Staff memo

Equity market valuation in light of low interest rates

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S V E R I G E S R I K S B A N K

Table of contents

Staff Memo

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Summary

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Strong price development in equity markets worldwide in recent years has made equity valuations a recurring topic of discussion. One area of debate has been to what extent the low interest rates have contributed to higher equity prices, and what might happen when interest rates begin to rise again.

In this staff memo we study how well historical equity market valuations, captured in the form of the Cyclically Adjusted P/E (CAPE) ratio, have been able to explain stock price developments in subsequent time periods. Furthermore, we investigate whether a measure, which explicitly takes interest rates into account, Excess CAPE Yield, has more explanatory power.

The empirical analysis is conducted for several countries (Sweden, the United States, Germany and the United Kingdom) and the conclusion is that CAPE works well for all countries included in the analysis. In the case of Excess CAPE Yield, the results vary between different stock markets and time periods. In general, Excess CAPE Yield works well for the United States, though not as well for Sweden, Germany and the United Kingdom.

[1] Ola Melander helped to write this staff memo while he was working at the Financial Stability Department but he is not working at the Riksbank anymore. The authors would like to thank Johannes Forss Sandahl, Jens Iversen, Johanna Stenkula von Rosen, Tommy von Brömsen, Thomas Jansson, David Kjellberg, Carl Fredrik Pettersson, Jens Vahlquist, Lena Wiberg, Marianne Sterner and Olof Sandstedt for valuable input and comments on various drafts of this text. The authors would also like to thank Calum Mc Donald, Elizabeth Nilsson and Gary Watson for valuable assistance in translation of the publication. Any remaining mistakes are our own. The views presented in this publication are the authors' personal opinions and are not to be regarded as an expression of the Riksbank's view on these issues.

1 Equity price downturns could have consequences for financial stability

The equity market is an important part of the financial system, both from the perspectives of investors and the companies that need financing in the form of equity capital. Developments in equity markets can therefore provide valuable information on the state of the financial system and the economy as a whole. This also means that downturns in equity prices could have consequences for financial stability. How vulnerable the financial system is depends on which participants are exposed to the stock markets and to what extent different participants and markets are interlinked with one another. High interconnectedness mean that stress can more easily be passed on in the system.

Strong price development in equity markets worldwide in recent years has made equity valuations a recurring topic of discussion. One area of debate has been to what extent the low interest rates have contributed to higher equity prices, and what might happen when interest rates begin to rise again. In the long run, fundamental factors, like earnings, should drive stock prices. But interest rates should also matter, as they can help to value equity prices in relation to less risky investment alternatives, like the risk-free rate. Given this, the purpose of this analysis is to study to what extent valuations have been able to explain historical equity price developments, and what effect it has if one takes interest rates more directly into account.

This analysis is part of the Riksbank's continuous work on financial stability, which is in general regularly presented in, for instance, the Financial Stability Report.[2] Other central banks, such as the United States Federal Reserve (Fed) and the European Central Bank (ECB), regularly analyse the valuation of equities and other assets in their financial stability reports. The importance of systematic monitoring of valuation metrics emerges as high valuations typically implies increased risks of large price declines going forward.[3]

[2] See also Giordani et al. (2015) where equity, bond and housing markets are analysed for the purpose of seeing whether valuations are high in a historical perspective. Please note that asset valuations are also typically examined in the Riksbank's Monetary Policy Report, in addition to the financial stability analysis.

[3] See Federal Reserve (2021) and ECB (2021). For a more in-depth review of why, for instance, the Federal Reserve analyses valuations of equity and other assets in the framework of the financial stability analysis, see also Adrian et al. (2015).

2 Interest rate levels in theory affect equity valuations

This section provides a theoretical background to the role of interest rates in equity valuation. A common valuation model that is based on expected future dividends is used to exemplify this.

In the case of so-called *fundamental equity analysis*, one tries to evaluate the company and its shares on the basis of accounting information. This is to provide theoretical foundation of the equity price and put this in relation to the actual, observed equity price. In this way, investors can form an opinion of whether an individual share can be regarded as fairly valued or not. The basis for this type of valuation is often a forecast of income statements and balance sheets (pro forma model).

There are several valuation models which all aim to achieve the same goal, namely to derive the fundamental price, but make use of different accounting items. One commonly used model is the *Dividend Discount Model* (DDM), which uses forecasted dividends for the purpose of valuing the company. Dividends, like earnings, are a fundamental value driver for a company. Moreover, dividends are closely related to earnings, as earnings can either be paid out as dividends to shareholders or be transferred to equity capital.

