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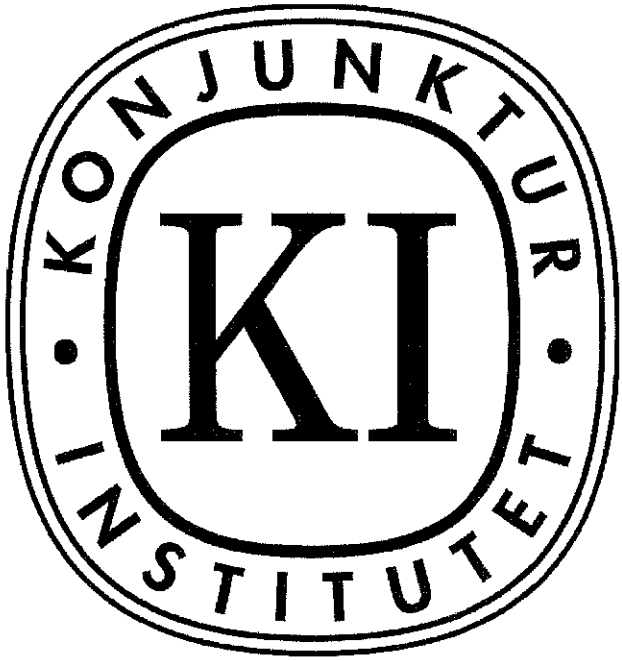

The Long-Run Relationship between Stock Prices and GDP in Sweden*

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October 2015

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Abstract

In this paper, we investigate the long-run relationship between stock prices and GPD in Sweden. Using quarterly data from 1995 to 2015, our empirical analysis suggests that the two variables are cointegrated and, hence, that a long-run equilibrium relationship between them exists. In light of this long-run relationship, we estimate a vector error correction model. The estimated model provides information as to whether Swedish stocks are correctly valued. Results indicate that stocks in Sweden might be overvalued at the end of the sample and forecasts from the model suggest that the disequilibrium will generate a modest development in the stock market over a number of quarters.

JEL classification code: E17, G10, G17

Keywords: Cointegration, Bubbles

Sammanfattning

I denna studie undersöks det långsiktiga sambandet mellan aktiepriser och BNP Sverige. Den empiriska analysen använder kvartalsdata från 1995 till 2015 och tyder på att de två variablerna är kointegrerade, det vill säga att det existerar ett långsiktigt jämviktssamband mellan dem. I ljuset av detta resultat skattas en vektorfelkorrigeringsmodell som förser oss med information om huruvida svenska aktier är korrekt värderade. Analysen tyder på att svenska aktier kan vara övervärderade vid slutet av den studerade tidsperioden. Prognoser från modellen indikerar att denna ojämvikt kommer att generera en blygsam avkastning på aktiemarknaden under ett antal kvartal framgent.

1 Introduction

During the recovery after the global financial crisis of 2008-2009, prices in many stock markets around the world have risen substantially. For example, in the United States, the S&P 500 index increased by approximately 80 percent between the beginning of 2010 and the middle of 2015 and in Sweden, the OMX Stockholm 30 index increased by more than 60 percent during the same period. At the same time, the development of the macro economy has been fairly weak. This raises questions about how the stock market is related to the macro economy, where one aspect is if stock prices reflect fundamentals or whether there might be a bubble in the stock market. Clearly, rapid growth in stock prices is not sufficient in and of itself for there to be a bubble – it could, for example, be a response to stock prices that initially were too low relative to fundamentals. In order to get an indication as to whether the stock market is correctly valued, it accordingly needs to be related to some relevant information concerning the economy.

The purpose of this paper is to investigate whether there is a long-run relationship between stock prices and GDP in Sweden. That there might be cointegration between stock prices and macroeconomic variables is a notion that has received some attention in the literature; see, for example, Cheung and Ng (1998), Chahudri and Smiles (2004) and Humpe and Macmillan (2009). The more specific idea that stock prices and GDP should be cointegrated has been expressed by, for example, Rangvid (2006) and Peng *et al.* (2012). Cointegration between stock prices and GDP has intuitive appeal since stock prices should reflect production. It is also in line with the research that suggests that stock dividends and consumption are cointegrated – such as Bansal *et al.* (2008) or Hansen *et al.* (2009) – since dividends ought to be cointegrated with stock prices and consumption with output measures such as GDP or GNP; see, for example, Cochrane and Sbordone (1988).

