Using CECM Model to Analyze the Asymmetric Relationship between Stock Index and Inflation: An Empirical Analysis from Iran

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Abstract

The existing differences in the views about the relationship between the stock return and the inflation result from the diverging opinions of financial economists, and serve as evidence of an asymmetry between these variables. The present study attempts to examine the relationship between the inflation and the stock return index in Tehran Stock Exchange using the CECM model based on the monthly time series data from August 2004 to August 2014. It is noteworthy that the model used in this study, in addition to analyzing the long-term nonlinear relationships between the variables, has another important capability for modeling the asymmetry between different variables particularly financial ones (based on the analyzed data). The results of this study confirmed the existence of an asymmetric relationship between the mentioned variables; only the negative components (shocks) of the stock index and inflation had a long-term relationship with each other, while the positive shocks were not significantly correlated.

Key Words*:* Stock Index, Inflation, Asymmetric Relationship, CECM Model.
JEL Classification*:* G19, E31, C01, C58.

1. Introduction

Finding the variable or variables that can explain the relationship of the financial aspect of economy with the real economy is much essential in studying the behavior of the factors affecting the market and in adopting an orientation towards the market economy; On the other hand, the financial structure of the countries is under the influence of financial and monetary markets because these markets are to provide resources for the real economy [Hristu-Varsakelis & Kyrtsou, 2008]. For this reason, many economists such as Goldesmith (1969), Mckinnon (1973), Shaw (1973) and Levine & Zervos (1996) have emphasized the key role of financial markets in achieving economic growth and development. According to them, a difference in quantity and quality of services provided by financial markets can explain the major part of the difference between the countries in growth rate. Among these markets, the stock market as the heart of financial markets is one of the investment alternatives in any country and, in fact, its main function is to direct the cash towards the private section and productive activities in the society. In this way, it prevents the development of the underground economy and financial corruption and considerably helps the development of public ownership and consequently fair distribution of incomes [Geetha et al, 2011].

Considering the fact that there is a wide range of potential investors in the stock market, providing the ground for earning their trust and their presence in the stock market, capital market consolidation, and promoting this market is one of the most basic means of economic development. Therefore, identifying the influential factors in the stock return series has a considerable role in making a deeper analysis and more appropriate decisions by the investors. One of these factors is the inflation because its damaging effects are one of the serious problems afflicting the economy of the developing countries [Farka, 2012]. It seems that inflation not only has a determining role in

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the development of monetary and financial markets in developing countries but also will have a large effect on the financial and monetary markets in developed countries as well though basically they have a lower inflation rate [Barnes, 1999].

Different results have been obtained in experimental studies examining the relationship between inflation and the stock return such that there is no consensus among the economists in this regard and the effect of inflation on the stock return and the relationship between inflation and stock return in different countries and periods of time is still vague [Nori Mousa et al, 2012]. On this basis, the present study aims to examine the relationship between inflation and the stock return index of Tehran Stock Exchange to shed more light on the relationship between these variables. Whether investment in the stock market can act as a shield against inflation will be also investigated.

2. Theoretical background

Inflation as one of the most important economic variables has attracted the attention of analysts, economists, policy-makers, and researchers due to its large effects on other key economic variables. The following can be mentioned as some of these important effects:

1. Inflation leads to redistribution of properties and incomes. Owners whose properties have had a larger increase in value compared to the inflation rate benefits from the trend of inflation and those whose properties have experienced a lower increase in value against the inflation rate will suffer a loss. Similarly, economic activists who are able to increase their nominal income to a rate higher than the inflation rate will benefit and those who cannot due to legal and constitutional restrictions will make a loss. With regard to shareholders, those whose nominal stock return is higher than the inflation rate will benefit and those whose nominal stock return has a lower growth compared to the inflation rate will sustain a loss.

2. As in the trend of inflation, political decisions for supplying the least livelihood for low-income people are directed at stabilizing the price of goods and services, production will consequently decrease in terms of both quantity and quality. Keeping the prices of agricultural products low is a clear example of the measures taken to stabilize the prices.