In the DDM, expected future dividends are discounted to their present value and aggregated. The interest rate effect feeds through via the discount factor. Company value today, V_0, can according to the DDM be specified as *equation (1)*, with typically two distinctive parts to be aggregated (periods t, that is the forecast horizon, and period T and onwards, that is the long-run value or the "steady state").

$$V_0 = \sum_{t=1}^{T} \frac{Div_t}{(1+k_E)^t} + \frac{V_T}{(1+k_E)^T}. \qquad \text{Eq. (1)}$$

In *equation (1)*, Div_t constitutes the dividend at time t, k_E the cost of equity capital and V_T the long-run value. The long-run value is normally determined using Gordon's formula:

$$V_T = \frac{Div^*}{k_E - g^*}, \qquad \text{Eq. (2)}$$

where Div^* is the dividend in the steady state and g^* is the long-run growth rate of dividends.

The cost of equity capital can be estimated via the *Capital Asset Pricing Model* (CAPM) as follows:[4]

$$k_E = r_f + \beta_E(k_m - r_f), \qquad \text{Eq. (3)}$$

where r_f is the risk-free interest rate and $k_m - r_f$ the market risk premium (the investors' required return). β_E is normally determined via an estimation. Often, a government bond rate is chosen as risk-free rate, for instance, the ten-year benchmark rate.[5] Higher risk-free rate gives higher capital cost and consequently lower present value for future dividends. In other words, lower risk-free rate, all else being equal, gives a higher fundamentally motivated equity price.[6] Similarly, a low market risk premium, all else being equal, lowers capital cost and consequently gives a higher present value, and therefore a higher fundamentally motivated equity price. Another way of expressing it is to say that the risk appetite among investors, reflected in their current required return, is an important factor in the fundamental equity price determination.

All in all, the assessment or estimate of the investors' required rate of return, and the choice of risk-free interest rate, are important determinants behind model valuation.

[4] There are as well other ways of estimating capital costs, for instance, multi-factor models.

[5] Some investors might though prefer to use an alternative discount factor. See for example PwC (2021).

[6] Note that there are studies saying that in practice all else is not equal, which means that the relationship does not always hold. Asness (2003) argues, for instance, that low interest rates go hand in hand with low inflation, which has a negative effect on companies' profits. A low inflation rate can therefore counteract the positive valuation effect from a low risk-free interest rate.

3 Valuation metrics and historical equity price developments

This section describes some common equity valuation metrics and the extent to which some of them, according to earlier studies, have been able to explain historical equity price developments. We present one metric that indirectly take interest rates into account and another metric that does so explicitly. The purpose of this section is to give an introduction and a background to the next analysis section.

3.1 P/E ratio as a common metric of equity valuation

As mentioned in the previous section, dividends are closely related to earnings. It is also possible to link DDM to simple, earnings-related valuation multiples such as the P/E (Price-to-Earnings) ratio, which bring equity price in direct relation to earnings.

First, assume that Gordon's formula holds. Then the following is also true:

$$\mathrm{V_0} = \frac{\mathrm{Div_{T+1}}}{\mathrm{k_E} - \mathrm{g^*}} = \frac{\mathrm{pr} \times \mathrm{NP}}{\mathrm{k_E} - (1 - \mathrm{pr}) \times \mathrm{ROE}}. \quad \text{Eq. (4)}$$

In *equation (4)*, pr is the dividend payout ratio, NP is the net profits and ROE is the return on equity. The other terms are the same as before. Consequently, the fundamentally motivated P/E ratio, which would be equal to $\mathrm{V_0}/\mathrm{NP}$, can be given by:

$$\frac{\mathrm{V_0}}{\mathrm{NP}} = \frac{\mathrm{pr}}{\mathrm{k_E} - (1 - \mathrm{pr}) \times \mathrm{ROE}}. \quad \text{Eq. (5)}$$

The fundamentally motivated P/E ratio thus depends on the dividend payout ratio, the cost of equity capital and the return on equity in the future. In theory, interest rates are, as seen in *equation (5)*, indirectly taken into account in the P/E ratio. In practice, it is more unclear to what extent investors take interest rates into account when valuing information given by the P/E ratio. It is also not straightforward how interest rates affects the components in the ratio, i.e. prices and earnings, particularly given the fact that interest rates have been trending down for a long time.

The P/E ratio is perhaps the most common valuation multiple which is often used in practice, since it is simpler to calculate compared to the DDM. In this staff memo we are primarily interested in valuations of stock market as a whole rather than of individual companies, over a long period of time, which makes the P/E ratio more convenient to use.

3.2 CAPE ratio has performed well in explaining equity price developments

Historically, P/E ratios have been shown to carry important information on subsequent equity price movements. However, the P/E metric tends to be volatile as earnings can sometimes vary considerably from year to year and over business cycles. One way to remedy this issue is to use an average of recent years' earnings instead. An example of this is the CAPE (Cyclically Adjusted P/E) ratio, where an average of the inflation-adjusted earnings over the past ten years is used to calculate the P/E ratio. CAPE has been developed by Nobel laureate Robert Shiller and is based on previous work by Benjamin Graham and David Dodd.[7] This metric has been shown to be good at explaining equity price developments, at least in the United States. Campbell and Shiller (2001) show that high CAPE ratios, indicating equity prices that are high in relation to earnings, are usually followed by weaker price developments in the United States in the following ten-year period.[8] This is true for the period 1871-2000.