If a relationship between the two variables can be established this can, for example, be used as an input when assessing whether the Swedish stock market is correctly valued. High (low) prices to GDP might indicate that the stock market is overvalued (under-valued) and it would then be reasonable to expect low (high) returns over a future period as a an adjustment takes place. This paper is accordingly related both to the literature on predictable excess returns (Campbell, 1987; Lettau and Ludvigson, 2001; Hjalmarsson, 2010) and bubbles (Shiller, 1981; Diba and Grossman, 1988; Gürkaynak,

2008). Methodologially, it is also closely related to the literature using cointegration models or related measures to assess whether house prices are in line with fundamentals; see, for example, Case and Shiller (2003), Krainer and Wei (2004), Gallin (2008) and Claussen (2013). A benefit of the employed framework is that it relies on a high aggregation level – which makes data easily available – and straightforward analysis. It could hence be a convenient and useful tool to policymakers and other economic decision makers. For instance, for the government it is relevant to have an idea about future stock prices in order to make projections concerning its net asset position or revenues from the capital gains tax; it is also useful in order to make informed decisions concerning questions related to pensions.

The rest of this paper is organised as follows. In Section 2, we present the data and conduct our empirical analysis. Section 3 discusses the implications of our findings, including forecasts from the estimated model. Finally, Section 4 concludes.

