Risk Profile of Long-Term Equity Investments: The Perspective of Endowment Management

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1 Introduction

There is a vast empirical literature in financial economics on the mean return of different asset classes. Sample means of historical returns are frequently used as estimates for expected future returns in asset pricing models like the CAPM. Starting with the seminal yearbooks published by Ibbotson and Sinquefield[3] a growing literature[4] demonstrates impressively that equity investments have on average higher returns than other asset classes like bonds and bills, in particular when accounting for inflation. A little less attention, however, has been spent on the risk profiles of different asset classes. In essence, sample standard deviations of historical returns are reported in many studies as the only risk measure leaving aside other features of the return distribution which may be important for optimal portfolio formation in the case that returns deviate from normality. In recent years the general distributional properties of long-term return series of different asset classes were analyzed more intensively[5] shedding a more critical light on the traditional view that stocks outperform bonds and bills in the long run for any risk preference profile by using different performance and/or risk measures.

From a theoretical point of view, it seems heroic to assume that any empirical study will provide that general results which hold for any risk preference profile or any institutional setup. For some investors, the risk that the portfolio value falls below its initial value may be extremely important (i.e., they care about book losses in their annual reports) while they do not care that much about the risk of not reaching a long-term target rate of return. Other investors may not care so much about annual reports but reaching a minimum level of long-term return is extremely important. This implies that it may pay off to first define the specific risk preference profile and institutional setup including the legal constraints and then conduct the empirical analysis how different asset classes would perform in the long-run given the specific setup.

With this in mind, this paper aims at providing an empirical analysis of long-term risk characteristics of various asset classes from the perspective of a specific type of investor. Our focus in on the perspective

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[3] Ibbotson, R., Sinquefield, R., *Stocks, Bonds, Bills and Inflation: Historical Returns: The Past and the Future (1926-year of publication)*, several annual editions, McGraw Hill.
[4] See, e.g., Dimson, Elroy, Paul Marsh und Mike Staunton, *Global Investment Returns Yearbook 2023*, Credit Suisse Research Institute; Jordà, Ò., Knoll, K., Kuvshinov, D., Schularick, M., und A.M. Taylor, *The rate of return on everything, 1870–2015*, The Quarterly Journal of Economics, 134(3), 2019, 1225-1298.
[5] See, e.g., Anarkulova, A., Cederburg, S., O'Doherty, M., *Stocks for the long run? Evidence from a broad sample of developed markets*, Journal of Financial Economics 143, 2021, 409-433.

of long-term oriented portfolios or endowments[6], where the generated returns are used to finance certain activities or some sort of future consumption[7]. A prototype of such endowments which have a significant economic relevance are university endowments. Typically, university endowments are in place to generate a stream of cash flows (usually aimed at an infinite time horizon) which is used to cover certain financial needs of the beneficiary university. In general, the university plans its long-term budget by counting on the contributions to be generated by its endowment. These expected or required contributions do not necessarily constitute a legal liability for the endowment[8]. Nevertheless, the objective function of the endowment should focus on its ability to meet the financial need of the beneficiary university. Note, that this analysis is valid for any other endowment with a similar institutional setup.

To formalize the objective function of an endowment we assume that the endowment wants to maximize the expected return of its portfolio subject to the risk that the required contributions cannot be generated. Since the required contributions should be generated periodically (typically per annum) and over a very long or even infinite time horizon, we start our analysis with assuming that there is only a single required contribution to be generated at time T. In a second step, our results could be generalized by compiling the results for all different cash flow dates of relevance.

2 Theoretical framework with one period

Consider an endowment with initial value V_0 which is required to generate a cash flow Z at date T. Further, assume that the value of the endowment should not decrease below its initial value after paying out the required cash flow. This implies that the realized time-T return of the endowment must be greater or equal to the cash flow relative to the initial value of the endowment.

$$R_T = \frac{V_T}{V_0} - 1 \geq \frac{Z}{V_0} \; or \; V_T - V_0 \geq Z$$

The requirement to pay out a certain cash flow Z while maintaining the substance implies that a minimum rate of return $R^* = \frac{Z}{V_0}$ has to be generated by the endowment.