3. Government's budget deficit can rise in the process of inflation due to political decisions and an increase in subsides which, regardless of its negative effects and transfer of income distribution from one period to another, will cause reduced productivity in the public section. In this way, by controlling the incomes in the public section, the employees will be attracted by the private section which has a higher productivity; the result will be an increased budget deficit.

4. Inflation makes the relationship between the loaner and borrower more complicated and vague. In inflation conditions, both sides should have an estimation of the future inflation rate when making a deal. The higher the inflation is, the more difficult and erroneous the estimation of the expected inflation will be.

5. In inflationary conditions, the government prints more money. The government earns revenue by printing money which is called seigniorage. This income is spent in cases which are not necessarily the same cases as the primary holders of purchasing power wanted to spend their money in. In this way, new cost allocation can be representative of a lower level of satisfaction and comfort in the society.

6. As taxes are collected based on the nominal incomes, when there is inflation, nominal incomes will be considered as higher and higher taxes will be required. This change in the amount of taxes may have undesirable effects on social welfare because of the changes in allocation of costs.

7. When there is inflation, institutions have to consistently change their price forms and labels and prepare a new price list for the goods they supply.

8. Inflation causes many problems for financial statements because usually in accounting properties and debts are registered based on the price and costs of the time. Inflation causes the running value of the properties and debts to distance from their value at the time of registration. In this way, the analyses based on the figures recorded by the accountants in financial statements cannot be a clear reflection of the real world.

9. During high inflation periods, there are more changes to the inflation rate. Volatility of the inflation rate adds to the problems of the economic decision-makers which are already serious under inflationary pressures.

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10. A decrease in inflation rate to an acceptable level leads to higher unemployment and lower production during a certain period. This adds to the primary costs of inflation [Komijani & Tavakolian, 2011].

Furthermore, two of the most important theories in the field of the relationship between inflation and stock market index are Pigou and Fisher's theory. Based on Pigou's theory, an increase in the general level of prices causes a decrease in the real value of properties and considering the existence of a direct relationship between real value of the properties and consumption, a decrease in the real value of properties leads to decreased consumption which consequently leads to an increase in savings. Assuming that savings equal investment, the rate of investment will increase along with the increase in their savings; therefore, with an increase in inflation, individuals' investment increases in the long term. However, inflation has different effects on the economy of the capital market. It leads to a decline of value in companies and the increased price of companies' shares. In addition, by analyzing the general effects of inflation it can be concluded that there is an increase in the price of the shares of the companies in the stock market that have properties the price of which increases as the result of inflation [Du, 2006]. In Fisher's theory, the nominal interest rate is reflective of the information related to the expected inflation rate. This theory known as Fisher effect is very popular among the economists and plays a key role monetary and financial theories and macroeconomics. Furthermore, financial economists believe that the relationship between the stock return and inflation can be explained based on this theory. Indeed, this theory can be generalized the return of all types of properties [Omran & Pointon, 2001].

Moreover, under inflationary conditions the managers and investors are interested in experience considerable changes and many of them want to know how much inflation and inflationary expectations influence the stock market. Considering lack of researchers' consensus on the nature of relationships between inflation and the stock index, this issue has acquired a special status in the economy; many researchers believe that inflation decreases the investment return in the stock market and some others believe that it causes an increase in the stock return. Therefore, in order for a complete coverage of the effects of the inflation, the real rate of return should be minimum during inflation or more than the real rate of return in the non-inflationary periods [Constantinos et al, 2012]. Therefore, people always try to make investments in the most secure markets to avoid costs imposed by inflation so that they can not only participate in productive activities or providing services but also receive benefits, at least, of the same amount as the inflation rate. For example, based on previous experiences in Turkey, the people of this country who have individual savings prefer to make investments in the stock market due to the high inflation in this country finally achieved an undesirable unanticipated outcome due to the negative effects of the inflation on the stock return [Sari & Soytas, 2005].