As with the P/E ratio, the CAPE ratio does not directly take interest rates into account. Therefore, the potential effects of declining real interest rates, which have been observed in recent decades, on equity prices and valuations may not be fully taken into account in the CAPE ratio. During the last couple of years, equity prices have developed relatively strongly, which has meant that the common valuation metric has been quite high in a historical context and thus signalled high valuations in equity markets. In contrast, since in theory lower interest rates should have a positive effect on equity valuations, this led to a debate on whether presently high CAPE values actually reflect overvalued equity markets, or whether equities are in fact fairly priced when taking into account the low interest rate environment, which the CAPE ratio does not.

3.3 Excess CAPE Yield is a simple valuation metric that directly takes into account the level of interest rates

There are models that more directly set the P/E ratio in relation to the level of interest rates. One such model is the "*Fed Model*", which subtracts the nominal ten-year interest rate from the so called earnings yield (Earnings-to-Price ratio or E/P, that is, the inverse of the P/E ratio).[9] One criticism of the Fed Model is that it mixes variables in nominal terms (interest rate) and real terms (earnings yield). However, recently Shiller et al. (2020) have developed a similar metric, the *Excess CAPE Yield*, which builds on

[7] Graham and Dodd (1934).

[8] In addition, Campbell and Shiller (2001) also study the relationship between the dividend yield (Dividend/Price, D/P) and future stock price developments, not only in the United States but in several other countries, including Sweden. They show that high dividend yield is usually followed by strong future equity price developments in the United States, as well as in some other countries (Australia, Canada, Japan, Spain and the United Kingdom). In other countries included in the study (France, Italy, Switzerland, Sweden and Germany), no robust relationship between dividend yield and subsequent stock price developments was found.

[9] See Yardeni (1997). The name Fed Model originates from an interpretation of communication from the Federal Reserve, which asserted that they used the model to analyse the valuation of the stock market. It can also be argued that the Fed Model is loosely based on DDM, see Estrada (2006).

the previous CAPE ratio measure, but in addition takes into account the level of real interest rates.[10] More specifically, the new ratio is calculated as the inverse of CAPE minus the ten-year real interest rate.[11] Thus, the Excess CAPE Yield can be expressed as:

$$\text{Excess CAPE Yield}_t = \frac{1}{\text{CAPE}_t} - \text{ten-year real interest rate}_t. \qquad \text{Eq. (6)}$$

This ratio can be interpreted as a proxy for the equity risk premium, or in other words, the excess return that investors expect from the risky investment in equities relative to the risk-free investment in government bonds. This interpretation, and the fact that the ratio directly takes into account the level of interest rates, makes the Excess CAPE Yield intuitively appealing. The Excess CAPE Yield measure and similar ratios are used by the Federal Reserve (2021), the ECB (2021), the BIS (2021) and the IMF (2021), as an alternative to the CAPE ratio metric, to analyse equity valuations in an environment with declining interest rate levels. For example, the ECB (2021) argues that equities do not look particularly highly valued in historical terms when taking into account the currently low level of interest rates.

The importance of taking the interest rate levels into account comes across as particularly relevant when valuing equity markets in the United States. The two measures, the CAPE ratio and Excess CAPE Yield, illustrated in Chart 1 and Chart 2, point to two distinct conclusions.

CAPE is currently at its highest level since the turn of the millennium and is higher than it was just before the global financial crisis of 2008-2009 (see Chart 1). This ratio thus indicates that the stock market in the United States is highly valued in a historical perspective.

On the other hand, Excess CAPE Yield (see Chart 2) does not signal particularly high valuations in a historical context. The ratio is now slightly higher than its average over the time period shown in Chart 2. This means that investors expect that stocks will continue to yield higher returns compared to government bonds, despite the already strong price development. This is an effect of declining interest rates, since they have decreased more than the stock prices have increased.

For the Swedish stock market, the difference between CAPE and Excess CAPE Yield is not quite as contrasting as in the United States. Chart 3 and Chart 4 show CAPE, ten-year interest rates and Excess CAPE Yield for Sweden. CAPE has risen somewhat recently as a result of the strong stock price developments, but remains around its historical average. CAPE thus suggests that the Swedish stock market is fairly valued, since it is currently in line with historically observed levels. On the other hand, the falling real interest rate in recent decades has led to Excess CAPE Yield being elevated compared to the historical mean.

[10] See Shiller, Black and Jivraj (2020).

[11] The real interest rate is the inflation-adjusted nominal interest rate.

There is generally a tendency for both CAPE and Excess CAPE Yield to return to their historical mean over time (so called *mean reversion*). Typically, periods of low valuations tend to be followed by periods of higher valuations, and vice versa. A relevant question from a financial stability point of view is therefore to what extent high valuations have been able to explain subsequent declines in stock prices.

