] |
| GOLDRETURN(-1) | 0.190925 | -0.606357 | -0.207628 | -0.002402 | 0.057496 | -0.239508 |
| | -0.12146 | -0.24273 | -0.07839 | -0.00396 | -0.05787 | -0.06658 |
| | [ 1.57190] | [-2.49812] | [-2.64878] | [-0.60733] | [ 0.99356] | [-3.59740] |
| GOLDRETURN(-2) | 0.035906 | 0.096545 | -0.018696 | -0.006357 | -0.070222 | 0.014549 |
| | -0.12752 | -0.25482 | -0.08229 | -0.00415 | -0.06075 | -0.0699 |
| | [ 0.28158] | [ 0.37887] | [-0.22719] | [-1.53091] | [-1.15585] | [ 0.20816] |
| GOLDRETURN(-3) | 0.208577 | -0.416855 | 0.013412 | -0.001915 | 0.091705 | -0.106508 |
| | -0.12688 | -0.25355 | -0.08188 | -0.00413 | -0.06045 | -0.06955 |
| | [ 1.64393] | [-1.64409] | [ 0.16380] | [-0.46353] | [ 1.51707] | [-1.53147] |
| GOLDRETURN(-4) | -0.078829 | -0.099374 | -0.095712 | -0.002715 | 0.072553 | -0.001112 |
| | -0.12694 | -0.25368 | -0.08192 | -0.00413 | -0.06048 | -0.06958 |
| | [-0.62098] | [-0.39173] | [-1.16829] | [-0.65665] | [ 1.19960] | [-0.01597] |
| GOLDRETURN(-5) | -0.042138 | -0.027638 | 0.043003 | -0.003615 | 0.099712 | -0.028543 |
| | -0.12864 | -0.25707 | -0.08302 | -0.00419 | -0.06129 | -0.07051 |
| | [-0.32757] | [-0.10751] | [ 0.51798] | [-0.86301] | [ 1.62692] | [-0.40479] |
| GOLDRETURN(-6) | 0.104452 | 0.227584 | 0.221665 | -0.002541 | 0.031454 | -0.01997 |
| | -0.12561 | -0.25102 | -0.08107 | -0.00409 | -0.05985 | -0.06885 |
| | [ 0.83153] | [ 0.90662] | [ 2.73435] | [-0.62111] | [ 0.52556] | [-0.29003] |

**APPENDIX B :** VAR Model Result with lag "6" (continued).

| | | | | | | |
|---|---|---|---|---|---|---|
| HOUSEPRICEINDEXRETURN(-1) | 7.316.514 | -1.219.482 | 1.050.888 | 1.373.375 | 1.558.576 | -1.977.315 |
| | -257.878 | -515.337 | -166.424 | -0.08398 | -122.863 | -141.354 |
| | [ 2.83720] | [-2.36638] | [ 0.63145] | [ 16.3540] | [ 1.26855] | [-1.39884] |
| HOUSEPRICEINDEXRETURN(-2) | -8.617.422 | 1.494.008 | -1.940.323 | -0.528207 | 0.150704 | 4.368.560 |
| | -442.210 | -883.701 | -285.385 | -0.14401 | -210.685 | -242.394 |
| | [-1.94872] | [ 1.69063] | [-0.67990] | [-3.66796] | [ 0.07153] | [ 1.80226] |
| HOUSEPRICEINDEXRETURN(-3) | 4.780.708 | -1.419.602 | 0.453003 | -0.282277 | 0.778177 | -3.353.446 |
| | -458.455 | -916.164 | -295.869 | -0.1493 | -218.425 | -251.298 |
| | [ 1.04279] | [-1.54951] | [ 0.15311] | [-1.89072] | [ 0.35627] | [-1.33445] |
| HOUSEPRICEINDEXRETURN(-4) | 1.924.589 | 6.556.730 | 3.371.512 | 0.48933 | -1.741.566 | -2.308.661 |
| | -454.393 | -908.047 | -293.247 | -0.14797 | -216.490 | -249.072 |
| | [ 0.42355] | [ 0.72207] | [ 1.14972] | [ 3.30689] | [-0.80446] | [-0.92691] |
| HOUSEPRICEINDEXRETURN(-5) | -3.290.071 | -1.911.323 | -0.328081 | -0.083426 | 0.812321 | 2.204.889 |
| | -448.448 | -896.167 | -289.411 | -0.14604 | -213.657 | -245.813 |
| | [-0.73366] | [-0.21328] | [-0.11336] | [-0.57126] | [ 0.38020] | [ 0.89698] |
| HOUSEPRICEINDEXRETURN(-6) | -0.622998 | 3.593.623 | -2.978.977 | -0.044835 | 0.504739 | -0.053058 |
| | -270.473 | -540.505 | -174.552 | -0.08808 | -128.863 | -148.257 |
