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The Impact of Earnings Per Share on Firm Valuation Indicators: Evidence from the BIST Banking Index

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Abstract

This study aims to reveal the effect of earnings per share on firm valuation indicators. For this purpose, the current study is conducted specifically on the BIST banking index and covers the period between 2000 and 2023. In the study, Price-to-Earnings/Earnings-to-Growth (PEG), Price-to-Earnings (PE), and Price-to-Book (PB) are used as dependent variables for firm valuation indicators, while Earnings per Share (EPS) is used as an independent variable. However, the variables Net Profit/Loss (NP) and Firm Age (AGE) constitute the control variables of the study. Long-term cointegration estimators (CUP-FM and BA-OLS) and the Panel Asymmetric Causality test are used to reveal the relationship between variables. According to long-term cointegration results, the EPS negatively affects the PEG and positively affects the PE. However, no statistically significant relationship is found between the EPS and the PB. According to the results of the Panel Asymmetric Causality analysis, a Granger causality link is found from positive shocks in the EPS variable to positive shocks in the dependent variables and from negative shocks in the EPS variable to negative shocks in the dependent variables. The findings indicate that reliance on a single indicator should be avoided in the firm valuation process.

Keywords: *Earnings Per Share, Firm Valuation, Panel Asymmetric Causality*

Jel Codes: *C33, D53, O16*

Pay Başına Düşen Kârın Şirket Değerleme Göstergeleri Üzerindeki Etkisi: BİST Bankacılık Endeksinden Kanıtlar

Öz

Bu çalışmada, pay başına düşen kar kaleminin şirket değerleme göstergeleri üzerindeki etkisinin ortaya çıkarılması amaçlanmaktadır. Bu amaç doğrultusunda mevcut çalışma, BİST bankacılık endeksi özelinde ve 2000-2023 dönem aralığında gerçekleştirilmektedir. Çalışmada, şirket değerleme göstergeleri olarak Fiyat-Kazanç/Kazanç-Büyüme Oranı (PEG), Fiyat/Kazanç Oranı (PE) ve Defter Değeri (PB) bağımlı değişken olarak kullanılırken, pay başına kar göstergesi (EPS) ise bağımsız değişken olarak kullanılmıştır. Bununla birlikte, Net Kar/Zarar (NP) ve şirket yaşı (AGE) değişkenleri ise çalışmanın kontrol değişkenlerini oluşturmaktadır. Değişkenler arasındaki ilişkiyi ortaya çıkarmak amacıyla uzun dönemli eşbütünleşme tahmincileri (CUP-FM ve BA-OLS) ve Panel Asimetrik Nedensellik testinden faydalanılmıştır. Uzun dönemli eşbütünleşme sonuçlarına göre EPS oranı PEG oranını negatif, PE oranını ise pozitif yönde etkilemektedir. Bununla birlikte EPS oranı ile PB oranı arasında istatistiki olarak anlamlı bir ilişki elde edilememiştir. Panel Asimetrik Nedensellik sonuçlarına göre ise EPS değişkendeki pozitif şoklardan bağımlı değişkenlerdeki pozitif şoklara ve EPS değişkendeki negatif şoklardan bağımlı değişkenlerdeki negatif şoklara doğru bir Granger nedensellik bağlantısı olduğunu bulgulanmıştır. Bulgular, şirket değerleme sürecinde tek bir göstergeye bağlı kalınmamasını göstermektedir.

Anahtar Kelimeler: *Hisse Başına Kâr, Şirket Değerleme, Panel Asimetrik Nedensellik.*

Jel Kodu: *C33, D53, O16*

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INTRODUCTION

There are different instruments that investors can invest in financial markets. These instruments can be categorized as stocks, mutual funds, bonds, and bills. Investors can choose between investment instruments according to their return expectations and risk perception and form a portfolio as a whole (Hoffmann & Post, 2017:759). In this context, the valuation of the investment instrument is a matter of great importance. As such, a rational investor should first comprehensively evaluate the performance of the investment instrument. To make a comprehensive and healthy valuation, all information about the relevant investment instrument should be available in the market and there should be no asymmetric information problem. Otherwise, it can be stated that the valuation results obtained will mislead investors, in other words, it will cause an adverse selection problem (Aldea & Marin, 2007:22).

The price formation process of an investment instrument is of great interest to researchers and investors. The Efficient Market Hypothesis introduced by Fama (1970) states that in an efficient market, the price of an investment instrument is formed randomly and therefore the random walk model is valid in the price formation process of investment instruments. According to the theory, all known information is reflected in prices. Therefore, information that causes prices to change is unpredictable. Based on this information about the theory, it can be said that in an efficient market, above-normal (above-index) returns cannot be obtained and prices cannot be predicted in advance. However, some studies in the literature suggest that markets may deviate from efficiency, and thus abnormal returns may be obtained (Chaudhuri & Wu, 2003; Palamalai et al., 2021; Asaad & Omer, 2024). This situation is referred to as an anomaly in the literature (Mandacı, 2021:116). Anomalies can be categorized into different groups as time-dependent, non-periodic, and technical (Turaboğlu & Nur Topaloğlu, 2017:218). With the increasing number of studies on anomalies, it has become clear that abnormal returns can be obtained in inefficient financial markets. As a result of these developments, firm valuation methods have gained importance, especially in the eyes of investors, and have been influential in the investment decision-making process. Therefore, it is considered important for both market participants and the literature to investigate the question “How does earnings per share affect firm valuation?” in terms of different valuation indicators.

Therefore, this study aims to reveal the relationship between PEG (Price-to-Earnings/Earnings-to-Growth), PE (Price-to-Earnings), and PB (Price-to-Book) indicators and EPS (Earnings per Share). In line with this objective, it can be stated that the current study is conducted on the BIST banking index for the period 2000-2023. In this study, CUP-FM and BA-OLS long-run cointegration estimators and Panel Asymmetric Causality tests are used to reveal the relationship between firm valuation indicators and earnings per share. However, to the best of our knowledge, this is the first time that the relationship between PEG, PE, and PB firm valuation indicators and EPS is investigated by including net Profit/Loss (NP) and firm age (AGE) control variables in the model. This gap in the literature reveals the originality of the current study. In addition, the study consists of five chapters: introduction, literature review, methodology, findings, and conclusions and recommendations. The findings of the study are expected to be useful for the related parties and ongoing field studies by comparing firm valuation indicators.