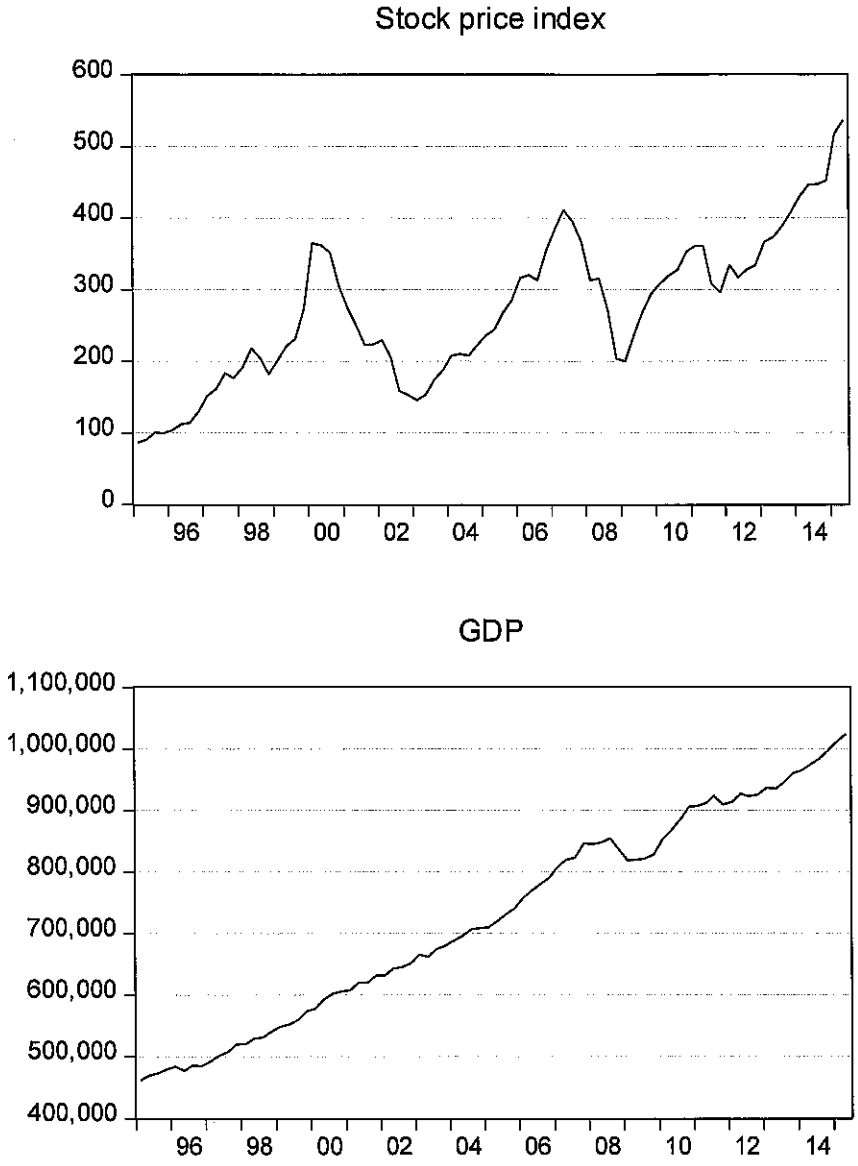
2 Data and empirical analysis

We use quarterly data on the OMX Stockholm 30 index and seasonally adjusted nominal GDP between 1995Q1 and 2015Q2.[1] Data are shown in Figure 1.

In the top panel, it can be seen that stock prices in Sweden have experienced substantial swings over the last 20 years. The build-up of the IT bubble was very fast in 1999Q4 and 2000Q1 when the index increased by 18 and 34 percent respectively. This was, on the other hand, followed by 12 quarters of low – and in most cases negative – returns as the bubble burst. After a few years of higher returns, a new dramatic fall occurred around the global financial crisis. Between 2007Q4 and 2008Q4, stock prices almost halved. This fall was in turn followed by a sharp rebound upwards in 2009. It can also be noted that while the development in the last few years maybe is less dramatic than that of previous periods, stock prices have risen more than 60 percent between the beginning of 2010 and the middle of 2015.

[1] The OMX Stockholm 30 index is 100 on the 29th of December 1995. Quarterly data are genereated by taking an arithmetic average over the daily values.

Figure 1. Data.



Note: GDP is given in millions of SEK, current prices.

The fairly volatile development of the stock prices can be contrasted with the evolution of GDP which is shown in the lower panel of Figure 1. As can be seen, this is generally smooth, although the sharp fall associated with the global financial crisis and the following strong growth in 2010 stand out. Since 2010, GDP has not grown particularly fast, unlike the stock prices.

Turning to the time series properties of the data, we are interested in employing a cointegration framework. In order for this to be relevant, we need the variables ana-

lysed to be integrated of order one, I(1).[2] Applying the Augmented Dickey-Fuller test (Said and Dickey, 1984) to the two series, we find support that both series are I(1) as the null hypothesis of a unit root cannot be rejected for the levels but is firmly rejected for the first differences; see Table 1. Seeing that both variables appear to be I(1), we continue with cointegration analysis to see whether there is also a long-run relationship between them.

Table I. Test statistics from unit-root tests.

	Test statistic
$ln(P_t)$	-3.11
$ln(Y_t)$	-1.45
$\Delta ln(P_t)$	-5.63[a]
$\Delta ln(Y_t)$	-5.37[a]

Note: Unit-root test conducted is the Augmented Dickey-Fuller test. When testing variables in levels for a unit root, a constant and a trend was included in the test equation. When testing variables in first differences for a unit root, only a constant was included in the test equation. a, b and c indicate significance at the one, five and ten percent level respectively.

In order to test for cointegration between the two variables, we employ Johansen's (1988, 1991) framework. This is based on the model

$$\Delta x_t = \mu + \Pi x_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta x_{t-1} + e_t \qquad (1)$$

where we first define $x_t = \left(ln(P_t), ln(Y_t)\right)'$. Lag length in the estimated model is set to $p - 1 = 1$ based on the Schwarz (1978) information criterion.[3] In this application, we are interested in finding out whether the coefficient matrix Π has a rank of unity since this implies that there is cointegration.[4] If we find a rank of unity, there exist two 2x1-vectors, α and β so that $\Pi = \alpha\beta'$ and $\beta' x_t$ is stationary. β is the cointegrating vector and α is the adjustment parameters. The results in Table 2 show that both Johansen's trace test and maximum eigenvalue test support that the rank of Π is one and, hence, that one cointegrating vector exists.

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[2] Cointegration is of course a meaningful concept also for higher orders of integration. However, in the present application, the relevant empirical question is whether the series employed are I(0) or I(1). That asset prices are I(1) is a viewpoint with strong support in the literature; see, for example, Fama (1965) and Samuelson (1965) for early contributions and Narayan and Smyth (2007) and Murthy *et al.* (2011) for some empirical evidence. There is more controversy when it comes to output; see, for example, Nelson and Plosser (1982), Papell and Prodan (2004) and Beechey and Österholm (2008).