| | [-0.23034] | [ 0.66486] | [-1.70664] | [-0.50903] | [ 0.39169] | [-0.03579] |
| SP500RETURN(-1) | 0.074934 | -0.007263 | -0.12672 | -0.001885 | 0.011355 | -0.029585 |
| | -0.20491 | -0.40949 | -0.13224 | -0.00667 | -0.09763 | -0.11232 |
| | [ 0.36569] | [-0.01774] | [-0.95825] | [-0.28243] | [ 0.11631] | [-0.26340] |
| SP500RETURN(-2) | 0.012077 | 0.331928 | -0.116049 | 0.000291 | -0.036159 | 0.116771 |
| | -0.2035 | -0.40666 | -0.13133 | -0.00663 | -0.09695 | -0.11154 |
| | [ 0.05935] | [ 0.81623] | [-0.88366] | [ 0.04384] | [-0.37296] | [ 1.04686] |
| SP500RETURN(-3) | 0.066869 | -0.425868 | -0.244926 | -0.001476 | 0.106618 | 0.005039 |
| | -0.20213 | -0.40393 | -0.13045 | -0.00658 | -0.0963 | -0.1108 |
| | [ 0.33082] | [-1.05431] | [-1.87759] | [-0.22419] | [ 1.10712] | [ 0.04548] |
| SP500RETURN(-4) | 0.265566 | 0.111678 | -0.090018 | 0.005113 | 0.182022 | 0.052093 |
| | -0.20847 | -0.41659 | -0.13454 | -0.00679 | -0.09932 | -0.11427 |
| | [ 1.27391] | [ 0.26808] | [-0.66911] | [ 0.75313] | [ 1.83267] | [ 0.45589] |
| SP500RETURN(-5) | 0.06076 | 0.296941 | 0.239946 | -0.007331 | -0.12557 | -0.035234 |
| | -0.2103 | -0.42026 | -0.13572 | -0.00685 | -0.1002 | -0.11528 |
| | [ 0.28892] | [ 0.70656] | [ 1.76793] | [-1.07039] | [-1.25325] | [-0.30565] |
| SP500RETURN(-6) | -0.498015 | 0.459901 | -0.003627 | 0.002569 | -0.33683 | 0.164154 |
| | -0.20984 | -0.41934 | -0.13542 | -0.00683 | -0.09998 | -0.11502 |
| | [-2.37330] | [ 1.09673] | [-0.02679] | [ 0.37589] | [-3.36912] | [ 1.42715] |
| USDTRYRETURN(-1) | -0.513261 | 0.780652 | 0.181501 | 0.001133 | -0.025172 | 0.28906 |
| | -0.24032 | -0.48024 | -0.15509 | -0.00783 | -0.1145 | -0.13173 |
| | [-2.13576] | [ 1.62553] | [ 1.17028] | [ 0.14483] | [-0.21985] | [ 2.19437] |
| USDTRYRETURN(-2) | 0.517536 | -0.585795 | -0.037472 | 0.009993 | 0.252848 | -0.136472 |
| | -0.23876 | -0.47714 | -0.15409 | -0.00778 | -0.11376 | -0.13088 |
| | [ 2.16757] | [-1.22773] | [-0.24319] | [ 1.28519] | [ 2.22273] | [-1.04275] |
| USDTRYRETURN(-3) | -0.426774 | 0.82221 | -0.13771 | 0.000893 | -0.091839 | 0.275578 |
| | -0.24229 | -0.48419 | -0.15637 | -0.00789 | -0.11544 | -0.13281 |
| | [-1.76139] | [ 1.69810] | [-0.88069] | [ 0.11324] | [-0.79557] | [ 2.07495] |
| USDTRYRETURN(-4) | 0.284966 | -0.098228 | -0.132977 | 0.006091 | 0.130664 | -0.066407 |
| | -0.24813 | -0.49585 | -0.16013 | -0.00808 | -0.11822 | -0.13601 |
| | [ 1.14846] | [-0.19810] | [-0.83042] | [ 0.75387] | [ 1.10528] | [-0.48825] |
| USDTRYRETURN(-5) | 0.179831 | -0.037032 | 0.065188 | -0.007927 | -0.13804 | -0.154259 |
| | -0.24218 | -0.48397 | -0.1563 | -0.00789 | -0.11539 | -0.13275 |
| | [ 0.74254] | [-0.07652] | [ 0.41708] | [-1.00511] | [-1.19634] | [-1.16201] |
| USDTRYRETURN(-6) | -0.250957 | 0.724864 | -0.311894 | 0.008176 | -0.027155 | 0.249716 |
| | -0.23071 | -0.46104 | -0.14889 | -0.00751 | -0.10992 | -0.12646 |
| | [-1.08777] | [ 1.57223] | [-2.09479] | [ 1.08824] | [-0.24704] | [ 1.97465] |