1. LITERATURE REVIEW

Firm valuation is an important issue for both investors and field studies. The importance of the valuation issue will be better understood if it is considered that the rational investor will not invest only with emotional feelings without valuation, but will act with measurable, calculable, and objective data. A review of the literature on the subject reveals that the issue of firm valuation has been addressed by different researchers for many years with different research questions (Berger & Ofek, 1995; Cheng & Tzeng, 2011; Margono & Gantino, 2021). As it is the subject of the current study, only the studies that examine the effect of earnings per share on firm valuation will be mentioned here. In this respect, Auret and De Villiers (2000) investigated the effect of earnings per share and dividends per share indicators on stock prices. The study was based on the period between 1981 and 1997 and examined 67 industrial firms traded on the Johannesburg Stock Exchange. The analysis revealed that earnings per share had a greater impact on stock prices than dividends per share. De Villiers et al. (2003), who addressed a similar topic through different variables, investigated the effect of earnings per share and cash flow per share variables on share price. The study found that simultaneous annual changes in earnings per share are statistically more meaningful in explaining annual changes in stock prices. On the other hand, Foerster et al. (2009), who brought a different perspective to the literature, examined the effect of earnings forecasts made by firm management on firm risk and value. The study examined publicly traded US firms between 1998 and 2007. The study using panel data analysis methods found a negative relationship between earnings forecasts and firm risk, while a positive relationship was found between earnings forecasts and firm value. In another study in the literature, Bhatt and Sumangala (2012) investigated the effect of earnings per share on market value for the 50 most valuable firms in India. The study, which was limited to a five-year data set, found that earnings per share affected market value.

Islam et al. (2014), who investigated the effect of earnings per share on firm value and share price, analyzed a 110-year data set on the banking sector. As a result of the analysis, it was determined that the share price increased slightly as earnings per share increased. Therefore, earnings per share has a positive, although limited, effect on firm value. The study also suggests some internal and external reasons, particularly macroeconomic and microeconomic factors, as the justification for this result. In another study on the banking sector, Talamati and Pangemanan (2015) examine the effect of earnings per share and return on equity on stock prices. The study conducted specifically for Indonesia covers the period 2010-2014 and examines five different banks. The analysis revealed a high correlation between the variables and found that the earnings per share indicator had a statistically significant and positive effect on stock prices. In another study in the literature, Indriawati (2018) investigates the relationship between earnings per share and several financial indicators and firm value for the Jakarta Islamic Index for the period 2013-2015. As a result of the study, it was found that earnings per share does not affect firm value. As a possible reason for this finding, it is stated that the value of the firm may not be affected when firms distribute their profits. Similarly, Ratnasari and Muniarty (2020) found that earnings per share did not affect firm value in their study on Indonesia for the period 2014-2018. In another study introduced to the literature the following year, Arsal (2021) analyzed the impact of earnings per share and dividend per share ratios on firm value for the country of Indonesia for the period 2014-2017. As a result of the study, it is determined that the earnings per share ratio has a positive effect on firm value, but the dividend per share ratio does not affect firm value. Internal and external factors are cited as possible reasons for this result. On the other hand, Safitri and Affandi (2022) investigated the effect of earnings per share

on the valuation indicator Price to Book Value (PB) and found that earnings per share has no direct effect on the valuation indicator. The study also states that earnings per share positively affect the PB variable when firm size is used as an intermediary variable. The reason for this result is that firm size is an important factor in company valuation.

In another recent study, Anton et al. (2023) examined the impact of earnings per share and various financial indicators on firm value in the agricultural sector for the period 2016-2021. As a result of the study in which the PB ratio was used as a firm valuation indicator, it was found that earnings per share did not have a statistically significant effect on the PB ratio. Similarly, Oktaviani et al. (2023) found that earnings per share does not affect the PB variable. The possible reason for this result is that high earnings per share does not always imply high valuation. In another study introduced to the literature in the same year, Arsifa and Tansar (2023) found that earnings per share have a modest positive effect on firm value. This finding is evaluated in the context of the implementation regulation. Similarly, Effendi (2024) finds that earnings per share have a positive effect on firm value. This result is interpreted as high earnings per share will attract investor interest and thus increase firm value. Another study that found similar results was contributed to the literature by Sulistiani and Ryanto (2024). The study was conducted based on the 2020-2022 period and focused on 94 companies listed on the Indonesia Stock Exchange (BEI). The study found that earnings per share positively affected stock returns. In contrast, Juniandra et al. (2024), in their study specific to the BEI stock exchange for the period 2018-2022, found that statistically significant results were not obtained between the earnings per share indicator and firm value. In other words, the study concludes that the earnings per share indicator does not affect the firm's value. This finding is interpreted in the context that the high earnings per share indicator does not always affect the firm value or contribute to the firm value immediately. In another recent study, Suryana et al. (2025) investigated the moderating effect of earnings per share on the relationship between economic value added and return on equity. The study was conducted specifically on Indonesian telecommunications firms during the 2017-2022 period. The analysis revealed that earnings per share had an indirect effect on the study. This finding is interpreted in the context of increasing the predictive power of the earnings per share variable.

1.1. Literature Gap

As can be seen from the above-mentioned literature studies, there is no conclusive finding on the relationship between earnings per share and firm value. While a positive relationship was found in some studies and a negative relationship was found in some studies, no significant relationship was found in some studies. Therefore, it can be said that literature studies are ongoing. However, to the best of our knowledge, there is no study in which the PEG ratio is examined alongside other firm valuation indicators by including the study's control variables in the model. Thus, the present study is expected to fill the gap in the literature, contribute to the ongoing field studies, and provide useful information to the relevant parties (investors and policymakers).

2. METHODOLOGY

In this section of the study, detailed information about the variables used in the study, the models developed and the econometric process applied will be provided.

