The Long-Horizon Returns of Stocks, Bonds, and Bills: Evidence from a Broad Sample of Developed Markets

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Abstract

We characterize the joint distribution of long-horizon returns on domestic stocks, international stocks, bonds, and bills. We study 38 developed countries with a sample period of 1890 to 2019, and our data formation procedures mitigate survivor and easy data biases. Bootstrap estimates of the joint distribution reveal substantial uncertainty in asset payoffs and large real loss probabilities over a 30-year horizon for domestic stocks (13%), bonds (27%), and bills (37%). The distribution features joint tail risk, such that simultaneous real losses across multiple asset classes over long horizons are not rare. The potential losses are most pronounced when current asset prices are high.

JEL classifications: C15, D31, G10, G11, G12, G15, G17, N20

Key words: Long-horizon returns, loss probability, survivor bias, easy data bias

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1 Introduction

For retirement savers and other long-horizon investors, forming expectations about the wealth generated by their assets during their savings period is crucial for financial planning. Equally important is an understanding of the range of potential outcomes and the probability of a loss over their investment window. To this end, recent studies estimate the distribution of long-horizon buy-and-hold returns from investing in the stock market. Fama and French (2018) use the historical US experience and estimate a large expected gain and a low probability of loss at a long 30-year horizon. Motivated by the short return history of the US and concerns over biases from survivorship [Brown, Goetzmann, and Ross (1995)] and easy data availability [Dimson, Marsh, and Staunton (2002)], Anarkulova, Cederburg, and O'Doherty (2021) consider evidence from a broad sample of developed countries. They estimate a real 30-year loss probability from the developed country sample that is an order of magnitude larger than their estimate from the US data. Investors can access a range of asset classes in addition to domestic stocks, and the long-horizon returns of international stocks, bonds, and bills affect portfolio performance for diversified retirement savers. Little systematic evidence exists in the literature, however, on the long-horizon distributions for these asset classes and the relations in long-run outcomes across asset classes.

In this study, we use a bootstrap approach to estimate the joint distribution of real returns on domestic stocks, international stocks, government bonds, and government bills for developed economies. We consider horizons for buy-and-hold cumulative wealth ranging from one month to 30 years. The joint distribution allows us to study the marginal distribution for each asset class, so our study characterizes distributions of long-horizon returns for each of domestic stocks, international stocks, bonds, and bills within a consistent framework. The marginal distributions for international stocks, bonds, and bills provide new information to the literature and offer additional context for analyzing the distribution for domestic stocks. The joint distribution allows us to study the relations in long-run performance across assets and to estimate joint and conditional loss probabilities. As such, we provide a systematic analysis of the short- and long-term performance of the four asset classes, both individually and jointly.

We use a broad sample of asset returns from developed countries to estimate return distributions. Our data span nearly 2,500 years across 38 countries with an overall study sample period of 1890 to 2019. We are cognizant of the potential for survivor bias [Brown, Goetzmann, and Ross (1995)] and easy data bias [Dimson, Marsh, and Staunton (2002)], which arise from conditioning on eventual market outcomes or easy availability of data while forming a sample. Anarkulova, Cederburg, and

O'Doherty (2021) show that survivor and easy data biases can have a large quantitative effect on the estimated distribution of long-horizon stock market returns. Our sample formation techniques are designed to mitigate these biases. We identify developed countries using ex ante available information, and we ensure that our data contain no unintentional gaps in the middle or at the end of our sample for any of the four asset classes.

We identify developed countries following Anarkulova, Cederburg, and O'Doherty (2021). Before 1948, countries are classified as developed when their agricultural labor shares drop below 50%, drawing from evidence in the economics literature about labor patterns and economic development [e.g., Kuznets (1973)]. Beginning in 1948, developed country classifications are based on membership in the Organisation for Economic Co-operation and Development (OECD) and its predecessor, the Organisation for European Economic Co-operation (OEEC). We calculate real monthly returns on domestic stocks, bonds, and bills during the developed period of each country. We also calculate returns on a value-weighted portfolio of all foreign stock markets (excluding the domestic market), and we measure international stock portfolio performance using real returns denominated in the domestic currency of the country under consideration.[1] Our dataset spans nearly 91% of the potential sample of developed country asset returns.

We estimate joint distributions of asset returns using a block bootstrap approach. Our bootstrap approach draws blocks of multiple consecutive months from a given developed country period, and we simultaneously draw the set of returns on domestic stocks, international stocks, bonds, and bills for each month in the block. The block structure preserves time-series dependencies in the data, and drawing all four asset returns preserves cross-sectional dependencies.

Our empirical analysis begins with an examination of the marginal distributions of the four asset classes. Figure 1 plots the bootstrap marginal distributions of 30-year cumulative real wealth from a $1.00 investment. Panel A compares the distributions for domestic stocks (blue bars) and international stocks (gray bars), and Panel B compares bonds (blue bars) and bills (gray bars). We note that all returns are denominated in the home country currency to reflect the investment experience of a developed country investor, and we denote wealth in dollars only for the convenience of specifying a currency when we discuss wealth levels.

Figure 1 shows that domestic and international stocks have favorable payoff distributions relative to bonds and bills with a 30-year horizon. Stocks have high average payoffs at $7.45 for domestic stocks and $7.83 for international stocks compared with only $2.34 for bonds and $1.32 for bills.

[1] We only consider domestic bonds and bills. About two-thirds of total public debt is held by domestic investors [Reinhart and Rogoff (2011)].

Domestic and international stocks also have lower real loss probabilities relative to bonds and bills. The loss probability for domestic stocks is 12.6%. This estimate is consistent with the results in Anarkulova, Cederburg, and O'Doherty (2021), who emphasize that the estimated loss probability for domestic stocks in developed countries is quite high relative to the conventional wisdom that stocks are safe over long horizons [e.g., Siegel (2014)]. Relative to domestic stocks, the diversification achieved with an international stock portfolio outweighs additional exchange rate risk to produce a low loss probability of 4.1%. We find that bonds and bills often fail to outperform relative to inflation at long horizons with real loss probabilities of 26.8% and 36.9%, respectively, and these asset classes occasionally realize catastrophic real outcomes in inflationary periods.

