

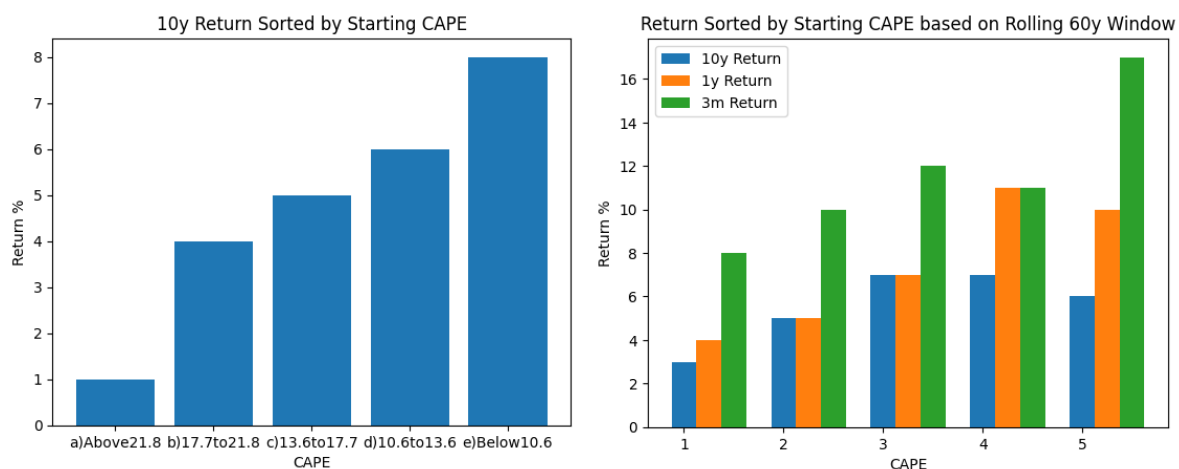
Equity and Fixed Income: P/E-based Market Timing Strategy on DAX Index

The goal of this project was to test the market timing strategy described in Asness, C., Ilmanen, A., & Maloney, T. (2017). *Market timing: Sin a little resolving the valuation timing puzzle*. *Journal of Investment Management*, 15(3), 23-40 on a chosen market.

For the full Python workbook and bibliography, see *EFI_HW_Project_Foster.html* in <https://github.com/afoster28/efi-hw-mktTimingStrat>

US: S&P500

Initially, as a benchmark, US equity market statistical evidence was reproduced using the data of Robert Shiller in order to demonstrate the validity of the methodology. Returns were calculated across 10y, 1y, 3m and 1m time horizons, each of which was annualised into separate columns. Cyclically-adjusted P/E ratio (CAPE) was bucketed into quintiles – once assuming the entire fixed time series, once assuming a 60y rolling window. The resulting variables were lagged to match the return time horizon. EP was calculated as the inverse of CAPE and similarly lagged.



For the fixed window, the quintiles were closely aligned with those obtained by the authors of the paper and return was monotonically increasing with decreasing CAPE, indicating greater room for price increases over a 10y period for undervalued equities. However, this result was subject to hindsight bias, whereby the market was evaluated relative to both past and future valuations; at a point in time investors might not have known the relative strength of the current CAPE.

The rolling window approach reduced this bias. As in the paper, the pattern held for shorter time horizons, but not for the 10y horizon at lower CAPE values. Differences in rates of return quoted compared to the paper were likely due to:

- Different series used for the risk-free rate of return (none used in this part of the project; only annualised returns used)
- Different assumptions regarding rolling window applicability for calculating CAPE quintiles (a minimum of one observation and maximum of 60y used in this project in order to be able to generate values for earlier rows without the full 60y history)
- Different selection of value per bar (mean used in this project)

Testing this relationship further, OLS regressions were run for returns on EP and produced the following results.