2.1. Scope and Data Set

This study analyzes the impact of earnings per share on firm valuation indicators. In line with this objective, it can be stated that the current study is conducted on the BIST banking index for the period 2000-2023. Accordingly, the list of banks that are continuously traded in the BIST banking index between 2000 and 2023, and thus included in the analyses conducted in the current study, and the list of banks included in the banking index but excluded from the analysis are presented in Table 1 below;

Table 1: Study Scope

List of Banks Included in the Analyses			
Queue	Code	Name	Public Offering Date
1	AKBNK	Akbank T.A.Ş.	1990
2	GARAN	Türkiye Garanti Bankası A.Ş.	1990
3	ICBCT	ICBC Turkey Bank A.Ş.	1990
4	ISCTR	Türkiye İş Bankası A.Ş.	1986
5	SKBNK	Şekerbank T.A.Ş.	1997
6	TSKB	Türkiye Sınai Kalkınma Bankası A.Ş.	1986
7	YKBNK	Yapı ve Kredi Bankası A.Ş.	1987
List of Banks not Included in the Analyses.			
Queue	Code	Name	Public Offering Date
1	ALBRK	Albaraka Türk Katılım Bankası A.Ş.	2007
2	HALKB	Türkiye Halk Bankası A.Ş.	2007
3	ISATR	Türkiye İş Bankası A.Ş.	1986
4	ISBTR	Türkiye İş Bankası A.Ş.	1986
5	VAKBN	Türkiye Vakıflar Bankası T.A.O.	2005

The table above shows the list of banks traded in the BIST banking index that are included and excluded in the analyses conducted within the scope of the current study. When the information in the table is analyzed, it is seen that seven banks are included in the analysis and five banks are excluded within the scope of the study. Considering that the scope of the study covers the period 2000-2023, it can be said that ALBRK and HALKB-coded banks are excluded from the scope since they were publicly offered in 2007, while VAKBN-coded bank was publicly offered in 2005. However, the table above shows that there are three different stock certificates in the name of Türkiye İş Bankası A.Ş. These can be listed as ISATR, ISBTR, and ISCTR. Among these, ISCTR-coded stock is an indicator for investors on behalf of Türkiye İş Bankası A.Ş. and has a higher trading volume compared to the other two stocks. ISATR and ISBTR stocks, on the other hand, have almost no trading volume and extraordinary price movements can be observed from time to time. Based on this information, to obtain consistent and reliable results, ISCTR-coded stocks of Türkiye İş Bankası A.Ş. are taken as a basis, while ISATR and ISBTR-coded stocks are excluded from the scope.

The data set of the current study includes dependent, independent, and control variables. Firm valuation indicators constitute the dependent variables of the current study, while the earnings per share indicator constitutes the independent variable of the study. In addition, net profit/loss and company age, which are thought to affect firm valuation indicators, constitute the control variables of the study. Based on this information, explanatory information on the variables used in the study is given in Table 2 below;

Table 2: Variables

	Description	Symbol	Calculation Method
Dependent Variable	Price-to-earnings/Earnings to Growth ratio	PEG	$\frac{\text{Share Price}/_{Earnings\ per\ Share}}{Earnings\ per\ Share\ Growth}$
	Price-to-earnings	PE	$\frac{\text{Share Price}}{\text{Earnings per Share}}$
	Price-to-book	PB	$\frac{\text{Market Capitalization}}{\text{Book value of Equity}}$
Independent	Earnings per share	EPS	$\frac{\text{Earning after Tax}}{\text{Outstanding Shares}}$
Control	Net profit/loss	NP	Ln (Net profit/loss)
	Firm Age	AGE	Ln (Firm Age)

When the table above is analyzed, it is seen that the firm valuation indicators, which constitute the dependent variable of the current study, are represented by the symbols PEG, PE, and PB, while the independent variable of the study, earnings per share, is represented by the EPS indicator, and the control variables of the study, net profit/loss and company age, are represented by the indicators NP and AGE, respectively. The PEG ratio is the PE indicator divided by the profit growth rate. Therefore, the PEG ratio is the PE ratio adjusted for the profit growth rate. In this respect, the PEG variable is considered to be more inclusive than the PE variable in terms of considering expectations. A PEG ratio of 1 means that firm stocks and profit growth may be compatible, a ratio less than 1 means that firm stocks may be undervalued relative to profit growth, and a ratio greater than 1 means that firm stocks may be overvalued relative to profit growth (Lajevardi, 2014:1403). PE, another dependent variable of the current study, is calculated as the ratio of stock price to earnings per share (Icke & Ayturk, 2011:104). This ratio, which is frequently used by investors as a company valuation method, shows how much investors are willing to pay for each 1 unit of profit per share (Samiloglu & Akgun, 2015:440). The third and final dependent variable of the study, PD, is calculated as the ratio of the market value of the stock to the value of equity per share (Toraman & Korpi, 2015:44). This ratio, which is another indicative valuation method, shows how many times the market capitalization of a firm exceeds its equity value. If the PE and PB ratios described above are higher than those of competitors or the sector average, it means that the firm's stocks may be overvalued, while the opposite situation means that the firm's stocks may be undervalued. On the other hand, the earnings per share indicator, which is the independent variable of the study, is obtained by dividing after-tax corporate profit by outstanding shares. Net profit/loss and firm age variables, which are thought to affect the dependent variables of the study, constitute the control variables of the study. Firms will be able to pay per share based on net profit. Therefore, for dividend investors, the net profit/loss item is considered to be an important indicator in firm valuation. In addition, as companies get older, they will become more institutionalized. In this context, it is thought that institutionalization may also have an impact on firm valuations, especially on value investors.

2.2. Developed Models and Hypotheses

Firm valuation indicators, which are the dependent variables of the study, are represented by three different variables. Therefore, it can be stated that three different models are developed in this study based on the dependent variables. These models are presented in the following equations respectively;

Model 1;

$$PEG_{it} = \beta_{0it} + \beta_{1it}EPS_{it} + \beta_{2it}NP_{it} + \beta_{3it}AGE_{it} + \epsilon_{it} \quad (1)$$

Model 2;

$$PE_{it} = \beta_{0it} + \beta_{1it}EPS_{it} + \beta_{2it}NP_{it} + \beta_{3it}AGE_{it} + \epsilon_{it} \quad (2)$$

Model 3;

$$PB_{it} = \beta_{0it} + \beta_{1it}EPS_{it} + \beta_{2it}NP_{it} + \beta_{3it}AGE_{it} + \epsilon_{it} \quad (3)$$

In the above equation, t is the time dimension, i is the cross-sectional dimension, β_0 is the constant coefficient, $\beta_{1,2\ ve\ 3}$ are the slope coefficients of the independent variables and finally ϵ is the model error term. The hypotheses tested with the help of these three models are shown in the table below;

Table 3: Tested Hypotheses

Hypotheses	Description
Hypothesis 1	H_0: There is no linkage between EPS and PEG. H_1: There is a linkage between EPS and PEG.
Hypothesis 2	H_0: There is no linkage between EPS and PE. H_1: There is a linkage between EPS and PE.
Hypothesis 3	H_0: There is no linkage between EPS and PB. H_1: There is a linkage between EPS and PB.