Basically, the traditional thought that the expected nominal return of a property has a direct and one-to-one relationship with the expected inflation was first proposed by [Fisher, 1930]. Later on, the relationship between inflation and the stock return was also examined by Jaffe & Mandelker (1976), Bodie (1976), Nelson (1976) and Modigliani & Cohn (1979) (interestingly, despite taking different approaches to this issue, they have all found a negative relationship between these two variables). After these preliminary studies in this regard, Fama & Schwert (1977) tested the effect of inflation on some different assets. They found that based on the previous studies it seems that the stock index is a weak shield against the expected and unexpected inflation. In fact, the stock return is negatively correlated with the expected and unexpected inflation and changes in the expected inflation. Hence, international studies on the Fisher's hypothesis have not yielded unanimous results. Gultekin (1983) examined Fisher's hypothesis in 26 countries using two sets of time series and cross-sectional data. The results of analysis related to the time series was found to be inconsistent with Fisher's hypothesis whereas the results of analysis related to cross-sectional data showed that the countries with a high rate of inflation have a high rate of nominal return.

2.1. Causes of Inflation in Iran

The consistent and fast rising of prices in Iranian economy started in the early years of 1350s after a considerable increase in the oil revenues and quickly became one of the most

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serious economic-social problems in Iran (Komijani et al, 2014). The existence of a number of reasons, such as the Islamic revolution due to the lack of a systematic developmental plan, the Iran-Iraq war, foreign shocks, social-political tension in the country, and the lack of fiscal and monetary discipline caused many inflationary problems which appear in the country are still continuing. However, the most important factors leading to inflation in Iran are as follows:

1. Making up the budget deficit by drawing loans from the central bank or selling the currency earnings from oil sale to the central bank led to an increase in the monetary base and liquidity which is manifested in the form of an increase in the general level of prices (inflation).
2. Structural factors and problems caused by lack of coordination between different sections, infrastructural constraints, and price stickiness in key sections such as industry and agriculture which leads to inelastic demand in these sections such that when there is a quick growth of demand, it is not possible to accordingly and simultaneously increase supply causing inflation.

Inflation as one of the most basic economic problems has become a chronic disease for Iran's economy for these reasons. Accordingly, examining the nature and the causes of inflation in Iran can help to find appropriate solutions for facing these problems. In other words, considering the effects of inflation on other economic sections such as the capital market is very important not only due to its inconsistent economic effects but also the social and political consequences [Oxman, 2012].

3. Methodology

The asymmetrical effects of an exogenous variable on an endogenous variable mean that the reaction of the dependent variable to a given amount of increase or decrease in the independent variable is not fixed (Honarvar, 2009). Various models have been proposed to model the asymmetrical relations between economic variables. One of these models that are able to model asymmetrical short-term, long-term, and dynamic relationships between the variables is CECM, which is going to be explained. The Crouching Error Co-integration Model (CECM) which is based on hidden co-integration method was proposed by Granger and Yoon in 2002. They examined the co-integration between the negative and positive integrative combinations of the time series data using the CECM model. Based on this theory, if the combinations of the data related to two time series (positive and negative) have co-integration, these data have a hidden co-integrated relationship. Hidden co-integration is an example of nonlinear co-integration which cannot be examined using the commonly used tests of linear co-integration. The model is as follows:

Assume that x_t and y_t are two time series stochastic variables which have been defined as follows:

$$x_t = x_{t-1} + \varepsilon_t = x_o + \sum_{i=1}^{t} \varepsilon_i \quad (1)$$

$$y_t = y_{t-1} + \eta_t = y_o + \sum_{i=1}^{t} \eta_i \quad (2)$$

In which x_0 and y_0 are the primary values of x_t and y_t, ε_t and η_t are residual and the mean of these two variables are zero, and the co-integration vector of x_t and y_t is linear. When the changes of y_t and x_t are asymmetric, we can have a hidden co-integration between them with a nonlinear vector. Granger and Yoon (2002) defined positive and negative shocks in this equation as follows:

$$\begin{aligned} &\varepsilon_i^+ = Max(\varepsilon_i, o) \ , \ \varepsilon_i^- = \min(\varepsilon_i, o) \\ &\eta_i^+ = Max(\eta_i, 0) \ , \ \eta_i^- = Min(\eta_i, 0) \\ &\eta_i = \eta_i^+ + \eta_i^- \ , \ \varepsilon_i = \varepsilon_i^+ + \varepsilon_i^- \end{aligned} \quad (3)$$