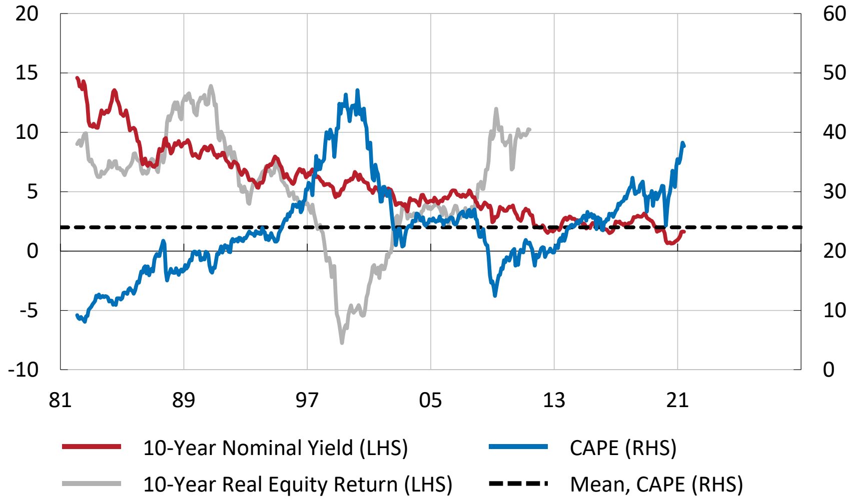
The purpose of the analysis in the next section is to study the extent to which historical equity market valuations, captured in the form of the CAPE ratio, have been able to explain stock price developments in subsequent time periods. Furthermore, we will investigate whether a measure which explicitly takes interest rates into account, Excess CAPE Yield, has more explanatory power.[12] Some studies have previously compared how well the P/E ratio and the Fed Model can explain subsequent equity price movements.[13] As mentioned before, Campbell and Shiller (2001) analyse how well CAPE has been able to explain historical equity price developments. Moreover, Shiller et al. (2020) use Excess CAPE Yield in predicting the future excess returns, though without referring to the metric's ability to explain historical price developments.

[12] Note that the analysis does not intend to model a stock market crash, but only to investigate to what extent different valuation ratios have been able to explain subsequent stock price developments historically.

[13] See, for instance, Asness (2003) and Estrada (2006). Both of these studies find that standard P/E ratios perform better than the Fed model when it comes to explaining subsequent stock price developments.

Chart 1. CAPE, nominal yield and real equity return for the United States

Per cent (LHS), ratio (RHS)

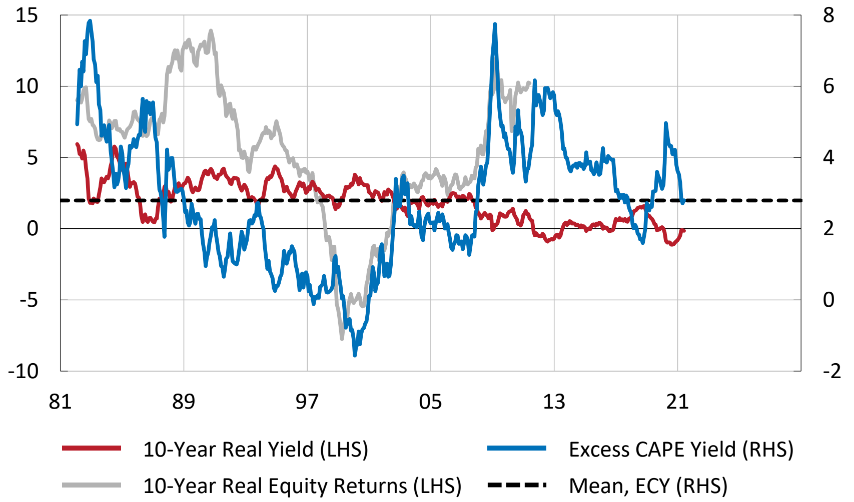


Note. CAPE is based on the MSCI USA stock index. 10-year nominal yield corresponds to the 10-year United States government bond rate. 10-year real equity return corresponds to the inflation-adjusted 10-year year equity return.

Sources: Barclays and Macrobond.