When the table above, which shows the hypotheses tested based on the models developed in the study, is analyzed, it can be stated that the first hypothesis tests the linkage between EPS and PEG, the second hypothesis tests the linkage between EPS and PE and finally the third hypothesis tests the linkage between EPS and PB. However, the question of whether the H_0 hypothesis or the H_1 hypothesis is rejected in the established hypotheses will be decided as a result of the analysis. However, the detailed equations and explanations of the tests used in the study have been moved to the Appendix section in order to maintain the flow of the text.

3. FINDINGS

In this section of the study, the findings obtained as a result of the econometric process described in detail above will be discussed. In this context, firstly, descriptive statistics information is given to see the structure of the study data set. The results are presented in Table 4 below;

Table 4: Descriptive Statistics

Variables	Mean	Median	Max.	Min.	Skewness	Kurtosis	J-B

PEG	0.1882	0.0030	26.2959	0.0002	12.7158	163.735	185379.1***
PE	12.2932	8.1241	110.8958	0.6153	3.8373	19.2861	2268.968***
PB	1.2598	1.0222	4.2495	0.2276	1.5550	5.2564	103.3455***
EPS	1.0663	0.4441	20.7932	0.0000	5.2435	34.0648	7525.026***
NP	20.3350	20.8177	25.1929	14.5333	-0.2189	2.5637	2.6751
AGE	4.0645	4.1431	4.5951	2.7725	-1.5867	5.3542	109.2967***

Note: ***, **, and * indicate respectively statistical significance at the 1, 5, and 10 percent levels.

When the table above, in which descriptive statistics of the variables used in the current study are presented, it is seen that the variable with the highest mean is the NP variable with a value of 20.33. In addition, it can be stated that the variable with the highest value in the study data set is PE, which has a value of 110.89, while the variable with the lowest value is EPS. On the other hand, when the Jarque-Bera results, which is an indicator of normal distribution, are analyzed, it is seen that all variables except the NP variable give statistically significant results at the 1% confidence level. In other words, it is determined that the NP variable shows normal distribution characteristics, but all other variables used in the study do not exhibit normal distribution characteristics. It can be said that the findings obtained regarding normal distribution are supported by skewness and kurtosis values.

In the next stage of the econometric process, the multicollinearity problem is tested with correlation analysis and VIF test. Since the variables used in the study do not exhibit normal distribution characteristics in general, Spearman method is preferred in correlation analysis. The findings are as in Table 5 below;

Table 5: Results of Correlation Analysis and VIF test

Panel A: Correlation Analysis			
Variables	EPS	NP	AGE
EPS	1.000		

NP	0.5372	1.000	
	[8.2065]	-----	
	(0.0000)	-----	
AGE	0.2543	0.7497	1.000
	[3.3884]	[14.5983]	-----
	(0.0009)	(0.0000)	-----
Panel B: VIF test			
Variables	Coefficient Variance	Uncentered VIF	Centered VIF
EPS	0.0042	1.2742	1.0751
NP	0.0104	1.0390	1.0386
AGE	0.1949	132.80	1.0951
C	3.1900	130.39	NA

Note: [ ] indicates t-stat values, ( ) indicates prob. values.

Panel A of the table above presents the results of the correlation analysis, while Panel B presents the results of the VIF test. Panel A shows that the highest correlation between the independent variables is found between the NP and AGE variables, which is 74.97% positive. However, when the VIF test results in Panel B of the table above are analyzed, it is seen that the central VIF value determined for the independent variables is shaped around 1. It is stated that a correlation of 80% or more

between independent variables (Correlation coefficient > 0.80) or a VIF value of 5 or more (VIF > 5) may cause multicollinearity problems in studies (Shrestha, 2020:41). In light of this information, it can be stated that the independent and control variables used in the study do not cause multicollinearity problem and the results of correlation analysis and VIF test support each other in this context.

When the preliminary tests of the study tested so far are evaluated in general, it can be interpreted that the variables used in the study do not pose any problems and that there is no problem in modeling the variables by using them together. Based on these results, in the next step of the econometric process, the cross-section dependence test, which is one of the basic assumptions of the panel data analysis method, is analyzed. The findings are presented in the table below;

Table 6: Results of Cross-Section Dependence Test

Variables	LM	CD_{LM}	CD	LM_{Adj}
PEG	374.3875***	54.5288***	18.3467***	54.3767***
PE	88.1643***	10.3636***	5.8002***	10.2115***
PB	165.1283***	22.2394***	8.2661***	22.0873***
EPS	386.6538***	56.4216***	19.4431***	56.2694***
NP	373.8658***	54.4483***	19.1875***	54.2962***
AGE	503.2278***	74.4093***	74.2571***	22.4327***

Note: ***, **, and * indicate respectively statistical significance at the 1, 5, and 10 percent levels.

The table above, which shows the results of the cross-sectional dependence tests on a variable basis, shows that the analysis is performed with four different tests. Considering that the cross-sectional dimension is 7 and the time dimension is 24 in the study dataset, it can be stated that the results of the LM test developed by Breusch and Pagan (1980) should be taken into account among the tests in the table. In this context, the results of the LM test indicate that the null hypothesis is rejected and cross-section dependence is detected in all variables used in the study at the 1% confidence level. In other words, it can be stated that a shock to the variables used in the current study also affects other variables. However, it can be said that similar results are obtained in the other cross-section dependence tests in the table and the test results support each other.

Another basic assumption of the panel data analysis method is the homogeneity/heterogeneity test. The results of the Delta test are shown in Table 7 below;

Table 7: Results of Homogeneity/Heterogeneity Test

Variables	$\tilde{\Delta}$	$\tilde{\Delta}_{adj.}$
PEG	-1.565	-1.673
PE	6.561***	7.014***
PB	1.679**	1.795**
EPS	1.942**	2.076**
NP	0.981	1.049
AGE	25.167***	26.905***

Note: ***, **, and * indicate respectively statistical significance at the 1, 5, and 10 percent levels.

The table above presents the Delta test results tested on a variable basis. In this context, both delta and adjusted delta results show that all variables except PEG and NP are statistically significant. Based on these findings, it can be concluded that the null hypothesis cannot be rejected for PEG and NP variables, that is, the series are homogeneous, while all other variables are heterogeneous.