| C | 0.006024 | 0.00588 | 0.007294 | 0.000485 | -0.012236 | 0.01355 |
| | -0.01016 | -0.02031 | -0.00656 | -0.00033 | -0.00484 | -0.00557 |
| | [ 0.59264] | [ 0.28949] | [ 1.11195] | [ 1.46427] | [-2.52655] | [ 2.43192] |
| R-squared | 0.268448 | 0.266507 | 0.290624 | 0.913371 | 0.331553 | 0.287235 |
| Adj. R-squared | 0.086821 | 0.084398 | 0.114503 | 0.891863 | 0.165593 | 0.110272 |
| Sum sq. resids | 0.804819 | 3.214.043 | 0.3352 | 0.000853 | 0.182688 | 0.241815 |
| S.E. equation | 0.074502 | 0.148882 | 0.04808 | 0.002426 | 0.035495 | 0.040837 |
| F-statistic | 1.478.018 | 1.463.451 | 1.650.135 | 4.246.668 | 1.997.794 | 1.623.140 |
| Log likelihood | 2.350.774 | 1.090.726 | 3.147.834 | 8.583.396 | 3.700.158 | 3.444.997 |
| Akaike AIC | -2.176.674 | -0.792007 | -3.052.565 | -9.025.710 | -3.659.514 | -3.379.118 |
| Schwarz SC | -1.525.310 | -0.140643 | -2.401.201 | -8.374.346 | -3.008.150 | -2.727.754 |
| Mean dependent | 0.011745 | -0.002467 | 0.006669 | 0.007157 | 0.005986 | 0.008383 |
| S.D. dependent | 0.077963 | 0.155592 | 0.051094 | 0.007378 | 0.038858 | 0.043294 |

**APPENDIX C :** Impulse Response Function Table of VAR Model.

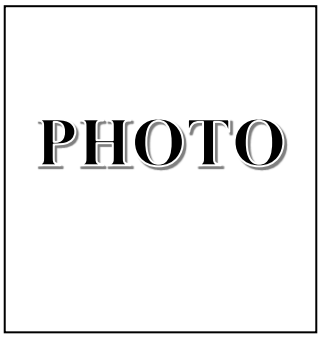
| Response of BIST100RETURN: | | | | | | |
|---|---|---|---|---|---|---|
| Period | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIN | SP500RETURN | USDTRYRETURN |
| 1 | 0.074502 | -0.049897 | 0.004817 | 0.001094 | 0.038027 | -0.035227 |
| | -0.0039 | -0.00486 | -0.00552 | -0.00552 | -0.00515 | -0.0052 |
| 2 | 0.001331 | -0.010116 | 0.009707 | 0.018034 | 0.00363 | -0.018256 |
| | -0.00636 | -0.00668 | -0.00612 | -0.00649 | -0.00625 | -0.00745 |
| 3 | 0.002402 | -0.00255 | 0.004255 | 0.004301 | -0.001599 | 0.009091 |
| | -0.00645 | -0.0069 | -0.0061 | -0.00713 | -0.00635 | -0.0078 |
| 4 | -0.001027 | -0.008788 | 0.003847 | 0.006562 | 0.000627 | -0.011767 |
| | -0.00637 | -0.00676 | -0.00612 | -0.00678 | -0.00639 | -0.00771 |
| 5 | 0.001268 | -0.003836 | -0.000894 | 0.008481 | 0.004785 | 0.000381 |
| | -0.00628 | -0.00697 | -0.00612 | -0.00667 | -0.00638 | -0.00812 |
| 6 | 0.005465 | -0.002345 | -0.004991 | 0.010582 | -0.000154 | 0.004249 |
| | -0.0063 | -0.00702 | -0.0062 | -0.00642 | -0.00642 | -0.00824 |
| 7 | -0.002463 | -0.00603 | 0.004686 | 0.009954 | -0.012 | -0.008633 |
| | -0.00643 | -0.00715 | -0.00635 | -0.00562 | -0.00654 | -0.00821 |
| 8 | -0.001297 | 0.001661 | 0.001572 | 0.006006 | -0.002662 | -0.002229 |
| | -0.00448 | -0.00529 | -0.00466 | -0.00534 | -0.00448 | -0.00619 |
| 9 | -0.000914 | 0.000846 | -5.99E-05 | -0.004474 | 0.001263 | 0.00098 |
| | -0.00388 | -0.00463 | -0.0038 | -0.0051 | -0.00382 | -0.00525 |
| 10 | -0.003819 | 0.001796 | -0.002263 | -0.005643 | -0.001455 | -0.00191 |
| | -0.0036 | -0.00421 | -0.0035 | -0.00447 | -0.0036 | -0.00481 |
| Response of CDSRETURN: | | | | | | |
| Period | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIN | SP500RETURN | USDTRYRETURN |