The coefficients of EP were all positive, as in the paper, supporting the visualisation above. They were slightly lower for 10y and 1y returns than the authors had predicted and higher for 1m returns – likely driven by the

Stat	Next 10Y	Next 1Y	Next 1M
Beta	0.69	1.00	4.79
T-statistic	43.01	15.42	3.92
R-squared	0.57	0.15	0.01

aforementioned reasons. T-statistics and R-squared were higher than those reported. Short-term returns exhibited a stronger causal relationship, although the statistical significance of this was weaker.

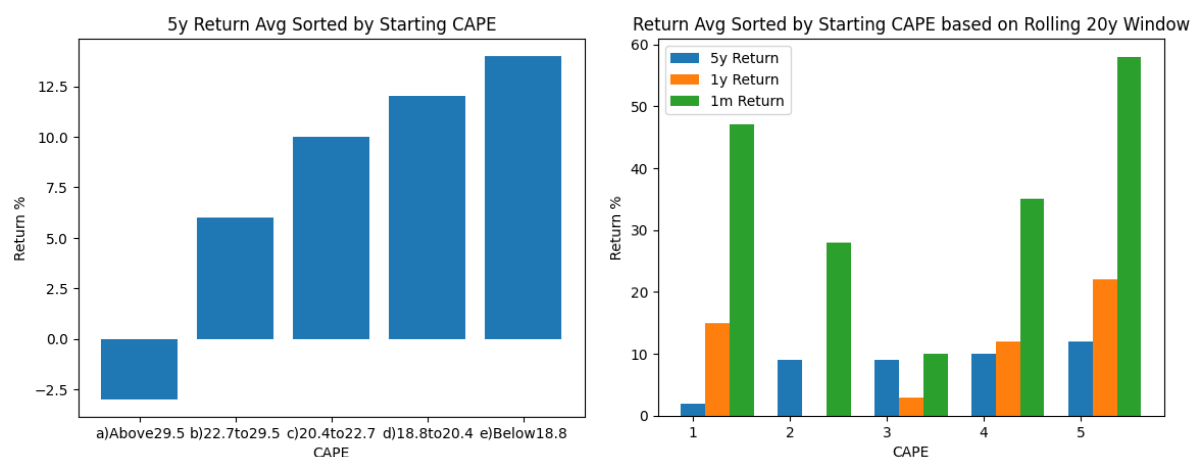
Germany: DAX

The German equity market was the market of choice. The analysis was produced using CAPE for Germany created by Barclays Research and DAX index prices from Yahoo Finance, as the latter was not available in the Barclays Research dataset. Yahoo Finance contained one of the longest uninterrupted DAX time series which was deemed an acceptable alternative and likely to overlap with the German equity selection used in the CAPE dataset.

CAPE data extended from Jan-82 to May-23 and DAX data was from Jan-88 to Apr-23, thus the time frame considered spanned the common Jan-88 to Apr-23 period. This is several decades shorter than the US data provided by Shiller. Thus long-term returns were reduced from 10y in the paper to 5y which avoided trimming the time series further when calculating returns and the rolling window of CAPE quintiles was reduced from up to 60y to up to 20y, still representing roughly half of the overall time period. The data was further bounded to start from Jan-93, the first date in which 5y returns were able to be calculated.

USD-1m-Libor was also included in the dataset as a proxy for return on cash. It was sourced from Macrotrends containing values up to Sep-20 and from Money.pl for the remaining values thereafter.

The quality of the data was high without any null values within the bounded period and the only transformation required being the filling of USD-1m-Libor observations with the last available value wherever they were missing. This was limited to sporadic days and the impact was minimal as the data was available with daily frequency, thus previous values were typically not that distant from the month-ends considered.



The return distribution remained similar to that of the US, whereby lower CAPE values tended to result in higher returns. Noteworthy differences include:

- Higher CAPE values in general
- Negative long-term returns for the most overvalued equities, indicating a more meaningful correction for such equities than in the US
- Skewed returns: high short-term returns observed at both low and high CAPE, indicating better short-term performance for both undervalued and overvalued equities

OLS regressions showed that EP coefficients were increasing with reduced return horizon more strongly than in the US. Decreasing statistical significance with return horizon was also observed, but still significant at 5% confidence level.