In the next stage of the econometric process, panel unit root tests are performed. At this point, unit root tests are divided into two groups: first-generation and second-generation. It can be stated that this distinction stems from whether the variables contain cross-sectional dependence or not. Since all variables used in the current study have cross-section dependence, second-generation unit root tests should be used in the unit root test of the study. In this context, the findings of the PANIC (with sharp breaks) test and the PANIC Fourier (with smooth breaks) test, which are the second-generation unit root tests used in this study, are shown in Table 8 below;

Table 8: Results of Panel Unit Root Test

Panel A: PANIC with sharp breaks (Bai ve Carrion-i-Silvestre, 2009)				
Variables	Level		First difference	
	P	P_m	P	P_m
PEG	3.688	-1.949	22.052*	1.522*
PE	3.781	-1.931	74.715***	11.474***
PB	6.959	-1.331	136.593***	23.168***
EPS	5.467	-1.612	50.814***	6.957***
NP	5.516	-1.603	53.853***	7.532***
AGE	8.718	-0.998	39.632***	4.844***
Panel B: PANIC Fourier with smooth breaks (Nazlıoglu et al., 2023)				
Variables	Level		First difference	
	P $m = 1{,}2$	P_m $m = 1{,}2$	P $m = 1{,}2$	P_m $m = 1{,}2$
PEG	15.684	0.318	35.898***	4.138***
PE	16.387	0.451	26.734**	2.406***
PB	11.564	-0.460	30.325***	3.085***
EPS	17.780	0.714	28.695**	2.777***
NP	14.559	0.105	24.746**	2.030**
AGE	11.022	-0.562	33.875***	3.756***

Note: ***, **, and * indicate respectively statistical significance at the 1, 5, and 10 percent levels.

Panel A of the table above presents the PANIC (with sharp breaks) test results, while Panel B presents the PANIC Fourier (with smooth breaks) test results. Firstly, Panel A of the table shows that the t-statistic values of all variables used in the study are not statistically significant at the level. However, the t-statistic values obtained after the first difference process are found to give statistically significant results. Based on these findings, according to the results of PANIC (with sharp breaks) test, it can be interpreted that all variables used in the study have unit roots at the level but become stationary after the first difference process.

On the other hand, Panel B of the table indicates that the test outputs are based on the cumulative frequency results of the test (m=1.2). However, it is seen that the t-statistic values obtained at the level of the variables are not statistically significant, while the t-statistic values determined after the first difference process are significant at 1% and 5% confidence levels. Therefore, according to the PANIC Fourier (with smooth breaks) test results, it can be stated that all variables used in the current study are non-stationary at the level and stationary after the first difference process. When the obtained panel unit root test results are evaluated in general terms, it can be stated that both tests give similar results and support each other, in other words, all variables used in the study have a unit root at the level ($X_{it} \sim I(1)$).

After determining that all variables used in the study contain unit roots at the level, the long-run cointegration relationship analysis proceeded. At this point, panel cointegration tests that take structural breaks into account, as in panel unit root analyses, are used in this study for completeness. The results of the Panel LM and Panel LM (Break) tests used for this

purpose are presented in Table 9 below

Table 9: Results of Panel Cointegration Test

Panel A: PANEL LM (Westerlund, 2006)		
Models	Constant	Constant+Trend
Model 1	-2.837	2.305
Model 2	1.143	-1.200
Model 3	1.950*	0.106
Panel B: PANEL LM (Break) (Westerlund and Edgerton, 2008)		
Models	Tau stat. (τ)	Phi stat. (φ)
Model 1	-3.002***	-2.167**
Model 2	-4.974 ***	-3.421***
Model 3	-4.681***	-2.594***

Note: ***, **, and * indicate respectively statistical significance at the 1, 5, and 10 percent levels.

Panel A of the above table shows the results of the Panel LM test for structural breaks in the level and trend. The output of this test calculates two different probability values: Asymptotic p-value and Bootstrap p-value. Bootstrap results are taken into account in studies with cross-section dependence, whereas Asymptotic results are taken into account otherwise. Since cross-sectional dependence is detected in all variables used in the current study, it can be stated that the interpretation of the above table is based on Bootstrap values. In the light of the information provided, it is seen that the LM stat. values calculated in the level and trend in all models developed in the current study are not statistically significant at the 5% confidence level. Recalling that the panel LM test is based on the opposite hypothesis (H_0: There is a cointegration linkage between the series), it can be stated that the null hypothesis cannot be rejected and a long-run cointegration relationship is detected in all models developed in the current study.

On the other hand, Panel B of the above table shows the results of the Panel LM (Break) test, which tests for general structural breaks in the cross-section and slope. It can be stated that two different probability values, τ and φ, are calculated in the panel results of the related test. As can be seen from the table, the probability values calculated for the models developed in the current study are statistically significant at the 5% confidence level. Recalling that the panel LM (Break) test is based on the straight hypothesis (H_0: There is no cointegration linkage between the series), it can be said that the null hypothesis is rejected and a long-run cointegration relationship is detected in all models developed in the current study. When the findings obtained for cointegration tests are evaluated in general terms, it can be interpreted that Panel LM and Panel LM (Break) tests provide similar results and support each other.

Since the long-run cointegration relationship is detected in all models developed in the current study, the next step of the econometric process is to estimate the long-run coefficient. The results of the CUP-FM and BA-OLS long-run cointegration estimators tested for this purpose are presented in Table 10 below;

Table 10: Results of Panel Cointegration Estimation

Panel A: Model 1 where dependent variable PEG				
Variables	CUP-FM		BA-OLS	
	Coefficient	t-stat.	Coefficient	t-stat.
EPS	-0.216***	-11.125	-0.248***	-12.787
NP	0.652***	10.008	0.670***	10.297
AGE	0.048	1.406	0.019	0.558
Panel B: Model 2 where dependent variable PE				
	CUP-FM		BA-OLS	

Variables	Coefficient	t-stat.	Coefficient	t-stat.
EPS	1.072***	3.635	1.257***	4.263
NP	-1.996	-1.282	-1.554	-0.998
AGE	4.909***	4.938	5.480***	5.512
Panel C: Model 3 where dependent variable PB				
Variables	CUP-FM		BA-OLS	
	Coefficient	t-stat.	Coefficient	t-stat.
EPS	0.012	0.550	0.015	0.641
NP	-0.043	-0.608	-0.053	-0.751
AGE	0.172***	3.996	0.184***	4.280

Note: ***, **, and * indicate respectively statistical significance at the 1, 5, and 10 percent levels.