Based on this result, we define the probability of a certain portfolio failing to generate the required cash flow as the failure probability

$$FP_T = Prob(R_T < R^*).$$

In the case of an endowment as described above it seems natural to use the failure probability as a risk measure. If we assume that the risk preferences of an endowment are as such that for equal expected returns the choice with the lower FP is always preferred, the failure probability is the appropriate risk measure[9].

For simplicity, we do not account for strategies where the value of the endowment may be below its initial value after paying the required contribution. In a multi-period framework, it is obvious that under

[6] For a discussion of the institutional framework and related investment goals of endowments see, e.g., Cejnek, G., Franz, R., Randl, O., und N. Stoughton, *A survey of university endowment management research*, Journal of Investment Management 12(3), 2014, 90-117.

[7] Some financing purposes may also be legally binding.

[8] In some cases the statute of the endowment may constitute a liability to generate certain cash flows.

[9] However, other risk measures could be more appropriate, like the expected difference between the required and the realized return conditional on that a failure occurs. But in any case, the appropriate risk measure is at least directly related to the failure probability.

certain time-series properties of the return process (e.g., mean reversion) a temporary cash-out of capital might still be optimal. Thus, our framework is implicitly based on the assumption of an infinite planning horizon (which usually makes sense for endowments) and a random-walk behavior of the underlying return processes.

Further, our framework does not explicitly account for inflation. This is not a limitation, because any expected rate of inflation could easily be taken into account when setting the target rate of return R^*. This is the reason why our empirical analysis is based on nominal returns only. We think that past realized inflation rates – in particular when observing very long time series - are not a representative sample of future inflation rates for many reasons. First, the general institutional setup of monetary policy changed significantly over time in almost all economies over the last century. Second, the specific goals of monetary policy (if there were any) were also subject to dramatic changes over time. We think it makes sense to form expectations about future inflation based on current economic conditions[10] and integrate these expectations in the setting of the required or target rate of return.

3 Empirical analysis

In our empirical analysis we provide evidence on sample estimates of expected returns (and some traditional risk measures like standard deviations or minimum returns) and failure probabilities based on a very long historical time-series of asset prices for four different economies. Expected returns and failure probabilities are computed for different time horizons and different levels of required returns.

Our data set is taken from DMS[11] and spans the time period from 1900 to 2022. In our analysis we report results for the U.S., the U.K., Germany and Austria. The asset classes under consideration are share prices of common stocks (equity), government bonds and government bills. While we take local bonds and bills for all markets, we use U.S. stocks for the U.S. and the DMS world equity return (measured in local currency) for the U.K., Germany, and Austria. While investors generally have a strong home bias, it is less pronounced for stocks, in particular for smaller economies. We are aware of the fact that the quality and reliability of any historical time series of asset prices deteriorates the longer it goes back to history. In particular the 'special' effects caused by the World War I and World War II crises in Germany and Austria may have created asset prices which may be drawn from not fully reliable sources and reflect very special political and legal actions which may not be representative for the future. To account for this issue we report results in our main analysis where we exclude the crisis years 1918 – 1923 and 1940-1948 for Germany and Austria. These years correspond to war and direct post war periods and account for the hyperinflation in Germany and Austria after World War I and the currency resets in these countries after World War II. In addition, we analyze the full time period from 1900 to 2022 and obtain results for all economies for the period from 1950 to 2022 which should not be affected by post-war turmoil at all.

3.1 Price charts

Figure 1 shows total return indices for the analyzed markets and assets. From the perspective of each country, stocks have performed best, followed by bonds, while bills have achieved the lowest performance.[12]

[10] E.g., the 2% long-term inflation target could be used for such purposes.

[11] Data source is the Dimson-Marsh-Staunton database retrieved from Morningstar. See Dimson, Elroy, Paul Marsh und Mike Staunton, *Global Investment Returns Yearbook 2023*, Credit Suisse Research Institute, for a description of the data and summary tables.

[12] For Austria and Germany we assume a return of zero for years excluded from the analysis.