Thus:

$$\begin{aligned} x_t &= x_{t-1} + \varepsilon_t = x_o + \sum_{i=1}^{t} \varepsilon_i^+ + \sum_{i=1}^{t} \varepsilon_i^- \\ y_t &= y_{t-1} + \eta_t = y_o + \sum_{i=1}^{t} \eta_1^+ + \sum_{i=1}^{t} \eta_i^- \end{aligned} \quad (4)$$

Therefore, based on the above formulas we will have:

$$\begin{aligned} x_t &= x_o + x_t^+ + x_t^- \\ y_t &= y_o + y_t^+ + y_t^- \end{aligned} \quad (5)$$

Then:

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$$\Delta x_t^+ = \varepsilon_t^+ \quad , \quad \Delta x_t^- = \varepsilon_t^-$$
$$\Delta y_t^+ = \eta_t^+ \quad , \quad \Delta y_t^- = \eta_t^- \qquad (6)$$

There are estimations of the values of first-order differencing of both time series can be observed in the positive and negative changes, for example in $(\Delta x_t^+, \Delta x_t^-)$. The next step involves calculation of the changes of all the variable's positive and negative integrative combinations (e.g., $x_t^+ = \sum \Delta x_t^+, x_t^- = \sum \Delta x_t^-$). X and y have hidden co-integration when their combination is also co-integrated. It is possible to examine hidden co-integration among all the possible combinations of the positive and negative components of y_t and x_t.

CECM model is similar to standard ECM model except in analysis of the price changes with positive and negative components. Observing the standardized ECM if y_t and x_t are co-integrated, the ECM model can explain the exogenous asymmetry with a co-integration vector of (1,β).

(7)

$$\Delta y_t = \psi_0 + \psi_1(y_{t-1} - \beta x_{t-1}) + \sum_{i=1}^{k} \psi_{x_i} \Delta x_{t-i} + \sum_{j=1}^{p} \psi_{y_j} \Delta y_{t-j} + v_t$$

$$\Delta x_t = \gamma_o + \gamma_1(y_{t-1} - \beta x_{t-1}) + \sum_{i=1}^{k} \gamma_{xi} \Delta X_{t-i} + \sum_{j=1}^{p} \gamma_{y-j} \Delta y_{t-j} + \varepsilon_t$$

4. Empirical Results

4.1. Data Analysis

In this study, the monthly time series data of inflation rate and Tehran Stock Exchange (TSE) return index from August 2004 to August 2014 were used as variables which obtained from the websites of central bank of Iran and Tehran stock market. As the main purpose of the study was to examine the asymmetric long-term effects and relationships between inflation rate and TSE return index, the variables used in this study included the following:

TD: Tehran Stock Exchange (TSE) return index.

TD^+ : Cumulative sum of positive components of TSE return index.

TD^-: Cumulative sum of negative components of TSE return index.

IN: Inflation Rate.

IN^+: Cumulative sum of positive components of inflation rate.

IN^-: Cumulative sum of negative components of inflation rate.

Basically, before modeling the time series data, their stationary should be examined because if the time series are non-stationary, there is a possibility of a spurious regression. Under such conditions, estimations of the model will not be reliable because the mean, variance, and covariance values of the non-stationary variables change over the time and also the t and F statistics and R^2 values would be unreliable. Therefore, in order to avoid the creation of spurious regression, stationary of the research variables were first examined in this study (see Table 1).

Table 1. The Results of the Stationary Test

Variables	Test	Critical Value	Calculated Value	Result
TD	ADF	-1.94	1.67	I(1)
	PP	-1.94	2.37	I(1)
TD +	ADF	-1.94	1.07	I(1)
	PP	-1.94	1.46	I(1)
TD -	ADF	-1.94	1.29	I(1)
	PP	-1.94	1.29	I(1)
IN	ADF	-1.94	-10.35	I(0)
	PP	-1.94	-10.19	I(0)
IN +	ADF	-1.94	6.39	I(1)
	PP	-1.94	9.38	I(1)
IN -	ADF	-1.94	2.09	I(1)
	PP	-1.94	2.97	I(1)

Source: The Findings of the Study

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As shown in Table 1, all the variables are non-stationary and first order integrated except the inflation rate. The results also show that estimating the relationship between TSE return index and inflation rate using the OLS method is incorrect because the order of co-integration of these two variables is not the same; therefore, there is no long-term relationship between these two variables. In this case, Engel-Granger's two-step method can be used to consider the existence of a hidden co-integration relationship between the components of these variables. In this method, first a regressive relationship between the non-stationary variables is estimated and then stationary of the residues of the estimated model is examined. If the residues are stationary, a long-term relationship can be concluded between the variables under investigation (see Table 2 for the results).