Panel A of the table above presents the long-run cointegration estimation results for Model 1, Panel B for Model 2, and Panel C for Model 3. In this context, when the results of Model 1 with PEG as the dependent variable are analyzed, it is found that according to both CUP-FM and BA-OLS test results, EPS and NP variables give statistically significant results at 1% confidence level, while AGE variable gives statistically insignificant results. When the coefficient values of the variables that give statistically significant results are analyzed, it is seen that a 0.01 unit increase in the EPS variable causes a 0.24 unit decrease in the PEG variable. According to the financial hierarchy theory introduced by Myers and Majluf (1984), companies should first resort to self-financing, then to external debt, and finally to new stock issuance when they need financing. The main reason for this is the high cost of external resources. More precisely, increases in dividend payments cause firms to hold less cash and therefore less self-financing. As a result, firms may face problems in financing projects with favorable conditions and urgent cash needs and may be reluctant to make new investments necessary for their growth. In this context, in line with the theory, it is thought that the negative effect of increases in the EPS variable on the PEG variable can be explained. However, another result in the table is that a 0.01 unit increase in the NP variable leads to a 0.67 unit increase in the PEG variable. Increasing net profit margin supports the future growth potential of firms in financial terms and may create a positive expectation in the eyes of investors. Therefore, it can be stated that it is expected that increases in the NP variable will positively affect the PEG variable.

On the other hand, the results of Model 2 in Panel B of the table above indicate that according to both long-run cointegration estimators used in the study, the EPS and AGE variables are statistically significant at the 1% confidence level, while the NP variable is statistically insignificant. Accordingly, an increase of 0.01 unit in the EPS variable causes an increase of 1.257 units in the PE variable. Increases in dividend per share payments are a policy that attracts investors, particularly dividend investors, who do not want to endure future risks. As investors are attracted to high dividend-paying stocks, the value of the firm is expected to be positively affected. Therefore, it can be stated that the firm's dividend policy affects the value of the firm. In the literature, this situation is expressed by the Bird in Hand Theory known as “a bird in the hand is better than a bird on the branch” (Lintner, 1962; Gordon, 1963). However, according to the Signaling Theory, increases in earnings per share send a positive signal to investors for future periods (Allen & Michaely, 2003). As a result, firm value is expected to be positively affected. In light of this information, it is expected that increases in the EPS variable will positively affect the PE variable in line with the theories. Moreover, it is observed that the EPS variable has a negative effect in Model 1 but a positive effect in Model 2. This difference can be explained by the fact that the calculation of the PEG ratio takes into account the firm's future growth expectations. The fact that the PE ratio, which is the dependent variable of Model 2,

does not take into account the future growth expectations of the firm may lead to different findings between PEG and PE ratios. Another finding in Panel B of the table above is that a 0.01 unit increase in the AGE variable causes a 5.480 unit increase in the PE variable. As firms get older, they become more institutionalized and may be preferred by risk-loving investors due to their dominance in the sector. Therefore, in this perspective, it can be said that the firm's age is also expected to positively affect the PE ratio.

Finally, if the results of Model 3 in the relevant section of the table above are analyzed, it is seen that the AGE variable positively affects the PB variable, which is the dependent variable of the model, while the EPS and NP variables used in the model have no effect. In other words, it can be stated that a 0.01 unit increase in the AGE variable causes an increase of approximately 0.18 unit in the PB variable. Considering that well-established and institutionalized companies may be preferred by risk-averse investors in the medium and long term, the market capitalization of firms will be positively affected by this situation. With this information, if we remember that the market capitalization of the company is on the equity side in the calculation of the PB variable, it is explainable that the PB variable is positively affected by the institutional identity and age of the firm. It can be stated that the results obtained are similar to the studies of Islam et al. (2014), Arsal (2021), Anton et al. (2023), Oktaviani et al. (2023), Arsifa and Tansar (2023) and Effendi (2024) in the literature.

To summarize the long-run cointegration results explained in detail above, it can be stated that the null hypothesis of Hypothesis 1 of Model 1 (H_0: There is no linkage between EPS and PEG) is rejected, the null hypothesis of Hypothesis 2 of Model 2 (H_0: There is no linkage between EPS and PE) is rejected and the alternative hypothesis of Hypothesis 3 of Model 3 (H_1: There is a linkage between EPS and PB) is rejected. After the estimation of the long-run coefficient, the next and final step of the econometric process is the causality analysis. In this context, since different firm valuation indicators are used in the current study, it is important to identify positive and negative shocks in the causality analysis to compare firm valuation indicators. The results of the Panel Asymmetric Causality analysis tested for this purpose are presented in Table 11 below;

Table 11: Results of Panel Asymmetric Causality Test

Causality			From X+ to Y+	From X+ to Y-	From X- to Y-	From X- to Y+
EPS	→	PEG	25.819**	9.732	61.446***	11.975
		PE	41.410***	4.740	56.637***	13.196
		PB	25.642**	15.038	26.125**	16.416
NP	→	PEG	31.737***	16.661	45.640***	16.399
		PE	38.539***	6.886	31.983***	12.274
		PB	95.846***	12.840	44.775***	15.219
AGE	→	PEG	41.644***	19.482	153.866***	19.333
		PE	43.870***	9.325	69.877***	17.620
		PB	45.380***	10.912	73.964***	19.584

Notes: ***, and ** indicate respectively statistical significance at the 1, and 5 percent levels.
Y where dependent variable, X where independent variable.

The table above shows the results of the panel asymmetric causality relationship from independent variable positive shocks to dependent variable positive shocks, from independent variable positive shocks to dependent variable negative shocks, from independent variable negative shocks to dependent variable negative shocks, and finally from independent variable negative shocks to dependent variable positive shocks. In this context, the results of the causality relationship from the

independent variable positive shocks to the dependent variable positive shocks (From X+ to Y+) show that the obtained panel fisher values are significant at the 5% confidence level. Therefore, it can be concluded that there is a Granger causality relationship from positive shocks in the independent variables to positive shocks in the dependent variables. In other words, it can be interpreted that positive effects on the independent variable are the cause of positive effects on the dependent variable.

Based on the findings, another statistically significant finding is the causality linkage from the independent variable negative shocks to the dependent variable negative shocks (From X- to Y-). The panel fisher values in this causality linkage are statistically significant at the 1% confidence level. Based on the results obtained, it can be stated that a Granger causality relationship is detected from negative shocks in the independent variables of the study to negative shocks in the dependent variables of the study. However, no Granger causality linkage is detected from positive shocks in the independent variable to negative shocks in the dependent variable (From X+ to Y-) and from negative shocks in the independent variable to positive shocks in the dependent variable (From X- to Y+).