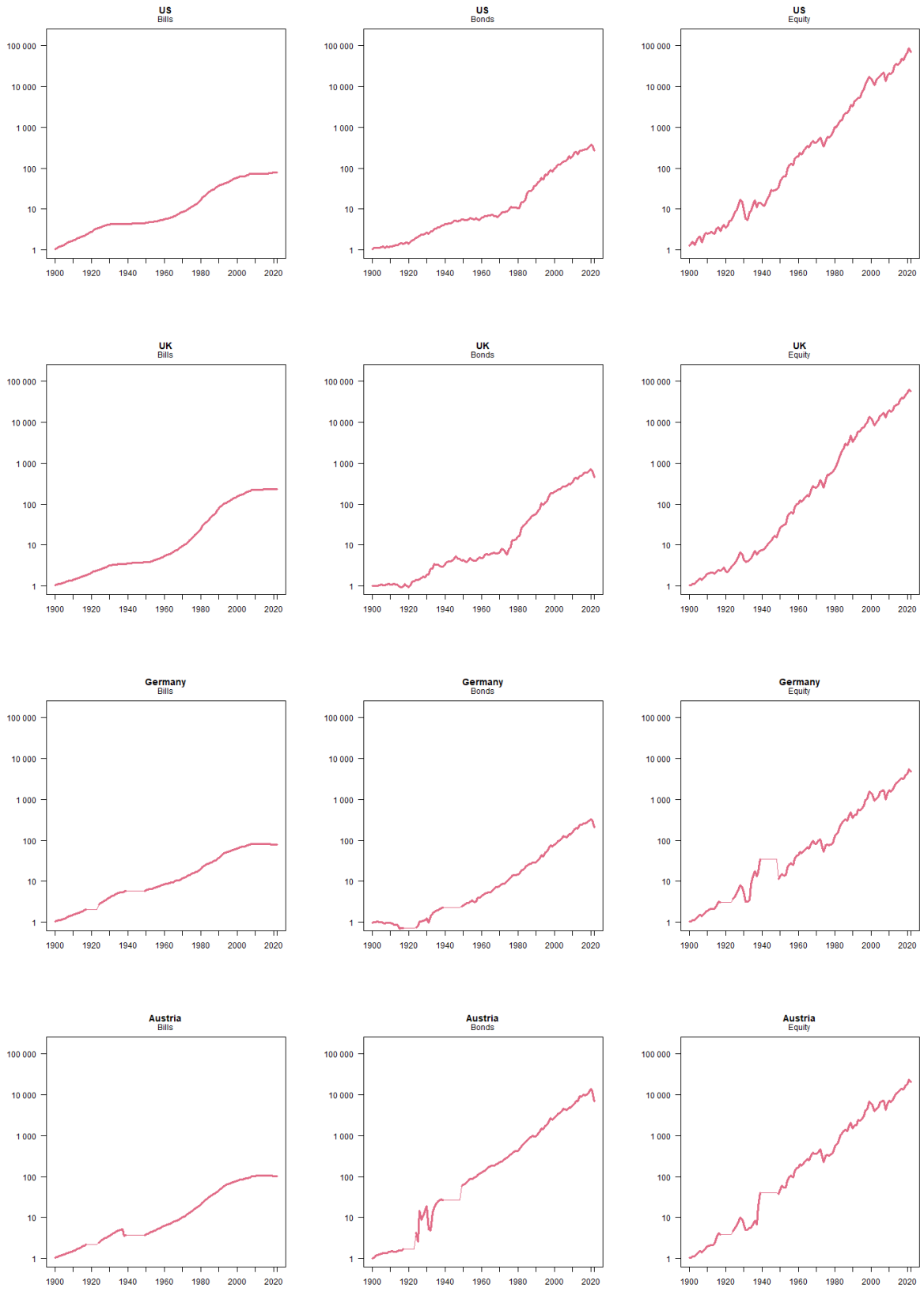

Figure 1: Total Return Indices.