Stat	Next 5Y	Next 1Y	Next 1M
Beta	1.98	2.44	7.94
T-statistic	23.32	9.91	6.80
R-squared	0.60	0.21	0.11

Market Timing Strategy: DAX

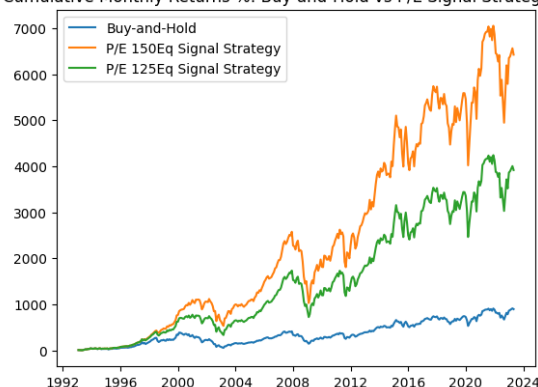
The contrarian tilt investment strategy was used, as described in the paper. 50-150% of the portfolio weight was allocated to equities and the remaining portion to cash earning USD-1m-Libor. The portfolio underwent monthly rebalancing.

$$Equity\ Weight = \min(1.5, \max(0.5, 1 + \frac{EP - Rolling\ Median\ EP}{95\ Percentile\ EP - 5\ Percentile\ EP}))$$

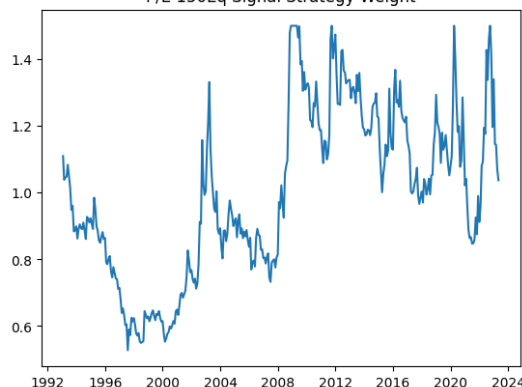
$$Cash\ Weight = 1 - Equity\ Weight$$

The strategy generated an impressive 6424% cumulative return between Jan-93 and Apr-23 compared to 895% under the buy-and-hold strategy. Modifying the equity leverage ceiling and floor to 1.25 and 0.75, respectively, generated 3917%.

Cumulative Monthly Returns %: Buy-and-Hold vs P/E Signal Strategy DAX



P/E 150Eq Signal Strategy Weight



Germany has enjoyed a bull market in the DAX between Jan-93 and Apr-23 with particularly large increases in the late 1990s, late 2000s and since the mid-2010s. EP has been demonstrated to have a large and statistically significant impact on future returns, particularly for the 1m time horizon. This has allowed for earning healthy returns generally by going long DAX, particularly when German companies had been relatively undervalued. The leverage employed amplified this benefit, even in situations when the USD-1m-Libor cost of borrowing had increased (for instance in the 2020s).

Annualised returns and volatilities under these strategies were significantly higher in Germany than in the US in the paper, but the Sharpe ratio was very similar at 0.35 compared to 0.37-0.38 in the paper. Maximum drawdown was slightly higher in absolute value and the average position of the value timing strategy had also remained close to 100%. Value timing had higher returns and volatilities than buy-and-hold.

Stat	Buy-and-hold	Value timing
Return %	35.52	47.00
Volatility %	102.47	135.35
Sharpe ratio	0.35	0.35
Max 12m drawdown %	-93.02	-93.02
Average position %	100.00	99.87

Therefore, investing in the DAX index in the 1993-2023 period based on CAPE signals would have been more profitable than the S&P500 index over a longer time horizon used in the paper (particularly when employing leverage), but would have carried more significant risk as well.