Chart 2. Excess CAPE Yield, real yield and real equity return for the United States

Per cent (LHS), percentage points (RHS)

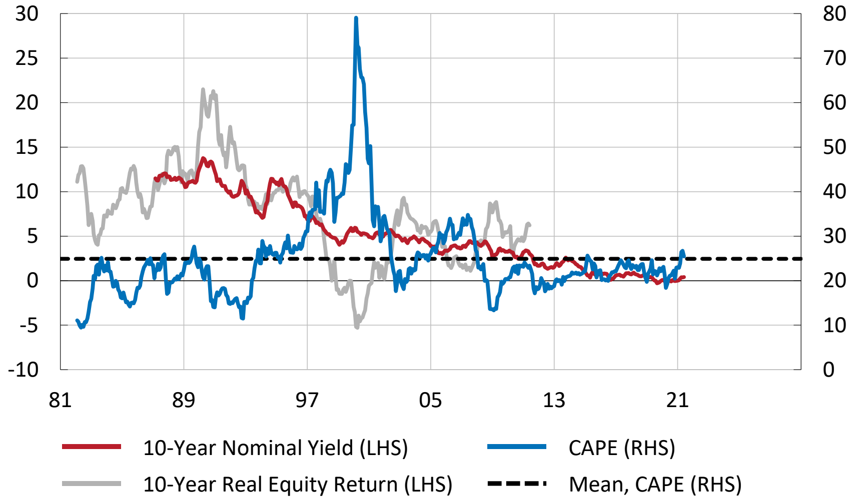


Note. 10-year real yield corresponds to the inflation-adjusted 10-year United States government bond rate. Excess CAPE Yield is calculated as the inverse of CAPE minus the 10-year real interest rate.

Sources: Barclays, Macrobond and the Riksbank.

Chart 3. CAPE, nominal yield and real equity return for Sweden

Per cent (LHS), ratio (RHS)

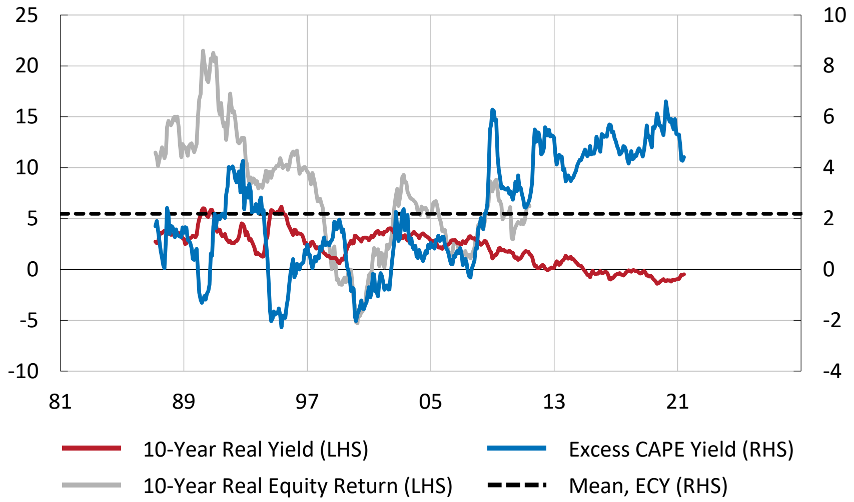


Note. CAPE is based on the MSCI Sweden stock index. 10-year nominal yield corresponds to the 10-year Swedish government bond rate. 10-year real equity return corresponds to the inflation-adjusted 10-year year equity return.

Sources: Barclays and Macrobond.

Chart 4. Excess CAPE Yield, real yield and real equity return for Sweden

Per cent (LHS), percentage points (RHS)



Note. 10-year real yield corresponds to the inflation-adjusted 10-year Swedish government bond rate. Excess CAPE Yield is calculated as the inverse of CAPE minus the 10-year real interest rate.

Sources: Barclays, Macrobond and the Riksbank.

4 Estimating equity price movements with different valuation metrics

This section provides an overview of how the analysis is conducted and reports the empirical findings. The analysis is performed for equity markets in several countries, including Sweden and the United States.

4.1 Method and data

In the empirical analysis, we employ the same method used in Campbell and Shiller (2001), where they study how well CAPE explains historical equity price developments in the United States. In addition, the analysis in this chapter includes Excess CAPE Yield, in order to evaluate which of the two valuation measures performed better historically. Moreover, the analysis covers equity markets in several countries (Sweden, the United States, Germany and the United Kingdom). As a small open economy, Swedish financial markets are to a great extent affected by the financial market developments in the United States and around Europe. Including other countries in the analysis also allows us to identify potential country-specific differences in the results. The data sources used for the empirical analysis are presented in Table 1.

Table 1. The data used in the empirical analysis

Variable	Description	Time period	Source
Stock price	Country-specific MSCI stock index, expressed in domestic currency, which covers approximately 85 per cent of the respective country's stock market.	Jan 1971 – May 2021	Macrobond
CAPE	Based on the country-specific MSCI stock index and developed by Barclays in cooperation with R. Shiller.	Jan 1982 – May 2021	Barclays
CPI (inflation)	CPI published by the Bank for International Settlements (BIS)	Jan 1971 – May 2021	Macrobond
Nominal government bond rates	10-year benchmark bond rate for each country.	Jan 1982 – May 2021 SE: starts Feb 1987	Macrobond
Alternative dataset for the United States	R. Shiller's dataset with long historical time series for stock prices (S&P 500), CAPE, CPI, government bond rate and Excess CAPE Yield.	Jan 1871 – Mar 2021	R. Shiller's website

Note. For more information on and access to R. Shiller's dataset, see http://www.econ.yale.edu/~shiller/data.htm.