We further study joint distributions of domestic stocks, international stocks, bonds, and bills at a variety of horizons. Domestic stocks are relatively closely linked with each of the other three assets, with correlations in 30-year log real wealth outcomes of 0.35 with international stocks, 0.46 with bonds, and 0.36 with bills. International stocks show little relation with bonds and bills. Consistent with intuition, real outcomes for bonds and bills have a high correlation of 0.81.

We also study loss probabilities for each asset class that condition on a loss in another asset class. The relatively low unconditional loss probability of 4.1% for international stocks at a 30-year horizon grows to 12.8% if domestic stocks suffer a loss. The effect of losses in domestic stocks are even more stark for bonds and bills, which have conditional loss probabilities of 61.0% and 60.4%. These conditional loss probabilities imply that investors face substantial risks of real losses across multiple asset classes even with a long investment horizon. We introduce a decomposition of these conditional loss probabilities into short-term and long-term correlation components as well as joint tail risk. We find that much of the risk of simultaneous losses is explained by longer-term relations and joint tail risk across assets, which may be missed by examining comovement across asset classes at short horizons.

Finally, we estimate conditional joint distributions that condition on the current value of a state variable reflecting market conditions. We specifically use the aggregate dividend-price ratio of the domestic stock market or the prevailing short-term interest rate. The distributions that we estimate do not condition on any information that is unavailable to investors at the beginning of the investment window.

We find important differences in the distributions of each asset across market states. For brevity, we focus here on stock distributions across dividend-price states and bond and bill distributions across interest rate environments. Average domestic and international stock payoffs at a 30-year horizon are nearly monotonically increasing with the dividend-price ratio. The mean payoff for domestic stocks is \$5.96 for a \$1.00 investment when the prevailing dividend-price ratio is less than 0.02 compared with \$10.03 when the ratio is greater than 0.06. International stocks have average payoffs of \$7.23 and \$9.53 when the domestic dividend-price ratio is low and high, respectively. The real loss probability on domestic stocks reaches 16.2% when current market prices are high versus 7.3% in low-price periods.

Bonds and bills are attractive assets in high interest rate environments with rates above 10%, with mean 30-year payoffs of \$5.01 and \$2.10 for bonds and bills, respectively, and real loss probabilities of only 7.9% and 10.5%. In low interest rate environments with rates below 2%, bonds produce real wealth of just \$1.43 on average over the subsequent 30 years and bills lose on average with a mean payoff of \$0.76. The loss probabilities are also high at 27.5% for bonds and 83.1% for bills. These results show that the current market environment is an important consideration for long-horizon investors as they form expectations about the performance of their investments.

We contribute to a large literature studying interrelations between domestic stocks, international stocks, bonds, and bills. For example, Forbes and Rigobon (2002); Goetzmann, Li, and Rouwenhorst (2005); Connolly, Stivers, and Sun (2007); Bekaert, Hodrick, and Zhang (2009); and Bekaert, Harvey, Kiguel, and Wang (2016) consider comovement in equity markets across countries. Shiller and Beltratti (1992); Campbell and Ammer (1993); Connolly, Stivers, and Sun (2005); Yang, Zhou, and Wang (2009); Baele, Bekaert, and Inghelbrecht (2010); Duffee (2021); and McQuarrie (2021), among others, study the relations between the returns on stocks and bonds. Finally, our focus on tail outcomes and loss probabilities across markets is related to studies by Longin and Solnik (2001); Christoffersen, Errunza, Jacobs, and Langlois (2012); and Gao, Lu, and Song (2019).

Our study also contributes to a literature that uses international data and long samples to address issues for which the relatively short US sample may fail to provide definitive evidence. These studies often examine tail probabilities and peso problems [Rietz (1988)] or economic issues for which statistical tests have low power. For example, Barro (2006), Barro and Ursúa (2008, 2012, 2017), Barro and Jin (2011), and Nakamura, Steinsson, Barro, and Ursúa (2013) study rare macroeconomic events using broad samples of countries and long periods. Goetzmann and Jorion (1995), Lundblad (2007), and Golez and Koudijs (2018) consider stock market return predictability and overcome power issues by extending their samples with longer historical periods. Several studies also estimate equity premiums across a broad set of countries [e.g., Jorion and Goetzmann (1999) and Dimson, Marsh, and Staunton (2002)], and Schmelzing (2020) uses a long sample of developed countries to study trends in real interest rates. Our study is most closely related to Anarkulova, Cederburg, and O'Doherty (2021), who estimate bootstrap distributions of domestic stock returns using a large sample of developed country returns.

The remainder of the paper is organized as follows. Section 2 describes our dataset construction, details return calculations, and provides summary statistics. Section 3 outlines our primary bootstrap approach for estimating payoff distributions. Section 4 discusses our empirical findings for the marginal distributions, joint distributions, and conditional distributions of the four assets we consider. Section 5 concludes.

2 Data

We construct a dataset of real returns on domestic stocks, international stocks, bonds, and bills for developed countries. When we form the return series for a given country, all returns are measured in the local currency and the local country's inflation rate determines the adjustment from nominal to real returns. The returns for each country, thus, reflect the experience of an investor living in that country. As we discuss further below, the overall sample period for our study is 1890 to 2019, but sample start dates for individual countries differ based on economic development and data availability. Our dataset contains monthly return observations, and we have a balanced panel of data for each country in the sense that no asset has a missing return for any of the country-months included in the sample.

Our primary data source is the GFDatabase by Global Financial Data (GFD). This database contains long time series of returns, prices, and dividend yields for stocks; yields for bonds and bills; inflation; exchange rates; and total stock market capitalization for a broad set of countries. For some countries, we supplement these data with observations that we hand collect from original source documents (e.g., statistical yearbooks) or gather from alternative sources [e.g., the St. Louis Federal Reserve or Jordà, Knoll, Kuvshinov, Schularick, and Taylor (2019)] to extend samples or fill gaps in the data. As we detail further below, the resulting dataset has no unintended gaps in the middle or at the end of the sample, which is important for mitigating the potential effects of survivor and easy data biases.

The remainder of this section is organized as follows. Section 2.1 provides information about real return calculations. Section 2.2 outlines the classification of developed countries and details country-specific sample periods. Section 2.3 discusses special data issues, and Section 2.4 presents summary statistics.