Table 2. The Results of the co-integration Test

Variables	Test	Critical Value	Calculated Value	Result
E1	ADF	-1.94	-1.38	I(1)
	PP	-1.94	-0.78	I(1)
E2	ADF	-1.94	-2.22	I(0)
	PP	-1.94	-2.51	I(0)
E3	ADF	-1.94	-2.38	I(0)
	PP	-1.94	-2.16	I(0)
E4	ADF	-1.94	-0.86	I(1)
	PP	-1.94	-0.89	I(1)

Source: The Findings of the Study

In Table 2, *E1* represents the residues of the regression equation among the TD^+ and IN^+ variables, E2 represents the residues of the regression equation among the TD^- and IN^- variables, and E4 is the residues of the regression equation among the IN^+ and TD^- variables. The results, as shown in this table, are indicative of the stationary of residues of E2 and E3 and also non-stationary of E1 and E4. Therefore, (TD^- and IN^-) and (TD^+ and IN^-) have a long-term relationship with each other. The stipulated form of the long-term relationship between these variables is as follows:

$$TD^- = 10/41 + 0/014\,IN^- \quad (8)$$
$$t: (4/18)\ (21/32)$$

$$TD^+ = -10/47 - 0/013\,IN^- \quad (9)$$
$$t: (-5/64)\ (21/38)$$

Based on the results, there is a hidden co-integration between TSE return index and inflation rate. Thus, CECM model will be used for examining the dynamic relationship between the variables of the equations (8) and (9). However, before using this model, it is necessary to determine the optimal lag because the results of this model are highly sensitive to the changes of lag. In this study, the optimal lag was determined using VAR model.

To determine the appropriate lag between the TD^- and IN^- variables, Akaike information criterion (AIC), Schwarz-Bayesian criterion (SBC), Hannan–Quinn Criterion (HQC), Final Prediction of Error (FPE) and Likelihood Ratio (LR) were used. These values were tested for the lags from 1 to 8 and based on all the above-mentioned criteria the optimal number of lags was found to be 2. In addition, to determine the optimal lag between the variables of TD^+ and IN^-, these criteria were used based on which three lags were found to be optimal. It should be noted that the number of lags in CECM model, is one unit smaller than normal because these variables are differential and in fact there is one lag in them. Therefore, the results of the CECM model are as follows:

$$dTD^- = -0/59 + 0/17\,dIN^-_{t-1} + 0/78\,dTD^-_{t-1} - 0/62\,E2_{t-1} \quad (10)$$
$$t: (-1/31)\ (9/62)\ (6/47)\ (-14/45)$$

$$dTD^+ = 0/46 - 0/02\,dIN^-_{t-1} - 0/009\,dIN^-_{t-2} + 0/54\,dTD^+_{t-1} + 0/51\,dTD^+_{t-2} - 0/48\,E3_{t-1} \quad (11)$$
$$t: (1/42)\ (-11/32)\ (-1/95)\ (5/69)\ (5/68)\ (-17/41)$$

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As it was previously mentioned, inflation is one of the most important indicators of economic instability at the at the macro level. On the basis of economic theories, it is expected that the relative stability of the level of prices has a positive effect on the investors' expectations. So it can be stated that the lower the inflation rate is, the higher its positive effects on the economic activities will be.

The results of equation (10) are consistent with the theoretical bases mentioned (Fisher's theory) based on which the negative components (negative shocks) of the TSE return index have a direct relationship with the negative components inflation (negative shocks) in the sense that a decrease in inflation leads to a decline in TSE return index but not to the same extent as the inflation rate. If the inflation has a one-unit decrease, the stock index will have a 0.17-unit decrease in the short term. Indeed, there is no one-to-one relationship between them. The coefficient of E2(-1) in the above models imply co-integration of the shocks of the TSE return index and inflation rate. Therefore, if there is a shock to the stock index caused by inflation, the mentioned index will return to its balanced state after about two periods.