[3] A low lag length in the model was only to be expected. Stock returns are typically considered to behave approximately like a martingale difference and Swedish GDP growth has very low serial correlation.

[4] If the matrix Π has a rank of zero, there is no cointegration. If it has full rank, the interpretation is that both series are stationary.

Table 2. Test statistics from cointegration tests.

	Test statistic
Johansen trace	
r=0	16.95[b]
r=1	1.35
Johansen maximum eigenvalue	
r=0	15.59[b]
r=1	1.35

Note: a, b and c indicate significance at the one, five and ten percent level respectively.

In Table 3, we show estimated key parameters from the vector error correction model in equation (1) under the assumption that there is one cointegrating vector. As can be seen, the adjustment parameters are $\hat{\alpha}_1 = -0.11$ and $\hat{\alpha}_2 = 0.01$. Both adjustment parameters are significant which tells us that both variables adjust to disequilibria. However, the magnitude of the adjustment parameters is quite different and it is clear that disequilibria are mainly adjusted through stock prices.

Table 3. Estimated key parameters and test statistics from VEC model.

$\hat{\alpha}_1$	-0.11[b]
	(-2.49)
$\hat{\alpha}_2$	0.01[a]
	(2.93)
$\hat{\beta}_2$	-1.49[a]
	(-6.24)
$H_0: \beta = (1, -1)'$	3.28[c]

Note: t-values in parentheses (). a, b and c indicate significance at the one, five and ten percent level respectively. The null hypothesis concerning the cointegrating vector is tested using a likelihood ratio test.

Looking at the estimated cointegrating vector, this is $\hat{\beta} = (1, -1.49)'$. This means that an increase of one percent in GDP is associated with an increase in stock prices of about 1.5 percent. It should of course be noted that we do not make causal statements here – the cointegrating vector simply describes the long-run relationship tying the two variables together. Concerning the estimate, it is of some additional interest to test the restriction $\beta = (1, -1)'$. This restriction was imposed by Rangvid (2006) and implies that the ratio between the two variables is mean reverting.[5] We test the restriction that the cointegrating vector is $\beta = (1, -1)'$ using a likelihood ratio test. As

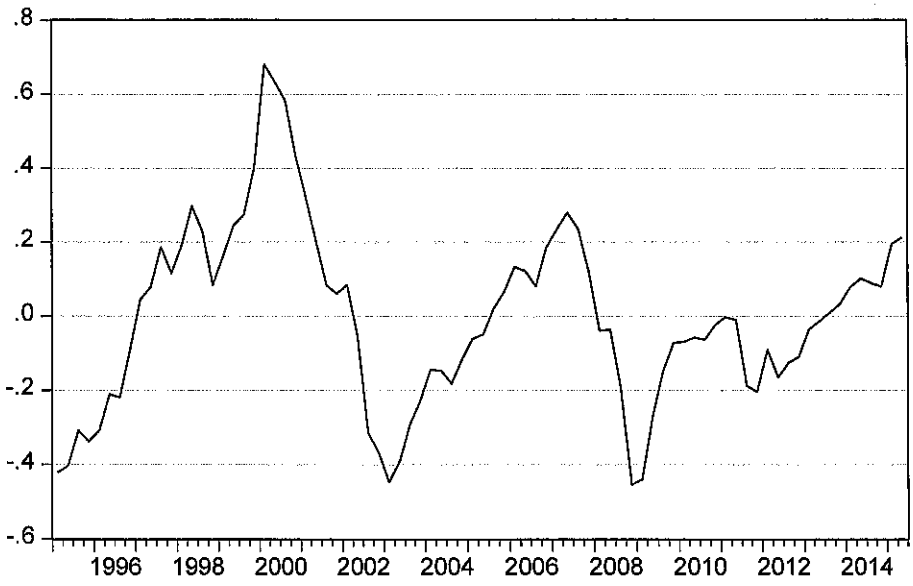
[5] This share should be mean reverting if a number of assumptions are met: The business sector should be a mean reverting share of the economy, the profit share should be mean reverting, the P/E ratio should be mean reverting and the stock exchange should represent a mean reverting (and representative) share of the business sector.

can be seen from Table 3, the null hypothesis is rejected at the ten percent level; the p-value is 0.07. We consider this strong enough evidence against the restriction and therefore prefer the model without the restriction imposed, in parts because we do not believe that the theoretical argument in favour of the restriction on the cointegrating vector is overwhelmingly strong.