2.1 Return calculations

Sections 2.1.1 to 2.1.4 describe the asset-specific real return calculations. Section 2.1.5 details calculations related to inflation and currency fluctuations, which we use in Section 4 to further analyze real asset returns.

2.1.1 Domestic stocks

Our domestic stock market return calculations mirror those in Anarkulova, Cederburg, and O'Doherty (2021) with minor exceptions. The GFDatabase contains data for total return indexes, price indexes, and dividend yields. It includes stock market indexes that are created and calculated by stock exchanges (e.g., the Tokyo Stock Price Index from the Tokyo Stock Exchange), by well-known index providers (e.g., the S&P 500 Index), or by GFD directly from original source documents. Multiple stock indexes are available in the database for some countries and periods. We select a single index in these cases by considering the breadth of market coverage and the length of historical coverage. We use a total return index whenever one is available, and we otherwise use a price index and a dividend yield to calculate returns. Our index choices for each country are available in the Internet Appendix.

For sample months in which a total return index is available, we calculate the monthly nominal return,

$$R_{i,t}^{Nominal\ stocks} = \frac{I_{i,t}^{Total}}{I_{i,t-1}^{Total}}, \tag{1}$$

where $I_{i,t}^{Total}$ is the total return index for country i at the end of month t and $R_{i,t}^{Nominal\ stocks}$ is the gross nominal return for country i in month t. If no total return index is available, we use price index and dividend yield data to calculate returns. Following Anarkulova, Cederburg, and O'Doherty (2021), we assume the annual dividend reflected by the reported dividend yield is paid equally across months in the year. If the price index is denoted $I_{i,t}^{Price}$ and $\hat{D}_{i,t}$ is the estimated dividend for country i in month t (appropriately scaled to the level of the price index), then we calculate the monthly nominal return,

$$R_{i,t}^{Nominal\ stocks} = \frac{I_{i,t}^{Price} + \hat{D}_{i,t}}{I_{i,t-1}^{Price}}. \tag{2}$$

Additional details on return construction are available in the Internet Appendix and in Anarkulova, Cederburg, and O'Doherty (2021).

We use CPI data to convert nominal returns into real returns. We first calculate gross inflation,

$$\Pi_{i,t} = \frac{I_{i,t}^{CPI}}{I_{i,t-1}^{CPI}}, \tag{3}$$

where $I_{i,t}^{CPI}$ is the CPI index for country i at the end of month t. We then calculate the gross real return on domestic stocks given the gross nominal return and gross inflation,

$$R_{i,t}^{Domestic\ stocks} = \frac{R_{i,t}^{Nominal\ stocks}}{\Pi_{i,t}}. \tag{4}$$

This return calculation produces real returns that are denominated in the local currency of country i.

2.1.2 International stocks

We calculate real returns on a portfolio of international stocks from the perspective of an investor in a developed country. For each country, the international stock portfolio is a weighted investment across all developed stock markets excluding the local stock market. The international stock portfolio is value weighted by total market capitalization, and the returns are expressed in the domestic currency such that they reflect the exchange rate risk incurred by investing in assets denominated in foreign currencies.

The return calculation for international stocks uses the gross nominal stock market returns calculated in the previous section. We first convert the nominal return for each country $j \neq i$ into a real return that is denominated in the domestic currency of country i,

$$R_{j,t}^{Real\ domestic\ currency} = \frac{R_{j,t}^{Nominal\ stocks}}{\Pi_{i,t}} \left(\frac{E_t^{i,j}}{E_{t-1}^{i,j}} \right), \tag{5}$$

where $E_t^{i,j}$ is the exchange rate at the end of month t expressed in country i currency per country j currency. We then calculate the gross real return on international stocks for country i in month t,

$$R_{i,t}^{International\ stocks} = \sum_{j \neq i} w_{j,t-1} R_{j,t}^{Real\ domestic\ currency}, \tag{6}$$

where $w_{j,t-1}$ is country j's weight in the international stock portfolio in month t,

$$w_{j,t-1} = \frac{M_{j,t-1}}{\sum_{j \neq i} M_{j,t-1}}, \tag{7}$$

and $M_{j,t-1}$ is the total market capitalization for the stock market in country j at the end of month $t-1$ expressed in US dollars.

2.1.3 Bonds

We calculate bond returns using monthly data on bond yields. For comparability across countries and periods, we focus on ten-year government bonds. The GFDatabase has variables for ten-year bond yields for most countries and periods in our sample, and we supplement these data in some cases to expand data coverage. We provide details on these instances in the Internet Appendix.

We first estimate ten-year bond prices given bond yields. We assume the bond has exactly ten years to maturity, semiannual coupons, and a coupon rate equal to the greater of the bond yield and zero at the end of month $t-1$. For nearly all observations in the sample, this calculation implies the bond is trading at par at the end of month $t-1$, but the bond price is above par in the few cases with negative bond yields. We then reprice this bond at the end of month t given the month-t yield and one month shorter maturity of the bond. We calculate the gross nominal return,

$$R_{i,t}^{Nominal\ bonds} = \frac{P_{i,t}}{P_{i,t-1}}, \tag{8}$$

where $P_{i,t}$ is the calculated dirty bond price (i.e., inclusive of accrued interest) for country i at the end of month t. Finally, we calculate the gross real bond return,

$$R_{i,t}^{Bonds} = \frac{R_{i,t}^{Nominal\ bonds}}{\Pi_{i,t}}. \tag{9}$$

This return calculation requires assumptions about the maturity and the coupon rate of the underlying bond. We validate this calculation in the Internet Appendix by comparing our calculated returns with returns from Datastream over the period of overlap between the two data samples. Our return calculations are very highly correlated and have similar moments to those from Datastream, and using bond yield data to calculate returns provides us with broad coverage across countries and periods.