3.2 Mean and minimum annual returns

	Mean annualized returns			Minimum annualized returns		
	Bills	**Bonds**	**Equity**	**Bills**	**Bonds**	**Equity**
U.S.						
1	3,65%	5,05%	11,39%	-0,02%	-26,08%	-44,30%
10	3,70%	5,06%	9,61%	0,15%	-0,07%	-2,00%
30	3,78%	5,20%	9,86%	0,94%	1,53%	4,19%
U.K.						
1	4,61%	5,77%	10,56%	0,00%	-32,03%	-31,52%
10	4,81%	5,77%	9,63%	0,35%	-2,48%	-0,29%
30	5,19%	6,16%	10,13%	1,70%	1,10%	4,30%
Germany						
1	4,18%	5,53%	11,06%	-0,82%	-32,99%	-67,85%
10	4,39%	5,83%	8,43%	-0,46%	-3,43%	-2,24%
30	4,63%	6,39%	8,57%	1,92%	2,13%	2,70%
Austria						
1	4,50%	14,05%	12,13%	-30,96%	-72,54%	-39,86%
10	4,67%	9,67%	10,14%	-0,23%	-0,27%	-1,69%
30	4,97%	9,95%	10,45%	2,11%	5,78%	6,40%

Table 1: Mean and minimum annualized returns for different holding periods. Data from 1900 – 2022, excluding years with extreme events for Germany and Austria.

	Mean annualized returns			Minimum annualized returns		
	Bills	**Bonds**	**Equity**	**Bills**	**Bonds**	**Equity**
U.S.						
1	4,07%	6,15%	12,20%	0,02%	-26,08%	-38,24%
10	4,45%	6,54%	10,52%	0,30%	0,61%	-0,23%
30	5,30%	7,54%	10,88%	2,22%	2,13%	9,40%
U.K.						
1	5,98%	7,49%	12,83%	0,00%	-32,03%	-31,52%
10	6,60%	8,08%	11,34%	0,35%	0,04%	1,88%
30	7,82%	9,46%	11,79%	3,05%	4,51%	7,91%
Germany						
1	3,67%	6,69%	10,33%	-0,82%	-32,99%	-39,86%
10	4,00%	7,23%	8,48%	-0,46%	0,24%	-2,24%
30	4,70%	7,55%	8,55%	1,92%	5,93%	6,91%
Austria						
1	4,70%	7,27%	10,62%	-0,64%	-43,18%	-39,86%
10	5,06%	7,80%	8,68%	-0,23%	-0,27%	-1,69%
30	5,82%	8,12%	8,71%	2,11%	5,78%	6,91%

Table 2: Mean and minimum annualized returns for different holding periods. Data from 1950 – 2022.

3.3 Failure probabilities

Figures 2 and 3 illustrate the probabilities of failure to achieve a minimum performance. In order to being capable to fulfil their spending requirements, investors need to achieve in the long run a minimum return level equal to the sum of the spending rate and the inflation rate in the long run. We analyze the failure probability of achieving a minimum return of 4% p.a. and 2% p.a. for the main asset classes of the four countries analyzed.