Equation (11) also shows that the positive components of TSE return index has a meaningful relationship with the negative components of the inflation rate in the short term. An explanation for this relationship can be that when there is a decrease in prices, the profitability of the stock companies will also decrease and following a decrease in the inflation rate, nominal rate of return is also expected to decrease in all economic activities; this decrease in the rate of return will, therefore, lead to a decrease in the stock index which is a nominal rate.

The effects of stationary economic variables on one another are expected to decrease during the time or, in other words, they are expected to have a lower effect in the previous periods. Based on Table 11, the coefficient of the negative components of the inflation rate has been -0.02 in one period ago (one month ago) and it has been -0.009 for two periods ago (two month ago) which has decreased in value (This is consistent with the time series econometrics issues). Furthermore, as the variable itself shows the stability of the positive components of the stock index, its small changes for the two previous periods is justifiable. The coefficient of $E3(-1)$ also shows that the shocks of the stock index and inflation rate are co-integrated. In this case if there is a shock from the inflation rate to the stock return index, then the stock index will return to its initial state (long-term balance) after about two periods.

5. Conclusion

Basically inflation has different effects on economy especially the capital market. As Iran has experienced inflation during the last two decades, its effect on the capital market and investment is very significant. The purpose of this study was to examine the asymmetry between inflation and TSE return index. A review of the literature on this topic shows the existence of completely different and opposing views about the relationship between the inflation rate and the stock return such that there is no consensus among the economists and financial scientists in this regard. Some have experimentally examined the existence of a positive or negative relationship between these two variables while others have concluded that there is no meaningful relationship between them. The present study was an attempt to test the relationship between these two variables using an econometric model.

The result of this study which the long-term nonlinear relationship (hidden co-integration) between these two variables was examined and modeled among the positive and negative components of the variables using the CECM method, imply that:

1. There is a short-term direct relationship between the negative components (negative shocks) of TSE return index and the negative components of the inflation rate. This implies

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that a decrease in inflation rate leads to a decrease in the TSE return index and if the inflation rate has a one-unit decrease, the stock return will decrease 0.15 units. Therefore, these two variables have a direct relationship with one another. In addition, if there is a shock from the inflation to the stock return index, the stock index will return to its balanced state after two periods.

2. The positive components of TSE return index have a negative meaningful relationship with the negative components of the inflation rate in the short and long term. And if there is a shock from the inflation to the stock return index, the inflation rate will return to its long-term balanced state after about six periods.

3. There is no meaningful relationship between the positive components of the inflation and the positive and negative components of the stock index.

Overall, the results of the study are indicative of the inflation have a direct relationship with the negative components of the stock index and an indirect relationship with the positive components of this variable. Therefore, it is only the decrease in inflation that influences the stock index causing a decrease in the stock index. Although the results of the study show that the inflation rate influences the stock index, the results can be said to be consistent with Fisher's hypothesis because according to this hypothesis the stock real index and the inflation rate are independent of each other; the third finding of this study, mentioned above, also confirms Fisher's hypothesis. From a different perspective, Fisher's hypothesis states that with a change in the inflation rate, people correctly impose their inflationary expectation over the nominal return and modify their nominal return against the changes in the inflation rate on a one-to-one basis. In this way, the second part of Fisher's hypothesis is also confirmed based on the first and second findings of this study.

The results of this study are consistent with the findings of Naik (2013), Ibrahim & Agbaje (2013), Alagidede & Panagiotidis (2012), Geetha et al (2011) and Wei (2010) but inconsistent with the results of Farka (2012), Yeh & Chi (2009), Naceur & Ghazouani (2007), Sari & Soytas (2005), Omran & Pointon (2001) and Barnes (1999).

Based on the results and considering the fact that the stock market plays a very important role in the economy of any country as an important source of capital circulation, it is suggested that policy-makers pay a special attention to this market in implementing their plans for decreasing the inflation to prevent episodes of crisis and capital flight. Also measures should be taken to ensure and promote transparency not only at the managerial level but also information-providing mechanisms in the market.

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