2.1.4 Bills

We estimate returns on bills using short-term yields and rates. For most countries and periods, the GFDatabase has coverage with yield data on short-term (typically three-month) government bills. When these data are missing, we next use central bank rates when available and then interbank rates from the GFDatabase. For a few countries and periods, we supplement these data with hand collected short-term rates from original source documents. We provide additional information about variables and sources for short-term rates in the Internet Appendix. We convert annual nominal rates on bills into monthly nominal returns denoted by $R_{i,t}^{Nominal\ bills}$ and then calculate real returns,

$$R_{i,t}^{Bills} = \frac{R_{i,t}^{Nominal\ bills}}{\Pi_{i,t}}. \tag{10}$$

2.1.5 Inflation and currencies

The real returns for domestic stocks, international stocks, bonds, and bills are affected by inflation. Further, international stock returns depend on fluctuations in foreign exchange rates during the investment period. We calculate real returns on cash as a reference point for understanding the effects of inflation on real returns. The gross real return on cash for country i in month t is

$$R_{i,t}^{Cash} = \frac{1}{\Pi_{i,t}}. \tag{11}$$

We also compute real returns for the basket of foreign currencies that are required to invest in the international stock portfolio. Specifically, the real return on the currency basket is

$$R_{i,t}^{Currency} = \frac{1}{\Pi_{i,t}} \sum_{j \neq i} w_{j,t-1} \left(\frac{E_t^{i,j}}{E_{t-1}^{i,j}} \right), \tag{12}$$

where $w_{j,t-1}$ is the weight of each foreign stock market in the international stock portfolio as defined in equation (7).

2.2 Development classification

We follow Anarkulova, Cederburg, and O'Doherty (2021) to classify countries as developed. We classify a given country as developed early in the sample period if its agricultural labor share is less than 50% based on evidence about labor patterns from the economics literature [e.g., Kuznets (1973)]. Beginning with the formation of the OEEC in 1948, we use membership in the OEEC and the OECD to identify development dates.

Table I displays the development date and the reason for classification for each country. As in Anarkulova, Cederburg, and O'Doherty (2021), our sample contains three instances in which a previously developed country is reclassified as developing. These instances occur in Argentina, Chile, and Czechoslovakia, and each reclassification results from substantial changes in governments and markets in these countries. Chile re-enters the sample in 2010 with its membership in the OECD, and Czechia and Slovakia re-enter on the same basis in 1995 and 2000, respectively. We include the early periods in these countries to avoid survivor bias.

In order to form a balanced panel, a developed country can not enter into our sample until its government issues ten-year bonds. Several countries achieved economic development, but did not immediately issue long-term government bonds. As such, sample eligibility for these countries postdates their development years. Estonia is the sole developed country that did not have outstanding long-term bonds during its developed period, such that this country is excluded from our dataset.

Table I shows the sample eligibility date and the data coverage for each country. The sample eligibility date is the latest of 1890 (i.e., the sample period start date for our study), the country development year, and the year in which the country first issued long-term bonds. The sample coverage dates denote the periods for which we have monthly data on domestic stocks, international stocks, bonds, and bills. Importantly, no country has data gaps in the middle or at the end of its series.

For some countries, we have missing data after the sample eligibility date. Domestic stock market returns are the binding constraint in each of these instances. That is, there are some periods for which we are missing both stock and bond data, but the bond data always become available before or at the same time as the stock data. Table I shows the sample coverage for each country by calculating the number of months in our sample as a proportion of the number of months between the sample eligibility date and the end of the sample period.

Figure 2 provides a visual representation of our sample coverage. The development dates and classification reasons are denoted by diamonds (agricultural labor share) and stars (OEEC/OECD membership), and years that predate the 1890 sample period start are shaded gray. The blue lines indicate developed periods in which we have continuous monthly data for domestic stocks, international stocks, bonds, and bills. The black dashed lines show periods in which the country is eligible to be in our sample but we have missing data. As the figure indicates, our dataset achieves broad coverage of the eligible sample periods. Overall, our data span 29,919 months (about 2,493 years) of the 33,007 possible months (about 2,751 years), such that we cover 90.6% of the potential sample.

2.3 Special data considerations

A systematic issue with data availability arises from stock market closures. Anarkulova, Cederburg, and O'Doherty (2021) discuss 35 instances in which stock exchanges closed for extended periods, often as the result of a major war, a political revolution, or a banking crisis. Investors tend to earn negative real returns in these periods, such that omitting countries or periods because of these stock return data gaps induces an easy data bias. Anarkulova, Cederburg, and O'Doherty (2021) treat each stock market closure period as a single multi-month observation in their bootstrap procedure. We also consider international stocks, bonds, and bills in this study, and a consistent monthly data frequency facilitates a cleaner analysis of the joint distribution of asset returns. As such, we produce a series of monthly returns on domestic stocks for each of the multi-month periods.

For some of the stock exchange closure periods, the GFDatabase provides monthly returns from black markets that operated during the period over which the regular exchange was closed. A prominent example of this type of market is the "New Street" market that formed within days of the closure of the New York Stock Exchange in July 1914 with the onset of World War I [Silber (2005)]. We use the data provided by GFD in these cases. For most other multi-month periods, we allocate the full-period real return to the first month of the period. An investor who held stocks when the stock market closed and was not able to trade in a black market would have eventually realized this full-period return, and the negative returns that occurred in many of these periods would have been foreshadowed to some degree by the negative nature of the event that caused the market closure. We also note that the block bootstrap design described in Section 3 often draws the entire set of returns that accompany an exchange closure, such that the buy-and-hold cumulative payoff reflects the full return realization that occurred during the exchange closure. Additional information about these periods is provided in the Internet Appendix.

We measure returns that are denominated in the primary home currency with one exception. Our real returns for Germany are denominated in gold marks (rather than paper marks) for the 1917 to 1923 period. Extraordinary hyperinflation during this period complicates the calculation of real returns based on nominal returns in paper marks, and the GFDatabase reports a series of stock market returns denominated in gold marks. We also calculate gold mark returns for international stocks, bonds, and bills.

The German bond market during this period of hyperinflation provides an interesting example of contrasting nominal and real outcomes. From the beginning of 1922 until Germany issued a new Reichsmark currency in January 1924, German bonds realized a paper mark capital gain of over 1,200,000,000,000%. The bonds were trading at an extremely large multiple of their par value, as investors anticipated that the German government may issue new bonds to holders of the original bonds to compensate investors for the enormous real losses from inflation. The ultimate compensation to investors was small, and the cumulative real bond return denominated in gold marks was about −98% over the inflationary period.