The dependent variable in all regressions is the *real equity price return* (hereinafter referred to as just "equity returns"). Using the raw data presented in Table 1, we calculate the ten-year real equity return as the percentage change in inflation-adjusted stock prices between the current time period and the period ten-years ahead, which implies that we use information about equity prices in the future. This will limit our estimation sample to end in 2011, since our last observed data point is in 2021.

As an independent variable in each estimation, either CAPE or Excess CAPE Yield is used. Excess CAPE Yield has been computed with the inflation-adjusted (real) ten-year government bond yield.[14] All variables are transformed so they are expressed in their natural logarithm. The two main models which will be estimated can be specified as follows:

$$\text{Equity Returns}_{t+10} = \beta_0 + \beta_1 \text{CAPE}_t + \epsilon_{t+10}, \text{ and} \qquad \text{Eq. (7)}$$

$$\text{Equity Returns}_{t+10} = \beta_0 + \beta_1 \text{Excess CAPE Yield}_t + \epsilon_{t+10}. \qquad \text{Eq. (8)}$$

Since Excess CAPE Yield combines two variables by taking the difference between the earnings yield (that is, the inverse of CAPE) and the real interest rate, it is not possible (in *equation (8)*) to separate the extent by which each individual component contributes to the estimated equity returns. According to the theory, the variables should have opposite effects on subsequent stock price developments, where the relationship is expected to be positive for the earnings yield and negative for the real interest rate. In order to empirically test the relationship between equity returns and the earnings yield and the real interest rate, we introduce a third model, where the coefficients for these variables are estimated separately. The breakdown of Excess CAPE Yield implies that the empirical relationship can be specified as follows:

$$\text{Equity Returns}_{t+10} = \beta_0 + \beta_1 \frac{1}{\text{CAPE}_t} + \beta_2 \text{Real Interest Rate}_t + \epsilon_{t+10}. \qquad \text{Eq. (9)}$$

For all estimates, a constant, β_0, greater than 0, is expected. This is because the constant captures the long-term average of the equity returns.

Because the empirical estimates are based on overlapping observations, problems can arise with autocorrelation in the error terms, that is, that the error terms are not independent of one another. Such problems are dealt with by using Newey-West standard errors in the regressions. In the next section, we present the results of the empirical estimations.

4.2 Which metric has historically been better at explaining stock price developments?

We estimate *equations (7)*, *(8)* and *(9)* for equity markets in Sweden, the United States, Germany and the United Kingdom. Campbell and Shiller (2001) evaluate the

[14] We have, like Shiller (2016), calculated real ten-year government bond rates by subtracting average annual actual inflation over the previous 10 years from nominal government bond rates. It is actually desirable to use ex ante real interest rate, i.e. nominal interest rate minus inflation expectations, but this ratio is excluded from the analysis in this staff memo due to data limitations.

predictive power of the CAPE ratio for equity returns at various time horizons and find that CAPE performs much better in explaining equity price developments at a ten-year horizon, that is, equity returns in the subsequent ten years. The same forward-looking time horizon is therefore used in this staff memo.[15]

In this section, we report the coefficient estimates for Sweden and the United States alone, as the results for the United States differ most from the Swedish ones. The results for the United Kingdom and Germany are similar to the results obtained for Sweden and are presented in the Appendix. All the estimates are based on equity price developments for country-specific MSCI stock indices. In the case of the United States, we have additionally estimated *equations (7), (8)* and *(9)* using Robert Shiller's dataset containing the S&P 500 price index and valuation ratios with long history.

The availability of an alternative index with long history, allows us to examine the extent to which the choice of an index and sample selection might be driving the coefficient estimates. In order to inspect the effect behind the choice of an index, we estimate the equations using valuation metrics based on the S&P 500 index and the same sample period as used with the MSCI stock indices, starting in 1982. Furthermore, to test the extent to which the sample choice might be driving the results, the sample is extended backwards to cover the whole available history, starting in 1881. The outcome of this exercise points to negligible differences in estimates being driven by the choice of index. Instead, significant differences in coefficient estimates seem to be driven by the sample period. Results based on the S&P 500 price index are reported in the Appendix (see Table 3, 4 and 5). Intuitively, the longer the coverage of the history the closer the estimates should be to the underlying relationship. On the other hand, the long history might be clouded by the shifts in regimes and structural changes in the underlying relationship. We avoid some of those structural changes since our sample starts in 1982.[16]