3 Implications and forecasts

The results presented above indicate that a long-run relationship exists between stock prices and GDP in Sweden. Having established this, it is interesting to look at what the model has to say about the deviations from this relationship, both in the past and presently. We accordingly calculate the disequilibrium based on the estimated cointegrating vector. The deviation from the equilibrium relationship is hence given as $d_t = ln(P_t) - 1.49ln(Y_t) + 14.60$ and is shown in Figure 2.

Figure 2. Deviation from equilibrium relationship.



Note: The deviation, d_t, is calculated using the estimated cointegrating relationship, $d_t = ln(P_t) - 1.49ln(Y_t) + 14.60$.

As can be seen from the figure, the model indicates that there was a massive disequilibrium around the turn of the millennium. One way to interpret the disequilibrium value of 0.68 is that stock prices were roughly twice as high as could be motivated by

fundamentals (which here are given by GDP).[6] This can rightfully be described as the IT bubble and was largely corrected through a substantial fall in the overvalued stock prices. According to the model though, stock prices may actually have fallen too far when the bubble burst. By 2003Q1, the estimated deviation is -0.44, consistent with a fairly large undervaluation of stocks, almost 40 percent. The stock market then again became overvalued before the breakout of the global financial crisis, only to become undervalued in its aftermath. In 2008Q4 and 2009Q1, the undervaluation was, once again, close to 40 percent. Looking at the estimated deviation in 2015Q2, this is 0.21 which could be interpreted as stocks being overvalued with a touch more than 20 percent.

A potential overvaluation of stocks does of course have interesting implications. One of these can be illustrated by looking at the forecasts from the estimated model. These are shown in Figure 3. As can be seen, the model predicts that stock prices will have a weak development over a number of quarters. In fact, they will even fall five quarters in a row (2015Q4 to 2016Q4). The reason behind this is the disequilibrium at the end of the sample which puts downward pressure on the stock prices.

The model's forecast can be contrasted with a commonly chosen alternative in the literature, namely a random walk with drift. Using a drift of 2.3 percent per quarter – based on the geometric mean from 1995Q1 to 2015Q2 – the random walk model obviously predicts a fairly strong development over the coming few years.[7] Over a reasonably long horizon, the difference between the two models becomes substantial. By 2020Q4, the predicted index level is 881 using the random walk with drift, indicating a return of 64 percent from 2015Q2. The estimated VEC model, on the other hand, suggests that the index level will be a more modest 627, with an associated return over the same period of merely 16 percent. Needless to say, this difference should matter to investors and other economic decision makers.

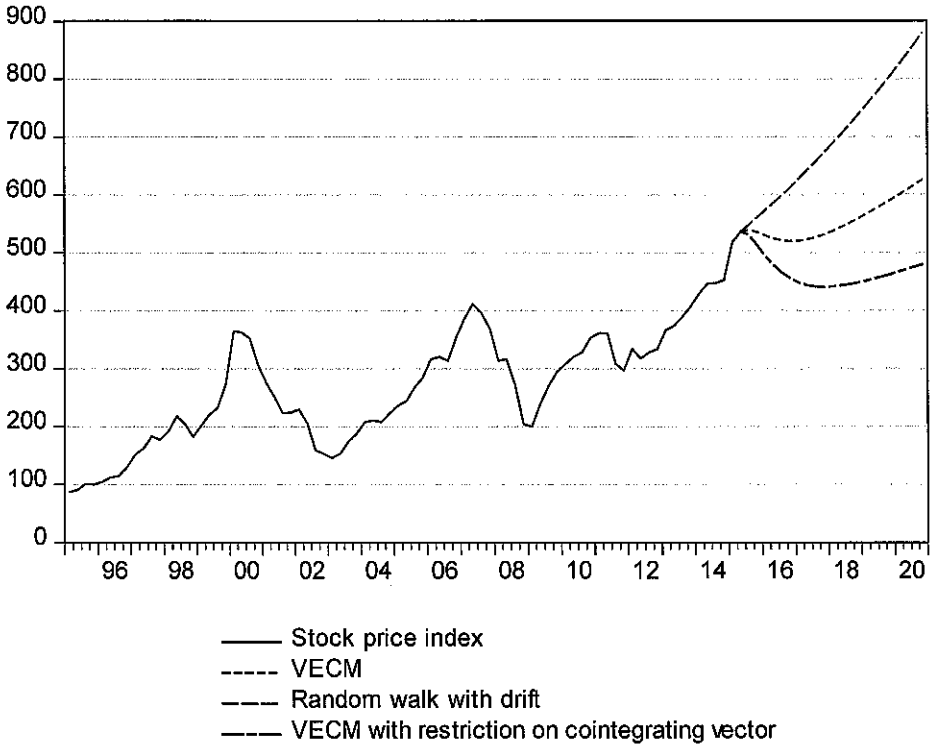
As a second comparison, we also show the forecasts from the VEC model when the cointegrating vector has been restricted to be $\beta = (1, -1)'$. We believe that the forecasts from this model could be of some interest given the focus the restriction was