The bond return calculation in Section 2.1.3 must be adjusted in the event of a default or bond exchange that produces a change in par value. Explicit defaults on domestic sovereign bonds are rare relative to external defaults, particularly for developed countries [Reinhart and Rogoff (2011)]. Rather, inflation is a more commonly used tool for eroding the real value of domestic debt.

A notable event that produced a change in par value is the Greek default in 2012. Greece undertook a debt exchange in March 2012 in which creditors exchanged their existing bonds for a package of new government securities with a lower face value. Zettelmeyer, Trebesch, and Gulati (2013) provide an issue-by-issue estimate of the haircut for existing bondholders. We use the 53.8% haircut estimate for the bond with maturity closest to ten years. The ten-year bond yield declined substantially from 36.6% to 21.0% in March 2012, such that our calculation based on bond yields produces a nominal return of 67.1%. Our calculation of the nominal gross return that incorporates the haircut is $1.671 \times (1 - 0.538) = 0.772$ to produce a nominal return of −22.8% for ten-year bonds in March 2012.

We also account for a bond conversion in Argentina in 1960 [Duggan (1963)] and the consequences of Germany's exchange in 1948 of Reichsmarks for Deutschemarks at a rate of 10:1 for sovereign bondholders [Schnabl (2019)]. Additional details are available in the Internet Appendix.

2.4 Summary statistics

Table II shows summary statistics for the monthly real returns in our sample.[2] The table reports the number of monthly observations, the arithmetic and geometric means, the standard deviation, the skewness and kurtosis, and the minimum and maximum returns for each asset and country. We also report statistics for the pooled sample of observations. The statistics in Panel A are for domestic stocks, those in Panel B are for international stocks, those in Panel C are for bonds, and those in Panel D are for bills.[3] We note that (i) cross-country comparisons are somewhat difficult in this setting because of sample period differences and (ii) the recently developed countries have

[2] We provide summary statistics for nominal returns in the Internet Appendix.

[3] We provide summary statistics for real returns on cash and the currency basket in the Internet Appendix.

short samples that are likely not representative of long-term expectations.

Panel A of Table II reports summary statistics for domestic stocks. Several countries earned extreme monthly real returns during the sample. Particularly notable losses occurred in Germany (−91.10%) and Czechoslovakia (−88.59%) in the aftermath of World War II and Portugal (−89.24%) during the Carnation Revolution in the 1970s. Relative to the US sample, the pooled sample from developed countries has lower means (0.53% versus 0.64% for arithmetic mean and 0.37% versus 0.52% for geometric mean), a higher standard deviation (5.59% versus 4.99%), and a higher kurtosis (39.91 versus 12.86).

Panel B of Table II shows results for real international stock returns. Investing in a portfolio of foreign markets produces a diversification benefit, but an investor's positions in assets denominated in foreign currency are subject to exchange rate risk. Given that the portfolio of international stocks is relatively similar across countries (i.e., the portfolio of international stocks is always a value-weighted investment in markets from all countries other than the one under consideration), much of the variation in international stock returns across countries is attributable to fluctuations in exchange rates. The most extreme examples of real returns that show this effect occur in countries that experienced large exchange rate shifts around currency reforms: Austria (299.72%), Germany (303.75%), Italy (371.89%), and Japan (373.05%). The pooled standard deviation of international stock returns in Panel B is higher than that of domestic stock returns in Panel A, but this difference is largely driven by the countries with volatile exchange rates. The international stock portfolio from the perspective of a US investor, for example, has a monthly standard deviation of only 3.78% compared with the pooled standard deviation of 6.74%.

A comparison of Panel C of Table II with Panels A and B reveals that bond investments earn lower real returns on average compared with stock investments, consistent with the historical US experience. The monthly arithmetic (geometric) mean return for bonds is 0.21% (0.10%) compared with 0.53% (0.37%) for domestic stocks and 0.58% (0.43%) for international stocks. Bonds have a higher pooled standard deviation compared with stocks, but this effect is attributable to the small set of extreme bond returns realized in the hyperinflation period in Germany discussed in Section 2.3. Bond returns have a lower standard deviation than do domestic stock returns for each country other than Germany.

Finally, Panel D displays results for bills. In our large sample of developed countries, bills earn, on average, just enough interest to offset inflation. The arithmetic (geometric) mean return of 0.01% (0.00%) indicates that the average real rate earned by investors in short-term, high-credit-quality debt is near zero.

3 Bootstrap design

We estimate the joint distributions of real returns on domestic stocks, international stocks, bonds, and bills over various horizons using a bootstrap simulation procedure. Broadly speaking, the bootstrap approach randomly draws returns from the 29,919 monthly observations with replacement, and we calculate cumulative buy-and-hold returns for each asset at an H-month horizon to produce a bootstrap joint distribution. To capture the effects of time-series properties of returns including time-varying volatility and mean reversion, we adopt a block bootstrap approach. A block bootstrap draws blocks of consecutive months of data from a country's sample, such that any time-series dependencies within these blocks are preserved. We draw random block sizes from a geometric distribution, and we set the block size parameter to produce an average block length of 120 months. Anarkulova, Cederburg, and O'Doherty (2021) demonstrate that this long average block length allows for the effects of relatively longer-term dependencies like mean reversion in returns to be reflected in the bootstrap distributions. We show robustness to this block length choice in the Internet Appendix.

As we draw a block of returns from a particular country, we maintain cross-sectional dependencies across assets by drawing the set of four asset returns for each month in the block. For example, the monthly bill return in a bootstrap draw is the return realization from the same country and month as the domestic stock return. Drawing the full set of four asset returns together allows us to estimate the joint distribution of returns while maintaining cross-asset relations.

We estimate bootstrap joint distributions at horizons up to 30 years, such that the longest horizon H is 360 months. Our approach is motivated by the stationary bootstrap of Politis and Romano (1994). This bootstrap method is designed to avoid undersampling from any portion of the sample. Specifically, to avoid undersampling returns at the beginning of each country's sample period, the stationary bootstrap specifies that a block that begins toward the end of a country's sample and is unfilled by the remaining data from that country wraps back to the beginning of a sample from a randomly chosen country to fill the block. The bootstrap procedure in iteration m is as follows:

1. We draw a random block size b from a geometric distribution with a probability parameter equal to the inverse of the desired average block length.