Table 2 shows the result of estimating *equation (7)* and *(8)*, where CAPE is used as an independent variable to explain subsequent ten-year equity returns. In general, the CAPE ratio carries considerable information that is relevant for subsequent equity price developments both in Sweden and the United States. The CAPE coefficients are statistically significant, and the model can explain about half of the variation in equity returns in both countries. The results for the other countries look similar, though when the longer sample period is used for the United States, the coefficient of determination (Adj. R^2) falls markedly (see Table 3 in the Appendix). As expected, the relationship between CAPE and subsequent equity price developments is negative, as is the estimated coefficient. In economic terms, the results for Sweden can be interpreted as meaning that an increase in CAPE by ten per cent, from today's levels (corresponding to 3-4 CAPE points), is followed by a reduction in annualized returns of

[15] In addition, estimations have also been made for the aforementioned equity markets for returns over the subsequent 2 and 5 years respectively. The conclusions drawn from these estimations are in line with those in Campbell and Shiller (2001), namely that the CAPE ratio has superior predictive power in explaining subsequent equity price developments at the ten-year horizon, in contrast to other shorter horizons, namely two and five years.

[16] Even if such changes do not impact the long run relationship, they still might have an effect on medium run co-movements.

about half to one percentage points over the next ten years. A one per cent decline in annualized equity return over the next ten-year period points to a reduction from the estimated value of 6.6 down to 5.6 per cent, which is somewhat below the historically observed mean of 6.9 per cent. This indicates that a potential increase in the CAPE ratio will likely be followed by a somewhat weaker stock price development.

Unlike in Sweden, where the CAPE level is presently in line with historical values and point to fair valuation that is in line with fundamentals, the CAPE ratio in the United States is currently around 37.7, which is well above its historical average (falls within the top 7 per cent of all observations since 1982). If the CAPE level would increase further, with about 3-4 CAPE points from today's value, it would suggest roughly a half to one percentage point decline in total equity returns annually over the next 10 years. Starting from the estimated equity return of -0.1 per cent, this would imply a decline down to -1 per cent, which is significantly below the historically observed mean of 5.1 per cent.

The results for both Sweden and the United States are thus in line with those of Campbell and Shiller (2001) in relation to the link between CAPE and subsequent stock price developments in the United States.

Table 2. Result from estimating subsequent stock price developments with CAPE and Excess CAPE Yield, 10 years ahead

	Sweden (MSCI Sweden)	**Sweden** (MSCI Sweden)	**United States** (MSCI USA)	**United States** (MSCI USA)
β_0, constant	0.3676***	0.0593***	0.3445***	0.0182**
β_1, CAPE	-0.0933***		-0.0953***	
β_1, Excess CAPE Yield		0.7624*		1.2891***
Adj. R^2	0.4922	0.0516	0.5639	0.3118
No. observations	353	292	353	353
Time period	1982 – 2021	1987 – 2021	1982 – 2021	1982 – 2021

Note. The significance level of the coefficient corresponds to (*) = 10%, (**) = 5%, and (***) = 1%, respectively. Statistical significance based on Newey-West standard error.

In Table 2, we show the resulting coefficient estimates for *equation (8)*, using Excess CAPE Yield to explain stock price developments in the next ten years. For Sweden, Excess CAPE Yield explains much less of the variation in equity price movements compared to CAPE. The Excess CAPE Yield coefficient is positive and statistically significant. The estimated positive coefficient suggests a high value of Excess CAPE Yield will be followed by strong stock price developments over the next ten years. However, the coefficient of determination for the model is considerably lower than it is for the model in which CAPE is used. Excess CAPE Yield can only explain five per cent of the variation in subsequent stock price development.

The results for the United States show the same tendency. In other words, the Excess CAPE Yield coefficient is positive and statistically significant, but the metric cannot explain as much of the variation in subsequent stock prices as the CAPE ratio can. When the Excess CAPE Yield is used, the coefficient of determination falls down to 31 per cent, which still is much higher than in the Swedish case. However, the results from our estimations for the United States based on the S&P 500 index show that the differences between using CAPE or Excess CAPE Yield become much smaller when a longer time period is used. Instead, the coefficient of determination increases marginally, by just under 3 percentage points, when we use Excess CAPE Yield and a longer time period (see Table 3 and 4 in the Appendix).

Coefficient estimates based on a metric such as Excess CAPE Yield, which is calculated as the difference between the earnings yield and the real interest rate, can be problematic as mentioned earlier. Therefore, we also use *equation (9)*, where coefficients for the earnings yield and the real interest rate are estimated separately. The results are presented in Table 5 in the Appendix. These regressions show that the coefficient for the earnings yield is statistically significant and positive for both Sweden and the United States, which is in line with expectations. On the other hand, there are differences between the countries with respect to the coefficient estimated on the ten-year real interest rate. In the Swedish case, the coefficient for the real interest rate is positive, which contrary to expectations would indicate that decreasing real interest rates will be followed by relatively weaker stock price developments over the next ten years.[17] For the United States, however, the coefficient for the real interest rate is negative, regardless of which stock index we use. Nonetheless, the coefficient is only statistically significant for the two models based on the S&P 500 index (see Table 5 in the Appendix).