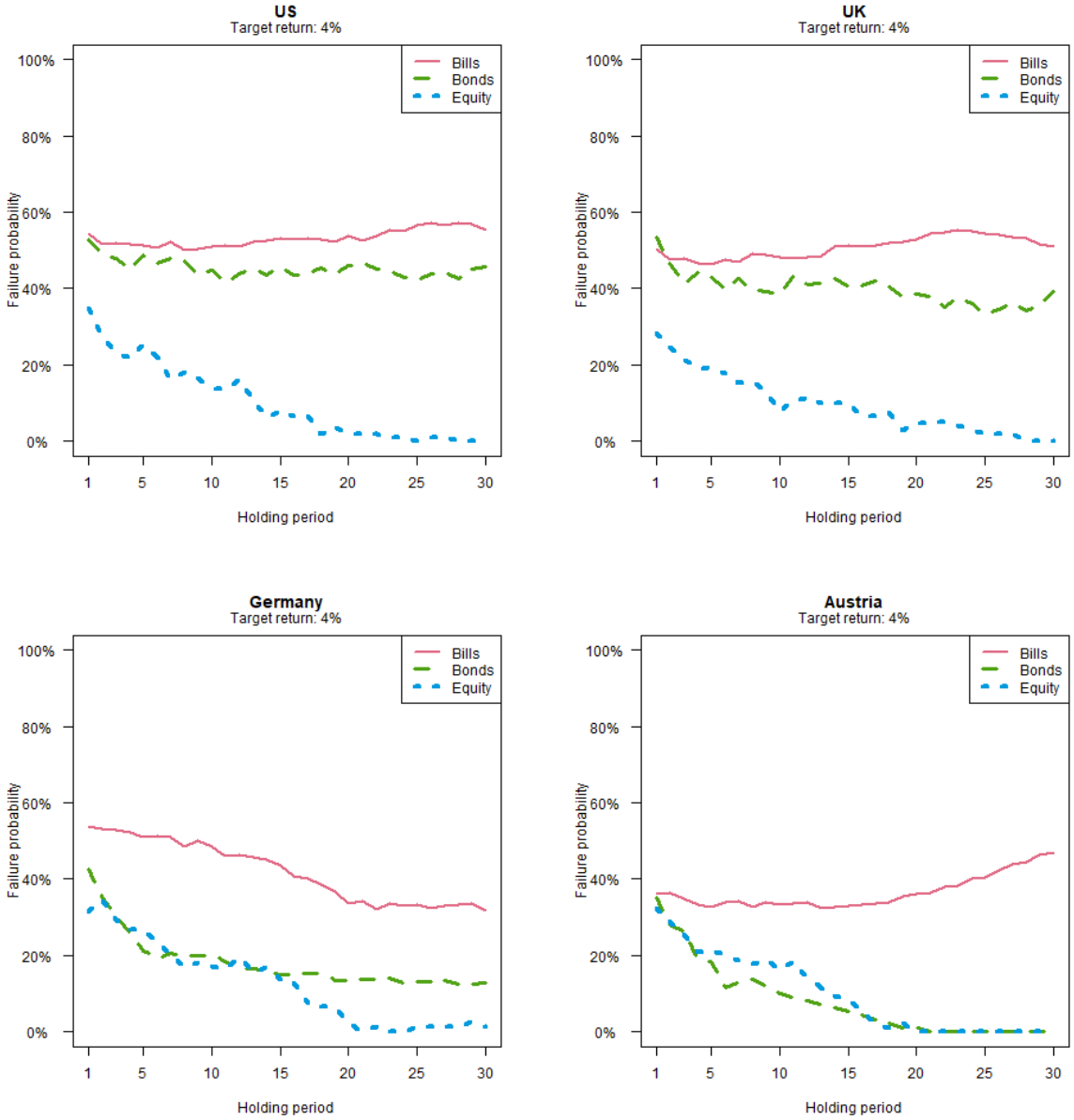

Figure 2: Probability of failure to reach a minimum return target of 4%.