2. We randomly select a starting observation return vector for the block from the 29,919 months

in the pooled sample. We denote this observation as

$$R_{i,t} = \left[R_{i,t}^{Domestic\ stocks} \quad R_{i,t}^{International\ stocks} \quad R_{i,t}^{Bonds} \quad R_{i,t}^{Bills} \right], \tag{13}$$

where i indexes the country and t indexes the month. If country i's sample contains return observations $R_{i,t}$ through $R_{i,t+b-1}$, the return block draw is $B_b = \{R_{i,t}, R_{i,t+1}, \ldots, R_{i,t+b-1}\}$. If not, then $\{R_{i,t}, R_{i,t+1}, \ldots, R_{i,T}\}$, where $R_{i,T}$ is the last observation in country i's sample, is insufficient to fill block B_b. In this case, we draw a random country j from the 39 developed periods discussed in Section 2.2. If country j has enough observations to fill the remainder of the block, the block is $B_b = \{R_{i,t}, R_{i,t+1}, \ldots, R_{i,T}, R_{j,1}, R_{j,2}, \ldots, R_{j,b-(T-t+1)}\}$. If not, the country j observations are added to the block, and we repeat the process and draw another random country until the block is filled.

3. We add B_b to the bootstrap return matrix draw $R^{(m)}$. We return to step one and repeat the process until the return matrix has 360 months of data for the four assets. The final bootstrap draw in iteration m is $R^{(m)} = \{R_1^{(m)}, R_2^{(m)}, \ldots, R_{360}^{(m)}\}$.

For a \$1.00 buy-and-hold investment, the draw of wealth for an H-month horizon is

$$W_H^{(m)} = \prod_{t=1}^{H} R_t^{(m)}. \tag{14}$$

We repeat this procedure for iterations $m = 1, 2, \ldots, 10{,}000{,}000$ to produce a bootstrap joint distribution of cumulative wealth in the assets at an H-month horizon. We choose the large number of draws because we consider conditional distributions in Section 4, and beginning with 10,000,000 draws from the joint distribution allows us to continue to have a large number of bootstrap draws even when we condition on relatively low probability events.

4 Results

We examine joint distributions of domestic stocks, international stocks, bonds, and bills in three broad stages. Section 4.1 provides information about marginal distributions for each asset class. Section 4.2 considers joint distributions of the four assets and conditional distributions that condition on a loss in another asset class. Section 4.3 studies conditional joint distributions of the four assets that condition on a particular value for either the dividend-price ratio or the short-term interest rate at the beginning of the holding period.

4.1 Marginal distributions

We begin our analysis by considering marginal distributions for each asset class. Table III reports statistics for bootstrap distributions of real payoffs from buy-and-hold investments in domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). Each panel shows results for horizons ranging from one month to 30 years. For the marginal distribution at each horizon, we report the mean and standard deviation of the payoffs, percentiles of the distribution, and the probability of a loss in real terms. Figure 3 plots the marginal distributions at horizons of one, ten, and 30 years. The distributions for domestic and international stocks are shown in the panels on the left (Panels A, C, and E), and the distributions for bonds and bills are shown on the right (Panels B, D, and F). The dashed line in each panel indicates the $1.00 initial investment, such that the line separates the regions of real loss and gain.

The marginal distributions for domestic stocks in Panel A of Table III closely match the main results of Anarkulova, Cederburg, and O'Doherty (2021). Stocks carry the potential for large real payoffs over long horizons, with mean real wealth reaching $7.45 at a 30-year horizon for a $1.00 initial investment. The distribution of long-term payoffs is highly skewed, as can be seen in Panel E of Figure 3, such that the mean of $7.45 is high compared with the median of $4.06. The substantial uncertainty about long-term payoffs is particularly striking. The 10th and 90th percentiles of the 30-year distribution, for example, are $0.82 and $15.76, which represent extraordinarily different economic outcomes. Anarkulova, Cederburg, and O'Doherty (2021) emphasize the relatively large real loss probabilities that persist even with long horizons and the potential for catastrophic investment outcomes. For our marginal bootstrap distribution, Panel A shows a real loss probability of 12.6% at a 30-year horizon. Further, the 5th percentile of the 30-year cumulative wealth distribution is only $0.46, indicating that outcomes in which half or more of the investor's buying power is lost are not exceedingly rare.

Panel B of Table III shows statistics for the marginal distributions of international stocks. The means and standard deviations of the international stock distributions are similar to those for domestic stocks. The most striking differences between the distributions for domestic and international stocks come from a comparison of loss probabilities. Whereas the two asset classes have similar loss probabilities on a monthly basis (42.7% for domestic stocks versus 41.6% for international stocks), the loss probability for international stocks drops more quickly with horizon. With a 30-year horizon, the loss probability in international stocks of 4.1% is small relative to the 12.6% loss probability for domestic stocks. This difference can clearly be seen in the distributions in

Panels C and E of Figure 3, as the international stock distributions have considerably less mass at low payoffs. The lower risk of loss reflects the importance of diversification across multiple markets.

The marginal distributions for bonds and bills are summarized in Panels C and D of Table III. Relative to equities, the average payoffs for the fixed income assets are low. At a 30-year horizon, the mean payoffs of \$2.34 and \$1.32 for bonds and bills, respectively, are dwarfed by the averages of \$7.45 for domestic stocks and \$7.83 for international stocks. These lower averages for bonds and bills are accompanied by lower risk as measured by standard deviation. Assessing risk with the probability of loss, in contrast, yields a different conclusion. Whereas loss probabilities for domestic and international stocks decline substantially as the holding period grows, those for bonds and bills are more stable across horizons. The 30.9% loss probability for bonds at a five-year horizon, for example, is similar in magnitude to the 26.8% probability of loss with a 30-year horizon. The odds of a real loss in bills have a small range of 36.9% to 40.2% across the six horizons we consider. These assets also carry non-trivial chances of overwhelmingly large losses, as the 5th percentiles of the 30-year marginal distributions for bonds and bills are only \$0.12 and \$0.16, respectively.