CONCLUSIONS

Firm valuation indicators are an important topic for both financial managers and investors. The topic became particularly important for financial managers after the 1950s in terms of maximizing firm value, while it became important for investors in the investment decision-making process.

Therefore, this study examines the impact of earnings per share on firm valuation indicators. For this purpose, the scope of the current study is determined as the BIST banking index and the period 2000-2023. The dependent variables of the study are PEG (Price-to-earnings/Earnings to Growth ratio), PE (Price-to-earnings), and PB (Price-to-book) ratios, while the independent variable is earnings per share (EPS). In addition, Net profit/loss (NP) and firm age (AGE) variables, which are thought to affect firm valuation indicators, constitute the control variables of the study. Accordingly, CUP-FM and BA-OLS long-run cointegration estimators and Panel Asymmetric Causality test are used to reveal the linkage between firm valuation indicators and earnings per share.

According to the long-run cointegration test results obtained for Model 1, a 0.01 unit increase in the EPS variable causes a 0.24 unit decrease in the PEG variable, while a 0.01 unit increase in the NP variable causes a 0.67 unit increase in the PEG variable. On the other hand, the AGE variable is found to provide statistically insignificant results in Model 1. The findings are significant in that they show that the increases in banking sector profitability are not supported to the same extent by the growth rates expected by the market. Based on this, it can be stated that investors are more cautious in their assessment of the future growth potential of banks that achieve high profitability. According to the long-run cointegration test results obtained for Model 2, a 0.01 unit increase in the EPS variable causes a 1.257 unit increase in the PE variable, while a 0.01 unit increase in the AGE variable causes a 5.480 unit increase in the PE variable. In addition, the NP variable is found to provide statistically insignificant results in Model 2. These results show that banks with high profitability are priced by market participants with high earnings multiples. Therefore, it can be stated that investors consider banks' profitability performance in their valuation process and interpret increases in EPS as a positive signal. Finally, according to the long-run cointegration test results obtained for Model 3, a 0.01 unit increase in the AGE variable causes an increase of

approximately 0.18 unit in the PB variable. In addition, EPS and NP variables are found to provide statistically insignificant results in Model 3. Based on this result, it can be stated that in market valuations of the banking sector, the profitability indicator alone is not sufficient, and that balance sheet and income statement-based factors play a more decisive role. These results are similar to the studies in the literature by Islam et al. (2014), Arsal (2021), Anton et al. (2023), Oktaviani et al. (2023), Arsifa and Tansar (2023) and Effendi (2024).

Moreover, Panel Asymmetric Causality test results indicate that there is a Granger causality linkage from positive shocks in the independent and control variables to positive shocks in the dependent variables and from negative shocks in the independent and control variables to negative shocks in the dependent variables. In other words, it can be interpreted that positive shocks on the independent and control variables of the study cause positive shocks on the dependent variables of the study, while negative shocks on the independent and control variables of the study cause negative shocks on the dependent variables of the study.

The present study offers several recommendations in line with the findings obtained. These are given below respectively;

1. When evaluating banking stocks, investors should focus not only on profitability indicators but also on indicators that reflect growth expectations,
2. Bank managers should not act solely based on the EPS variable in maximizing firm value,
3. Policy-makers should prioritize structural reforms that support the sustainable growth potential of banks,
4. Finally, it is suggested that the research questions developed can be compared on a sector basis by investigating other sectors.

ETİK BEYAN VE AÇIKLAMALAR

Etik Kurul Onay Bilgileri Beyanı

Çalışma, etik kurul izni gerektirmeyen bir çalışmadır.

Yazar Katkı Oranı Beyanı

Yazarların katkısı %100'dür.

Çıkar Çatışması Beyanı

Çalışmada potansiyel bir çıkar çatışması bulunmamaktadır.

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APPENDIX

Appendix 1. LM test (Breusch & Pagan, 1980)

$$LM = \sum_{i=1}^{N-1}\sum_{j=i+1}^{N} T_{ij}\hat{\rho}_{ij}^{2} \rightarrow x^{2}\frac{N(N-1)}{2}$$

In the regression above, i represents the cross-section of the panel, t represents the time dimension of the panel and $\hat{\rho}_{ij}^{2}$ represents the square of the correlation coefficient between the model residuals. However, the null hypothesis of the test states that there is no cross-section dependence between cross-sections, while the alternative hypothesis states that the opposite is valid. In other words, H_0: $\rho_{ij} = 0$ while H_1: $\rho_{ij} \neq 0$ (Baltagi et al., 2012:165).

Appendix 2. Delta test (Pesaran & Yamagata, 2008)

$$\tilde{\Delta}_{adj} = \sqrt{N}\frac{N^{-1}\,\hat{S} - E(\widetilde{Z_{it}})}{\sqrt{\hat{S}(Z_{it})}} \sim N(0,1)$$

In the above equation, $\tilde{\Delta}$ is the test result for small observations, $\tilde{\Delta}_{adj}$ is the test result for large observations, N is the number of panel cross-sections, $E(\widetilde{Z_{it}})$ is the number of independent variables used in the panel, $\hat{S}$ is the Swamy test statistic and finally $\sqrt{VAR}$ is the panel variance.

Appendix 3. PANIC with sharp breaks test (Bai & Carrion-i-Silvestre, 2009)

$$y_t = d_t + u_t$$

$$u_t = \alpha u_{t-1} + v_t \; t = 0,1,\ldots,T$$

In panel data analysis, there are two types of unit root tests: first-generation and second-generation (Hurlin & Mignon, 2006:3). In panel data analyses, second-generation unit root tests are used if cross-section dependence is detected, and first-generation unit root tests are used in the opposite case (Zhang et al., 2020:610). In light of this information, it can be stated that the second-generation unit root tests are utilized in the unit root test of the study since cross-section dependence is detected in the variables used in the current study.

In the above equation, u_t represents an observable process with zero mean, while v_t represents the error term. At the end of this stochastic process, five different information criteria are developed to determine whether the series are stationary or not.