| 1 | -0.099712 | 0.148882 | -0.012681 | -0.006086 | -0.070291 | 0.100405 |
| | -0.00972 | -0.0078 | -0.01102 | -0.01103 | -0.0104 | -0.0097 |
| 2 | -0.028224 | 0.011505 | -0.030171 | -0.029788 | -0.00983 | 0.025838 |
| | -0.01263 | -0.01337 | -0.01218 | -0.01302 | -0.01248 | -0.01495 |
| 3 | 0.011355 | -0.009376 | 0.005873 | -0.01213 | 0.018192 | -0.017244 |
| | -0.01279 | -0.01373 | -0.01207 | -0.0142 | -0.01254 | -0.01563 |
| 4 | 0.000468 | 0.011614 | -0.013713 | -0.01832 | -0.009396 | 0.018142 |
| | -0.01257 | -0.01342 | -0.0121 | -0.01349 | -0.01261 | -0.01533 |
| 5 | 0.004253 | 0.014737 | -0.01024 | -0.006661 | 0.007232 | 0.013506 |
| | -0.01243 | -0.01392 | -0.01214 | -0.01327 | -0.01268 | -0.0163 |
| 6 | -0.006554 | 0.012778 | 0.009452 | -0.025661 | 0.006221 | -0.00126 |
| | -0.01255 | -0.01414 | -0.01233 | -0.01277 | -0.01275 | -0.01675 |
| 7 | 0.006702 | -0.012844 | 0.011259 | -0.00854 | 0.013921 | 0.009606 |
| | -0.0127 | -0.01432 | -0.01248 | -0.01118 | -0.01294 | -0.01666 |
| 8 | 0.002546 | 0.003187 | -0.011663 | -0.00523 | 0.006091 | 0.010498 |
| | -0.00877 | -0.01048 | -0.0088 | -0.01046 | -0.00924 | -0.01218 |
| 9 | -0.000616 | 0.002353 | 0.000459 | 0.005157 | -0.003152 | 0.003274 |
| | -0.00739 | -0.00909 | -0.0072 | -0.00992 | -0.0081 | -0.01028 |
| 10 | 0.011123 | -0.01003 | 0.000637 | 0.010127 | 0.008824 | -0.005347 |
| | -0.00688 | -0.00842 | -0.00664 | -0.00895 | -0.00774 | -0.00965 |
| Response of GOLDRETURN: | | | | | | |
| Period | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIN | SP500RETURN | USDTRYRETURN |
| 1 | 0.003109 | -0.004095 | 0.04808 | 0.000467 | -0.001027 | -0.002468 |
| | -0.00356 | -0.00356 | -0.00252 | -0.00356 | -0.00356 | -0.00356 |
| 2 | 0.003103 | -0.003193 | -0.009271 | 0.003157 | -0.001679 | 0.002162 |
| | -0.00399 | -0.00421 | -0.00382 | -0.00412 | -0.00392 | -0.00475 |
| 3 | 0.001069 | 0.002924 | 0.000724 | -0.000215 | -0.002354 | 0.00017 |
| | -0.004 | -0.00423 | -0.00381 | -0.00438 | -0.00395 | -0.00472 |
| 4 | 0.006277 | -0.009714 | 0.001965 | 0.000228 | -0.0001 | -0.008984 |
| | -0.00395 | -0.00414 | -0.00384 | -0.00414 | -0.00399 | -0.00468 |
| 5 | 0.005093 | 0.000264 | -0.00112 | 0.007754 | 0.001184 | -0.004472 |
| | -0.00392 | -0.00436 | -0.0039 | -0.00419 | -0.00406 | -0.00507 |
| 6 | -0.006131 | 0.009872 | 0.002523 | 0.003988 | -0.000267 | 0.006586 |
| | -0.00399 | -0.00436 | -0.00398 | -0.00407 | -0.00412 | -0.00511 |
| 7 | 0.006509 | -0.003858 | 0.006009 | -0.00133 | 0.002223 | -0.007627 |
| | -0.00403 | -0.00442 | -0.00403 | -0.00327 | -0.00417 | -0.00499 |
| 8 | -0.000452 | -0.002525 | -0.003763 | -0.00266 | 0.001115 | -0.001326 |
| | -0.00285 | -0.0031 | -0.00309 | -0.00315 | -0.00251 | -0.00359 |
| 9 | 0.003853 | -0.000465 | 0.000176 | -0.00499 | 0.001987 | 0.003588 |
| | -0.00261 | -0.00289 | -0.00259 | -0.00308 | -0.00241 | -0.0034 |
| 10 | 0.000226 | 0.001069 | -0.001177 | -0.002671 | 0.001186 | -0.002368 |
| | -0.00245 | -0.00271 | -0.00248 | -0.00288 | -0.00233 | -0.00325 |