The stark contrasts across assets in the patterns of loss probabilities for different horizons are apparent in Figure 4, which plots the loss probabilities for domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D) at horizons from one to 360 months. Whereas the loss probabilities for domestic and international stocks steadily decline as the horizon grows, the loss probabilities for bonds and especially bills are relatively flat as a function of horizon. Long investment horizons are necessary for equity investors to ensure a high probability of real gains in wealth from domestic and international stocks. Fixed income investors, even those with very long horizons, face substantial risk of losses in buying power from buy-and-hold investments in bonds and bills.

4.1.1 Stochastic dominance

We next compare the marginal distributions across asset classes within a stochastic dominance framework.[4] Formally, if $F_{W_{H,A}}(x)$ ($F_{W_{H,B}}(x)$) is the cumulative distribution function (CDF) of wealth for asset A (B), then the first-order stochastic dominance criterion for asset A to dominate asset B is $F_{W_{H,A}}(x) \leq F_{W_{H,B}}(x)$ for all x and $F_{W_{H,A}}(x) < F_{W_{H,B}}(x)$ for at least one value of x. An equivalent condition is that the wealth generated by asset A is at least as high as that

[4] A large literature studies asset returns using stochastic dominance criteria. See, for example, Hadar and Russell (1969); Hanoch and Levy (1969); Rothschild and Stiglitz (1970); Bali, Demirtas, Levy, and Wolf (2009); and Levy and Levy (2021).

by asset B at each quantile of the distributions and strictly higher at some quantile. That is, $F^{-1}_{W_{H,A}}(\alpha) \geq F^{-1}_{W_{H,B}}(\alpha)$ for all $\alpha \in [0,1]$ and $F^{-1}_{W_{H,A}}(\alpha) > F^{-1}_{W_{H,B}}(\alpha)$ for some α. From an economic perspective, the first-order stochastic dominance condition implies that every utility-maximizing agent would prefer asset A to asset B.

We consider whether each asset class first-order stochastically dominates each other asset class. Our inferences are based on the CDFs implied by the 10,000,000 bootstrap draws for each horizon. The conditions for stochastic dominance in wealth or log wealth are equivalent, so we examine distributions of log wealth for reporting convenience. Figure 5 shows the CDFs for cumulative wealth levels for domestic stocks, international stocks, bonds, and bills at horizons of one, ten, and 30 years. Table IV reports the minimum value of $F^{-1}_{\log\left(W^{(m)}_{H,A}\right)}(\alpha) - F^{-1}_{\log\left(W^{(m)}_{H,B}\right)}(\alpha)$ across all $\alpha \in [0,1]$ for each horizon. To operationalize this calculation, we sort the 10,000,000 bootstrap draws for each asset class and calculate the difference between the log cumulative wealth levels across assets for each of the 10,000,000 paired sets of draws. A positive value of $\min_\alpha \left[F^{-1}_{\log\left(W^{(m)}_{H,A}\right)}(\alpha) - F^{-1}_{\log\left(W^{(m)}_{H,B}\right)}(\alpha)\right]$ is consistent with first-order stochastic domination of asset B by asset A. The absolute magnitude is the distance between log payoffs at the value of α that minimizes the quantity.

Table IV provides evidence that the equity asset classes are first-order stochastically dominant over the fixed income asset classes at longer horizons. Domestic stocks are first-order stochastically dominant over bonds at a 30-year horizon and bills at horizons of 20 and 30 years. Results are relatively similar for international stocks, which are first-order stochastically dominant over some horizons for bonds (30 years) and bills (ten, 20, and 30 years). As can also be seen in Figure 5, the long-horizon payoffs in portions of the international stock distribution are much higher compared with domestic stocks whereas the gap is relatively small over the regions in which domestic stocks outperform, but domestic stocks are not first-order stochastically dominated by international stocks. Bonds and bills are not dominant relative to any other asset class for the horizons we consider.[5]

4.1.2 Effects of inflation and currency

The real returns of the four asset classes under consideration are affected by realized inflation. International stock performance is also affected by changes in exchange rates during the hold-

[5] In unreported results, we find that cash is first-order stochastically dominated by domestic stocks at horizons of ten years and longer, international stocks at five years and longer, and bills at all horizons we consider. These findings indicate that utility-maximizing agents prefer to invest in some risky asset rather than simply saving cash. We also note that the first-order stochastic dominance criterion does not imply state-by-state dominance. There are observations in the data, for example, in which nominal short-term rates are negative, such that bills underperform relative to cash in these months. The distribution of bill outcomes, however, dominates the distribution of cash outcomes.

ing period. In this section, we examine the effects of inflation and currency fluctuations on the distributions of asset returns.

Figure 6 shows joint distributions for cash and each of domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D) at a horizon of 30 years. Each panel shows a scatterplot of the first 100,000 draws from the bootstrap distribution (for ease of presentation). Every dot represents a joint outcome of cash and one of the assets. The dots in higher density areas are shaded yellow and the dots in less dense areas are blue, so the dot colors produce a heat map for the joint distribution. Each axis has a log scale. Finally, the dashed lines mark a $1.00 initial investment. Dots in the lower left quadrant of a panel, for example, are bootstrap draws in which both assets lose relative to inflation.

The joint distribution of domestic stocks and cash is shown in Panel A of Figure 6. There appears to be a slight positive relation between the performance of domestic stocks and cash (or, equivalently, a negative relation between inflation and real returns on domestic stocks). In untabulated results, we estimate a correlation of 0.29 between log real payoffs on domestic stocks and cash. There are, however, many bootstrap draws in which the value of cash is drastically reduced but domestic stocks still produce a large real gain over the 30-year horizon. The joint distribution of international stocks and cash in Panel B shows even less of a relation. The correlation between log real payoffs in Panel B is 0.02. As such, we find evidence to support the contention that stocks tend to maintain or grow their real value in the face of inflation.[6]

The distributions for bonds and bills in Panels C and D of Figure 6 show a stark relation between fixed income and cash performance. High inflation erodes the real value of bonds and bills, and we see few exceptions of good performance for debt securities when the real value of cash is low. The correlations between log real cash payoffs with the log payoffs of bonds and bills are 0.74 and 0.83, respectively. Panel C also shows a considerable set of bootstrap draws with poor bond performance even without high realized inflation. Increases in interest rates and domestic defaults on long-term government bonds occasionally produce poor bond market outcomes in the absence of high inflation, but inflation is the primary driver of long-term performance.