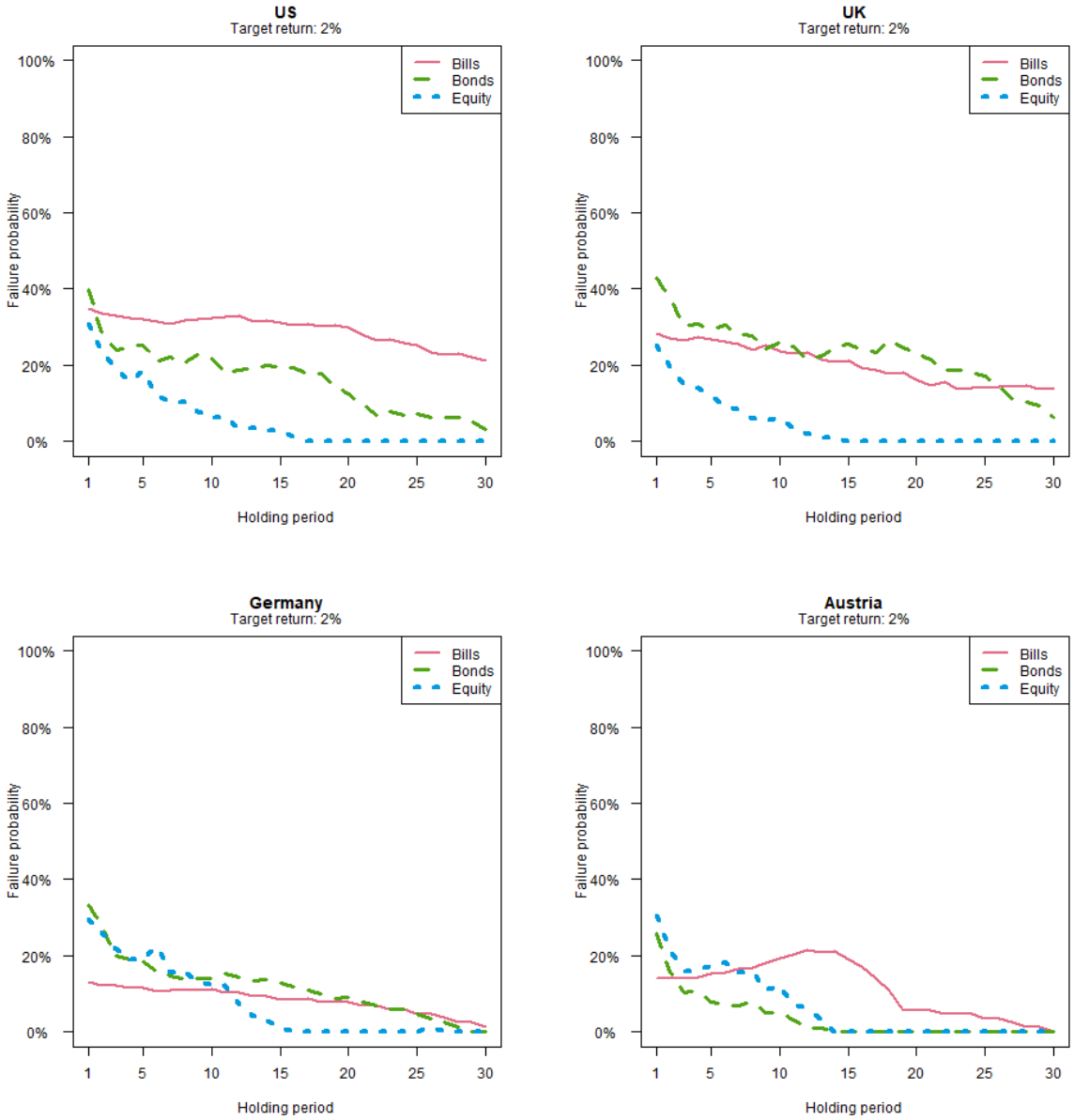

Figure 3: Probability of failure to reach a minimum return target of 2%.

Figures 2 and 3 show that historically, stocks have had the lowest failure probability. For a moderate minimum return target of 4%, bills and bonds are risky asset classes as they frequently underperform even over long horizons, while stocks appear relatively safe. This is in contrast to the well-known higher volatility of stocks in the short run. Thus, the investment horizon and spending requirements play a major role for investment decisions.

4 Conclusion

Investors with a long horizon that have to fulfil spending requirements out of their investments have to take minimum return targets into account when deciding on an investment strategy. An asset class with low risk of capital losses in the short run can simultaneously have high risk of failure to meet specified spending requirements in the long run. To meet even moderate spending requirements in the long run, an endowment has to earn a return that exceeds the spending requirement by the inflation rate. To provide evidence on the choice of asset classes for long-run investors, we have analyzed 123 years of annual stock, bond, and bill returns from the U.S., UK, Germany, and Austria. Our findings show a clear relationship between the investment horizon, and the risk of underperformance for different asset classes. For a plausible minimum return target of 4% and long horizons of 10 years or beyond, the risk of failure is by far lowest for equity.

The focus of our analysis is to understand which asset classes should be eligible for investment for a risk averse endowment. To minimize the risk of failure to meet spending requirements in the long run, it is essential to include stocks into an endowment portfolio.

A limitation of our study is that we do not aim to propose an optimal asset allocation. To do so, additional aspects would have to be considered, such as a richer set of markets, covariances between asset classes, the possible impact of valuation ratios and the levels of interest and inflation rates, and the need to consider a special role of near-term spending requirements. We leave this task for future analysis.

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