**APPENDIX C :** Impulse Response Function Table of VAR Model (continued).

| Response of HOUSEPRICEINDEXRETURN: | | | | | | |
|---|---|---|---|---|---|---|
| Period | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIN | SP500RETURN | USDTRYRETURN |
| 1 | 3.56E-05 | -9.92E-05 | 2.35E-05 | 0.002426 | -0.000284 | -7.40E-05 |
| | -0.00018 | -0.00018 | -0.00018 | -0.00013 | -0.00018 | -0.00018 |
| 2 | 0.000292 | -0.000529 | -4.46E-05 | 0.003356 | -0.000256 | -0.000335 |
| | -0.00032 | -0.00032 | -0.00031 | -0.00027 | -0.00032 | -0.00034 |
| 3 | 0.000284 | -0.000496 | -0.000295 | 0.003388 | -0.000287 | -0.000138 |
| | -0.00042 | -0.00044 | -0.0004 | -0.00041 | -0.00041 | -0.0005 |
| 4 | 0.000501 | -0.000462 | -0.000508 | 0.002178 | -0.000104 | 1.62E-05 |
| | -0.00046 | -0.0005 | -0.00042 | -0.00049 | -0.00045 | -0.00059 |
| 5 | 0.00019 | 6.67E-05 | -0.000624 | 0.001553 | -3.98E-05 | 0.000404 |
| | -0.00047 | -0.00054 | -0.00044 | -0.00052 | -0.00047 | -0.00065 |
| 6 | -0.000161 | 0.000446 | -0.000776 | 0.001438 | -0.000272 | 0.000589 |
| | -0.00049 | -0.00058 | -0.00045 | -0.00054 | -0.00049 | -0.00071 |
| 7 | -0.000583 | 0.0006 | -0.000872 | 0.001736 | -0.000434 | 0.000785 |
| | -0.00051 | -0.00063 | -0.00048 | -0.00055 | -0.00051 | -0.00078 |
| 8 | -0.000535 | 0.00042 | -0.000989 | 0.001631 | -0.000414 | 0.000735 |
| | -0.0005 | -0.00065 | -0.00049 | -0.00056 | -0.0005 | -0.00082 |
| 9 | -0.00041 | 0.000351 | -0.00103 | 0.001231 | -0.00022 | 0.0008 |
| | -0.00047 | -0.00063 | -0.00047 | -0.00057 | -0.00046 | -0.00081 |
| 10 | -0.000278 | 0.000356 | -0.000949 | 0.000768 | -0.000141 | 0.000784 |
| | -0.00043 | -0.00059 | -0.00043 | -0.00058 | -0.0004 | -0.00077 |
| Response of SP500RETURN: | | | | | | |
| Period | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIN | SP500RETURN | USDTRYRETURN |
| 1 | 0.018117 | -0.016758 | -0.000758 | -0.004159 | 0.035495 | -0.014647 |
| | -0.00245 | -0.00248 | -0.00263 | -0.00262 | -0.00186 | -0.00252 |
| 2 | 0.008352 | -0.00078 | 0.00291 | 0.003594 | 0.002824 | -0.001417 |
| | -0.00296 | -0.00315 | -0.00288 | -0.00308 | -0.00293 | -0.00354 |
| 3 | -0.003903 | 0.005349 | -0.004273 | 0.007119 | -0.004892 | 0.008393 |
| | -0.00309 | -0.0033 | -0.00292 | -0.00341 | -0.00303 | -0.00373 |
| 4 | 0.001526 | 0.000117 | 0.002392 | 0.006077 | 0.002375 | 0.000311 |
| | -0.00306 | -0.00327 | -0.00295 | -0.00327 | -0.00306 | -0.00374 |