Appendix 4. Information criteria

$$\mathrm{P_T}(\lambda^0) = \frac{[\mathrm{S}(\bar{\alpha},\lambda^0) - \bar{\alpha}\mathrm{S}(1,\lambda^0)]}{\mathrm{S}^2(\lambda^0)}$$

$$\mathrm{MP_T}(\lambda^0) = \frac{[\mathrm{c}^{-2}\mathrm{T}^{-2}\sum_{\mathrm{t}=1}^{\mathrm{T}}\tilde{\mathrm{y}}_{\mathrm{t}-1}^2 + (1-\bar{\mathrm{c}})\mathrm{T}^{-1}\tilde{\mathrm{y}}_{\mathrm{T}}^2]}{\mathrm{s}(\lambda^0)^2}$$

$$\mathrm{MZ}_{\alpha}(\lambda^0) = \left(\mathrm{T}^{-1}\tilde{\mathrm{y}}_{\mathrm{T}}^2 - \mathrm{s}(\lambda^0)^2\right)\left(2\mathrm{T}^{-2}\sum_{\mathrm{t}=1}^{\mathrm{T}}\tilde{\mathrm{y}}_{\mathrm{t}-1}^2\right)^{-1}$$

$$\mathrm{MSB}(\lambda^0) = \left(\mathrm{s}(\lambda^0)^{-2}\mathrm{T}^{-2}\sum_{\mathrm{t}=1}^{\mathrm{T}}\tilde{\mathrm{y}}_{\mathrm{t}-1}^2\right)^{1/2}$$

$$MZ_t(\lambda^0) = \left(T^{-1}\tilde{y}_T^2 - s(\lambda^0)^2\right)\left(4s(\lambda^0)^2 T^{-2}\sum_{t=1}^{T}\tilde{y}_{t-1}^2\right)^{1/2}$$

The PANIC (with sharp breaks) test analyzes the stationarity of the series under structural breaks using the information criteria given above. In this context, the H_0 hypothesis of the test implies that the series are non-stationary, while the H_1 hypothesis implies the opposite. In other words, H_0: a=1 while H_1: a<1.

Appendix 5. PANIC Fourier with smooth breaks test (Nazlıoglu et al., 2023)

$$y_{it} = d_i(t) + e_{it}\ t = 1, \dots, N$$

$$e_{it} = p_i e_{it-1} + \lambda_i F_t + \varepsilon_{it}\ i = 1, \dots, N$$

Cross-sectional dependence is included in the data generation process given above. In this context, F_t in the equation represents the unobserved common factor causing the cross-section, while λ_i represents the imputation weight distributions.

Appendix 6. Regression stationary equation

$$P_{LM}(k) = N^{-1}\sum_{i=1}^{N}\tilde{\tau}_i(k)$$

The regression equation used to determine stationarity in the PANIC Fourier with smooth breaks test is given above (Karul and Nazlıoglu, 2024:9). N in the equation is basically the average of the individual statistics. Hence, by averaging the individual statistical limit distributions, the $P_{LM}(k)$ a term representing the asymptotic distribution in panel statistics can be calculated (Carrion-i-Silvestre et al., 2005:162). The stationarity of the series is decided by looking at the bootstrap critical values of the obtained values.

Appendix 7. Panel LM test (Westerlund, 2006)

$$y_{it} = z_{it}'\gamma_{ij} + x_{it}'\beta_i + e_{it}$$

$$e_{it} = r_{it} + u_{it}$$

$$r_{it} = r_{it-1} + \emptyset_i u_{it}$$

In the above equation, y_{it} represents the multidimensional time series dependent variable, i represents the cross-sectional dimension and t represents the time dimension. In addition, the j index in the equation is used to detect structural breaks in the model. In addition, while the H_0 hypothesis of the test tests the existence of a cointegration linkage between the variables, the H_1 hypothesis tests the opposite.

Appendix 8. Panel LM with break test (Westerlund & Edgerton, 2008)

$$y_{it} = a_i + \eta_i t + \delta_i D_{it} + x_{it}'\beta_i + (D_{it}x_{it})'\gamma_i + z_{it}$$

$$x_{it} = x_{it-1} + w_{it}$$

The terms a_i and β_i in the equation represent the constant coefficient and slope before the break, δ_i and γ_i represent the changes in the constant coefficient and slope after the break, D_{it} represents the break dummy, i represents the cross-sectional dimension and finally t represents the time dimension. In addition, unlike the Panel LM test, it can be stated that the Panel

LM with break test is constructed with a straight hypothesis. In other words, for the Panel LM with break test, 'H_0: There is no cointegration linkage between the series' and 'H_1: There is cointegration linkage between the series'.

Appendix 9. CUP-FM estimator (Bai and Kao, 2005)

$$\hat{\beta}_{CUP} = [\sum_{i=1}^{n}\left(\sum_{t=1}^{T}\hat{y}_{it}^{+}\left(\hat{\beta}_{CUP}\right)(x_{it}-\bar{x}_i)' - T\left(\hat{\lambda}_i'\left(\hat{\beta}_{CUP}\right)\hat{\Delta}_{F\epsilon i}^{+}\left(\hat{\beta}_{CUP}\right)+\hat{\Delta}_{u\epsilon i}^{+}\left(\hat{\beta}_{CUP}\right)\right)\right)] \, [\sum_{i=1}^{n}\sum_{t=1}^{T}(x_{it}-\bar{\bar{x}}_i)(x_{it}-\bar{\bar{x}}_i)']^{-1}$$

In the above equation, the coefficient $\hat{\beta}_{CUP}$ is obtained by estimating the long-run covariance matrix and parameters and imposing recursion. However, the null hypothesis of the test with asymptotic chi-square distribution is 'H_0: Rβ=r', while the alternative hypothesis is the opposite.

Appendix 10. BA-OLS estimator (Westerlund, 2007)

$$\hat{k} = \min\big(C(k)\big), 1 < k < k_{max}$$

$$BIC(k) = V(k) + kV(k_{max})\left(\frac{(N+T-k)ln(NT)}{NT}\right)$$

In the regression estimator above, the minimum level of the $C(k)$ a term representing the information criterion is determined. The common factor structure (k) in the information criterion estimation is determined by the Bayesian Information Criterion $BIC(k)$.

Appendix 11. Panel Asymmetric Causality test (Hatemi-J, 2011)

$$x_{i1,t} = x_{i1,t-1} + e_{i1,t} = x_{i1,0} + \sum_{j=1}^{t} e_{i1,j}$$

$$x_{i2,t} = x_{i2,t-1} + e_{i2,t} = x_{i2,0} + \sum_{j=1}^{t} e_{i2,j}$$

Where i is the panel cross-sectional dimension, t is the panel time dimension and e is the panel error term. However, while the null hypothesis of the test is that there is no Granger causality relationship (H_0: $\beta_{i2,r} = 0, \forall\, r$), the alternative hypothesis is the opposite. This test can categorize shocks between variables as positive and negative. As such, it can be stated that the test provides detailed information about the direction of the causality relationship between variables.