[6] The calculation is given as exp(0.68)=1.97, indicating an overvaluation of approximately 97 percent.

[7] Using the sample mean for this forecast on can obviously be questioned. However, this does not seem unreasonable when considering estimates of the equity premium in Sweden based on long sample; see Mehra and Prescott (2008).

given by Rangvid (2006) and the fact that it "only" could be rejected at the ten percent level. As can be seen from Figure 3, the VEC model predicts a substantial fall in stock prices; by 2017q4, stock prices will be 18 percent lower than in 2015Q2. The driving force behind this development is the fact that when the restriction $\beta = (1, -1)'$ is imposed, the disequilibrium in 2015Q2 is even larger than that shown in Figure 2.[8]

Figure 3. Stock price index forecasts.



Note: "VECM" gives the forecasts from the estimated vector error correction model in equation (1) with one cointegrating vector. "VECM with restriction on cointegrating vector" gives the forecasts from the estimated vector error correction model in equation (1) with one cointegrating vector, where the restriction $\beta = (1, -1)'$ has been imposed.

It should be noted that the interpretation of the disequilibrium given above is that the stock market is overvalued at the end of the sample. This seems reasonable when looking at the properties of the estimated model; the historical patterns suggest that corrections to disequilibria have largely taken place through changes in the stock prices. That said, there is of course a possibility that the correct interpretation instead is that the stock market has spotted something that will make output (and dividends) boom and that the disequilibrium will be corrected through higher than usual GDP

[8] Under the assumption that the cointegrating vector is $\beta = (1, -1)'$, the estimated deviation in 2015Q2 can be interpreted as stocks being overvalued with almost 50 percent.

growth in the future. While this interpretation cannot be completely dismissed, we find it to be less likely than that stocks are overvalued. Since we use a reduced form model with a high level of aggregation, deeper economic interpretations should generally be made with caution though.[9]

4 Conclusions

After a period of substantial increases in stock prices, such as that seen over the last few years in Sweden, the question of whether stocks are correctly priced or if there is a bubble in the stock market often arises. In this paper, we have suggested a simple method to provide information concerning this issue.

The starting point is that GDP can serve as a proxy for the fundamental value of stocks. Our empirical analysis supports this notion – cointegration tests suggest that a long-run relationship exists between the two variables. The deviation from this equilibrium relationship can be seen as indicating whether stocks are over- or undervalued. We accordingly estimate a vector error correction model which can be used to provide an estimate of this deviation. Results indicate that the Swedish stock market appears to be somewhat overvalued at the end of the sample. Forecasts from the estimated vector error correction model indicate that the disequilibrium will generate a modest development in the stock market over a number of quarters to come.

Spotting bubbles is difficult – particularly in real time – and the method suggested in this paper does by no means provide a silver bullet. It does, however, offer a simple way to add information as to whether stock prices appear to be in line with fundamentals. While small disequilibria should not be overinterpreted, large deviations from the equilibrium relationship could be a cause to question whether the pricing is correct.

[9] It should, for example, be kept in mind that stock prices are based on expectations. While it in some cases quite easily can be said that expectations were unreasonable, it is not always obvious what the rational expectation is. What the model defines as incorrect pricing *ex post* was not necessarily incorrect in real time.

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