The positive coefficient for the real interest rate in the case of Sweden clarifies why the model that uses Excess CAPE Yield as an explanatory factor performs significantly worse compared to the model which uses CAPE instead. This is due to the fact that the constraints imposed on the earnings yield and the real interest rate coefficients, as the two components of the Excess CAPE Yield, do not seem to be supported in data.[18]

In conclusion, the empirical results for Sweden show that CAPE has superior explanatory power, compared to Excess CAPE Yield, in explaining subsequent ten-year equity returns. The results for Germany and the United Kingdom are roughly in line with the results for Sweden. For the United States, on the other hand, empirical results show that both valuation metrics perform comparatively well.

[17] A similar relationship exists for the United Kingdom and Germany (see Table 5 in the Appendix).

[18] Formally, in order to be equivalent to *equation (8)*, this implies that β_2 should equal $-\beta_1$ in *equation (9)*.

5 Conclusions

The results of the empirical analysis indicate that the CAPE ratio works well in explaining historical equity price developments in various stock markets, including Sweden. The results are thus in line with the results that Campbell and Shiller (2001) obtained for the United States for the long history sample.

In the case of Excess CAPE Yield, which contrary to CAPE directly takes into account the level of interest rates, the results of the empirical analysis are more widespread. The extent to which Excess CAPE Yield can explain historical stock price developments varies between different stock markets and the time periods used in the estimations. In general, the model specification which uses Excess CAPE Yield works well for the United States, though not as well for Sweden and other countries.[19]

Since taking interest rates directly into account by using Excess CAPE Yield, does not in general help to explain much of the variation in stock price returns in Sweden, there is a reason to consider CAPE as a relevant metric of stock market valuation in the financial stability analysis. Despite this, Excess CAPE Yield might still provide useful insights about equity price developments. Given the definition of Excess CAPE Yield, as a measure of relative return of equities over bonds, it can be better suited for explaining excess returns, which is a potential topic for further analysis.

[19] A possible remaining reservation regarding the overall results of the empirical analysis may be that the estimation sample actually ends in 2011. This may result in any major structural changes that have occurred since not being captured by the empirical analysis.

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APPENDIX

Here we report other results from estimations of *equation (7)*, *(8)* and *(9)* for Sweden, the United States, Germany and the United Kingdom.

Table 3. Result from estimating subsequent stock price developments with CAPE, 10 years ahead

	United States (S&P 500)	**United States** (S&P 500)	**Germany** (MSCI Germany)	**United Kingdom** (MSCI UK)
β_0, constant	0.2519***	0.3405***	0.2850***	0.3292***
β_1, CAPE	-0.0692***	-0.0891***	-0.0810***	-0.1064***
Adj. R^2	0.2964	0.6277	0.5736	0.4387
No. observations	1563	351	353	353
Time period	1881 – 2021	1982 – 2021	1982 – 2021	1982 – 2021

Note. The significance level of the coefficient corresponds to (*) = 10%, (**) = 5%, and (***) = 1%, respectively. Statistical significance based on Newey-West standard error.

Table 4. Result from estimating subsequent stock price developments with Excess CAPE Yield, 10 years ahead

	United States (S&P 500)	**United States** (S&P 500)	**Germany** (MSCI Germany)	**United Kingdom** (MSCI UK)
β_0, constant	0.0345***	0.0360***	0.0221***	0.0019
β_1, Excess CAPE Yield	0.6200***	1.2164***	0.7952***	0.6530***
Adj. R^2	0.3245	0.4082	0.1300	0.1839
No. observations	1563	351	353	353
Time period	1881 – 2021	1982 – 2021	1982 – 2021	1982 – 2021

Note. The significance level of the coefficient corresponds to (*) = 10%, (**) = 5%, and (***) = 1%, respectively. Statistical significance based on Newey-West standard error.

Table 5. Result from estimating subsequent stock price developments with earnings yield and real interest rate, 10 years ahead

	Sweden (MSCI Sweden)	**United States** (MSCI USA)	**United States** (S&P 500)	**United States** (S&P 500)	**Germany** (MSCI Germany)	**United Kingdom** (MSCI UK)
β_0, constant	0.3469***	0.3565***	0.2389***	0.3663***	0.2197***	0.3466***
β_1, 1/CAPE	0.1008***	0.0964***	0.0598***	0.0931***	0.0709***	0.1161***
β_2, Real Interest Rate	0.0168***	-0.0037	-0.0051***	-0.0058*	0.0110***	0.0042**
Adj. R^2	0.6450	0.5747	0.3696	0.6540	0.6545	0.4666
No. observations	292	353	1563	351	353	353
Time period	1987 – 2021	1982 – 2021	1881 – 2021	1982 – 2021	1982 – 2021	1982 – 2021

Note. The significance level of the coefficient corresponds to (*) = 10%, (**) = 5%, and (***) = 1%, respectively. Statistical significance based on Newey-West standard error.

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