| 5 | 0.000329 | -0.001824 | 0.002052 | 0.002091 | 0.004036 | 0.000824 |
| | -0.00302 | -0.00338 | -0.00294 | -0.00325 | -0.00306 | -0.00395 |
| 6 | 0.000561 | -0.000513 | -5.91E-05 | 0.003839 | -0.001931 | 0.001517 |
| | -0.00301 | -0.00339 | -0.00294 | -0.00307 | -0.00304 | -0.00401 |
| 7 | -0.00321 | 0.002824 | -0.000304 | 0.004394 | -0.009789 | 0.003769 |
| | -0.00309 | -0.00344 | -0.00301 | -0.00272 | -0.00308 | -0.00397 |
| 8 | 9.28E-05 | -0.001622 | 0.000195 | 0.004705 | -0.00147 | -0.001507 |
| | -0.00213 | -0.00254 | -0.00206 | -0.00255 | -0.00247 | -0.00292 |
| 9 | 0.000323 | -0.000305 | -0.00034 | 0.002084 | 0.00151 | -6.76E-05 |
| | -0.00186 | -0.00231 | -0.00173 | -0.00247 | -0.00231 | -0.00255 |
| 10 | -0.001267 | 0.000235 | -0.000525 | 0.001932 | -0.002936 | 0.000563 |
| | -0.00164 | -0.00207 | -0.0015 | -0.00209 | -0.00213 | -0.00229 |
| Response of USDTRYRETURN: | | | | | | |
| Period | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIN | SP500RETURN | USDTRYRETURN |
| 1 | -0.01931 | 0.027541 | -0.002096 | -0.001245 | -0.016852 | 0.040837 |
| | -0.00285 | -0.00266 | -0.00303 | -0.00303 | -0.0029 | -0.00214 |
| 2 | -0.006926 | 0.004812 | -0.011779 | -0.004875 | -0.003972 | 0.009847 |
| | -0.0035 | -0.00369 | -0.00334 | -0.00362 | -0.00345 | -0.00411 |
| 3 | -0.000489 | 0.000619 | 0.000514 | 0.001597 | 0.003128 | -0.002301 |
| | -0.00353 | -0.00382 | -0.0033 | -0.00395 | -0.00345 | -0.0044 |
| 4 | 0.000968 | 0.001509 | -0.004386 | 0.000473 | 0.000497 | 0.005673 |
| | -0.00345 | -0.00371 | -0.0033 | -0.00376 | -0.00346 | -0.00427 |
| 5 | -0.002321 | 0.006008 | -0.003547 | -0.00613 | 0.00167 | 0.005169 |
| | -0.00345 | -0.0039 | -0.00336 | -0.00367 | -0.00351 | -0.0046 |
| 6 | -0.001386 | 0.002089 | -0.000425 | -0.009901 | 0.00066 | -0.001457 |
| | -0.00352 | -0.00404 | -0.00345 | -0.00359 | -0.00357 | -0.00482 |
| 7 | 0.003045 | -0.000721 | -0.000247 | -0.006493 | 0.005783 | 0.003916 |
| | -0.0036 | -0.0041 | -0.0035 | -0.00327 | -0.00362 | -0.00481 |
| 8 | -0.002448 | 0.003247 | -0.003165 | -0.003408 | 0.001141 | 0.004933 |
| | -0.00254 | -0.00308 | -0.00259 | -0.00302 | -0.00263 | -0.00387 |
| 9 | -0.001422 | 0.000847 | 0.000639 | 0.000407 | -0.001577 | 0.001051 |
| | -0.00216 | -0.00272 | -0.00221 | -0.00294 | -0.00223 | -0.00336 |
| 10 | 0.0011 | -0.002207 | 0.000429 | 0.002426 | 0.000725 | -0.000519 |
| | -0.00203 | -0.00253 | -0.00206 | -0.00278 | -0.00213 | -0.00323 |

**APPENDIX D :** Variance Decomposition Tables of VAR Model.

| Variance Decomposition of BIST100RETURN: | | | | | | | |
|---|---|---|---|---|---|---|---|
| Period | S.E. | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIND | SP500RETURN | USDTRYRETURN |
| 1 | 0.074502 | 10.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 0.079656 | 87.50438 | 2.43219 | 1.26342 | 4.80192 | 0.00000 | 3.69288 |
| 3 | 0.081253 | 84.18580 | 2.36184 | 1.46185 | 4.88105 | 0.00000 | 6.70608 |
| 4 | 0.082962 | 80.76804 | 4.63156 | 1.55155 | 5.21020 | 0.00000 | 7.45154 |
| 5 | 0.083804 | 79.17759 | 4.76941 | 1.54132 | 6.08944 | 0.00000 | 7.63280 |
| 6 | 0.085231 | 76.95878 | 4.65418 | 1.87153 | 7.43972 | 0.00000 | 8.26301 |
| 7 | 0.087953 | 72.34782 | 5.75320 | 1.99404 | 8.16280 | 3.04986 | 8.69229 |
| 8 | 0.088328 | 71.75537 | 5.71896 | 2.01514 | 8.56496 | 3.03919 | 8.90639 |
| 9 | 0.088461 | 71.55166 | 5.70314 | 2.00912 | 8.79267 | 3.05686 | 8.88655 |
| 10 | 0.088869 | 71.08012 | 5.66417 | 2.04558 | 9.11225 | 3.03461 | 9.06327 |
| Variance Decomposition of CDSRETURN: | | | | | | | |
| Period | S.E. | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIND | SP500RETURN | USDTRYRETURN |
| 1 | 0.148882 | 44.85492 | 55.14508 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 0.159174 | 42.38604 | 48.63614 | 3.32270 | 3.46584 | 0.00000 | 2.13944 |
| 3 | 0.161196 | 41.82574 | 47.44569 | 3.33697 | 3.97517 | 0.00000 | 2.73107 |
| 4 | 0.164400 | 40.21181 | 46.56853 | 3.82241 | 4.96655 | 1.19361 | 3.23710 |
| 5 | 0.166923 | 39.07044 | 47.18421 | 4.01240 | 4.93336 | 1.48157 | 3.31803 |
| 6 | 0.170415 | 37.63360 | 45.70980 | 4.23303 | 6.91737 | 1.81937 | 3.68683 |
| 7 | 0.173720 | 36.36406 | 44.40654 | 4.42022 | 6.93612 | 2.05756 | 5.81551 |
| 8 | 0.174850 | 35.91671 | 43.97633 | 4.79577 | 6.92603 | 2.12988 | 6.25527 |
| 9 | 0.174975 | 35.86660 | 43.93576 | 4.79029 | 7.00705 | 2.13966 | 6.26066 |
| 10 | 0.175722 | 35.96296 | 43.60214 | 4.74990 | 7.26052 | 2.19007 | 6.23442 |
| Variance Decomposition of GOLDRETURN: | | | | | | | |
| Period | S.E. | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIND | SP500RETURN | USDTRYRETURN |
| 1 | 0.048080 | 0.00000 | 0.00000 | 99.26400 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 0.049748 | 0.00000 | 0.00000 | 96.43660 | 0.00000 | 0.00000 | 1.18393 |
| 3 | 0.050137 | 0.00000 | 1.33810 | 94.98103 | 0.00000 | 1.03512 | 1.44712 |
| 4 | 0.051545 | 2.25183 | 3.33869 | 89.91194 | 0.00000 | 2.11623 | 2.01510 |
| 5 | 0.052982 | 3.05528 | 4.03241 | 85.15207 | 2.57101 | 2.01208 | 3.17715 |
| 6 | 0.054524 | 4.14935 | 5.83575 | 80.78622 | 3.07456 | 3.13330 | 3.02083 |
| 7 | 0.055657 | 5.34978 | 5.61514 | 78.55796 | 3.01710 | 3.03743 | 4.42260 |
| 8 | 0.056001 | 5.29081 | 6.00883 | 78.09710 | 3.22839 | 3.00039 | 4.37448 |
| 9 | 0.056688 | 5.62534 | 6.11660 | 76.21670 | 3.90793 | 2.92883 | 5.20461 |
| 10 | 0.056936 | 5.57799 | 6.14675 | 75.59132 | 4.08261 | 2.94350 | 5.65783 |
| Variance Decomposition of HOUSEPRICEINDEXRETURN: | | | | | | | |
| Period | S.E. | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIND | SP500RETURN | USDTRYRETURN |
| 1 | 0.002426 | 0.00000 | 0.00000 | 0.00000 | 99.79957 | 0.00000 | 0.00000 |
| 2 | 0.004162 | 0.00000 | 1.22256 | 0.00000 | 98.20361 | 0.02099 | 0.00000 |
| 3 | 0.005398 | 0.00000 | 1.30799 | 0.00000 | 97.39766 | 0.04592 | 0.00000 |
| 4 | 0.005888 | 1.20546 | 1.18328 | 1.23091 | 95.46217 | 0.12015 | 0.00000 |
| 5 | 0.006156 | 1.19757 | 1.26193 | 2.15138 | 93.78757 | 0.13167 | 1.46987 |
| 6 | 0.006404 | 1.16992 | 1.67233 | 3.33328 | 91.90743 | 0.12605 | 1.79098 |
| 7 | 0.006747 | 1.79975 | 1.68160 | 4.48625 | 89.63198 | 0.14058 | 2.25984 |
| 8 | 0.007060 | 2.21738 | 1.54992 | 5.91996 | 87.33206 | 0.13085 | 2.84983 |
| 9 | 0.007296 | 2.39250 | 1.47101 | 7.42747 | 84.69918 | 0.15430 | 3.85555 |
| 10 | 0.007445 | 2.43714 | 1.50708 | 8.66362 | 82.45589 | 0.16761 | 4.76867 |
| Variance Decomposition of SP500RETURN: | | | | | | | |
| Period | S.E. | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIND | SP500RETURN | USDTRYRETURN |
| 1 | 0.035495 | 26.05234 | 3.07792 | 0.00000 | 1.73491 | 68.71891 | 0.00000 |
| 2 | 0.037335 | 28.55294 | 5.79642 | 0.00000 | 2.56523 | 62.12809 | 0.00000 |
| 3 | 0.039181 | 26.91819 | 6.14691 | 1.78660 | 5.85969 | 56.63385 | 2.65475 |
| 4 | 0.039941 | 26.04957 | 6.06277 | 2.07695 | 7.97895 | 55.22652 | 2.60525 |
| 5 | 0.040512 | 25.32641 | 6.17692 | 2.24254 | 7.99559 | 55.01010 | 3.24843 |
| 6 | 0.040816 | 24.97021 | 6.08750 | 2.21001 | 8.75660 | 54.46384 | 3.51185 |
| 7 | 0.042171 | 23.97013 | 5.74877 | 2.07032 | 9.33317 | 55.50365 | 3.37396 |
| 8 | 0.042511 | 23.58872 | 5.90123 | 2.03762 | 10.36554 | 54.74977 | 3.35713 |
| 9 | 0.042610 | 23.48514 | 5.87466 | 2.03569 | 10.55559 | 54.69461 | 3.35432 |
| 10 | 0.042767 | 23.40137 | 5.86901 | 2.03402 | 10.68021 | 54.68470 | 3.33069 |
| Variance Decomposition of USDTRYRETURN: | | | | | | | |
| Period | S.E. | BIST100RETURN | CDSRETURN | GOLDRETURN | HOUSEPRICEIND | SP500RETURN | USDTRYRETURN |
| 1 | 0.040837 | 22.35777 | 23.20448 | 0.00000 | 0.00000 | 1.09746 | 53.33496 |
| 2 | 0.044109 | 21.63018 | 19.89298 | 6.63687 | 1.13399 | 1.16892 | 49.53706 |
| 3 | 0.044478 | 21.28432 | 19.57161 | 6.54348 | 1.24768 | 2.15468 | 49.19823 |
| 4 | 0.045276 | 20.58657 | 19.29968 | 7.21701 | 1.22216 | 2.08644 | 49.58814 |
| 5 | 0.046388 | 19.86199 | 20.05764 | 7.31323 | 2.74456 | 2.57238 | 47.45020 |
| 6 | 0.047626 | 18.92757 | 19.13625 | 6.94072 | 6.85821 | 2.44747 | 45.68978 |
| 7 | 0.048867 | 18.36658 | 18.30857 | 6.59759 | 8.26581 | 3.14400 | 45.31744 |
| 8 | 0.049411 | 18.20959 | 18.09937 | 6.79639 | 8.52170 | 3.35146 | 45.02150 |
| 9 | 0.049450 | 18.26371 | 18.07177 | 6.80727 | 8.51546 | 3.38183 | 44.95996 |
| 10 | 0.049575 | 18.22055 | 18.13978 | 6.77532 | 8.69288 | 3.36587 | 44.80560 |
| | | | | | | | |
| Cholesky Ordering: BIST100RETURN CDSRETURN GOLDRETURN HOUSEPRICEINDEXRETURN SP500RETURN USDTRYRETURN | | | | | | | |

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