Figure 7 provides a similar analysis using the currency basket that underlies the international stock portfolio investments. The joint distributions of the payoffs on currencies and domestic stocks (Panel A), bonds (Panel C), and bills (Panel D) do not show any obvious patterns. We find

[6] Fama and Schwert (1977) test the Fisher (1930) hypothesis for stocks and find a negative relation between nominal stock returns and inflation at horizons less than one year, such that stocks appear to be a poor inflation hedge. Our findings for 30-year payoffs are consistent with subsequent studies [e.g., Boudoukh and Richardson (1993)] that find positive relations between nominal stock returns and realized inflation over longer horizons.

correlations of 0.13, 0.17, and 0.20 for domestic stocks, bonds, and bills, indicating some positive relation between currency depreciation and asset returns.[7] The most obvious relation, intuitively, appears in Panel B with the joint distribution of the currency basket and international stocks. The correlation between real payoffs is 0.63. Further, currency fluctuations contribute about half of the variance of log international stock returns. Whereas the international stock portfolio achieves lower risk through diversification, exchange rate fluctuations add an additional source of risk for investors who buy foreign assets.

4.1.3 Comparison with US results

Before proceeding to study joint distributions, we compare the marginal distributions estimated using our full sample of developed countries with distributions estimated using only US data. Table V reports statistics for the US distributions, and Figure 8 compares the 30-year payoff distributions from the developed country sample and the US sample for each of the four assets. Anarkulova, Cederburg, and O'Doherty (2021) emphasize that the loss probability in domestic stocks estimated from US data is small compared with the full developed sample. We similarly find in Panel A that the 30-year loss probability estimated using US data is only 1.2% compared with the 12.6% probability in Table III.

From the perspective of an investor who learns only from historical US data, international stocks appear less attractive relative to domestic stocks. This finding contrasts with that in Table III for the full developed country sample. The results for international stocks in Panel B of Table V show lower mean and median payoffs relative to domestic stocks in Panel A. Loss probabilities are also higher for international stocks compared with domestic stocks using the US data. At a 30-year horizon, for example, the international stock portfolio shows a 7.6% chance of loss relative to 1.2% for domestic stocks. Two effects combine to produce this result when learning solely from US data. First, the US stock market performed well relative to the markets in many countries during this historical period. The international stock portfolio excludes the US when we take the perspective of a US investor, whereas the US has a large weight in the international stock portfolios of other countries. Second, the US dollar appreciated relative to many currencies during this historical period. The US investor is effectively short the dollar while investing in foreign markets.

Panels C and D of Table V show that bonds and bills have low average payoffs compared with

[7] The correlation between real log payoffs on cash and the currency basket is 0.31, so these positive relations between asset returns and currency depreciation could arise as an indirect effect of the relation between inflation and exchange rates.

stocks, similar to the evidence from developed countries in Table III. The loss probabilities over long horizons are somewhat lower for the US analysis compared with the developed country analysis, but the chances of loss remain relatively high at 18.5% for bonds and 25.0% for bills over a 30-year horizon. The distribution comparisons in Panels C and D of Figure 8 show that the developed country sample produces much higher probabilities of catastrophic real losses in bonds and bills compared with the US sample.

A natural question is whether investors domiciled in the US should consider historical information from developed countries or solely learn from the US experience. Our perspective is that the developed country sample is informative to US investors. Our US sample spans just 130 years, which is a relatively short history when considering potential outcomes over long horizons such as 30 years. Further, there is evidence that the average realized US stock return exceeded the ex ante expectation over this period because the equity risk premium unexpectedly declined [Fama and French (2002) and Avdis and Wachter (2017)]. The extent of appreciation for the US dollar also may not have been fully anticipated by investors. The full developed country sample is much broader with nearly 2,500 years of information about asset returns, and the set of developed countries experienced a much larger variety of circumstances during our sample period compared with a US-centric view. In sum, we believe that US investors would be wise to consider the historical record of developed countries in addition to learning from their home-country experience.

4.2 Joint distributions

We continue our analysis by examining joint distributions of domestic stocks, international stocks, bonds, and bills for the developed country sample. We study joint distributions with horizons ranging from one month to 30 years. Of particular interest is the potential for joint tail risk across assets, as the degree to which assets tend to simultaneously have poor outcomes is important for investors who hold multiple asset classes.

Figure 9 shows the joint distribution of 30-year real payoffs for two asset classes in each panel. Panel A considers domestic and international stocks. The payoffs show a clear positive relation, and the correlation between log payoffs is 0.35. Despite the positive relation, many of the poor outcomes in domestic stocks are accompanied by gains in international stocks, such that investments in foreign markets may help investors hedge against local losses.

Panels B and C show the relations of domestic stocks with bonds and bills, respectively. Domestic stock payoffs are positively related to the payoffs of both bonds and bills. In the portions of the distributions with the most mass, a positive relation is visible in both panels. Another interesting pattern is that poor domestic stock outcomes appear to often coincide with poor outcomes in bonds and bills. That is, the distributions appear to show joint tail risk that is above and beyond what would be expected from the relations in the centers of the distributions. The correlations of log domestic stock payoffs with log payoffs on bonds and bills are 0.46 and 0.36, respectively, indicating economically meaningful connections between the long-term realized performance across these asset classes.

International stock performance appears to have little relation to bond and bill performance. Panels D and E of Figure 9 show the joint distributions, and there are no obvious patterns in the figure. Consistent with the visual appearance, the correlations of international stock payoffs with payoffs on bonds and bills are only 0.06 and 0.05, respectively. These results provide further evidence of the potential diversification benefits for investors who add international stock exposure to their portfolios.

Finally, Panel F of Figure 9 displays the joint distribution of bond and bill payoffs. An obvious positive relation exists in the figure, consistent with intuition. From Section 4.1.2, we have seen that realized inflation is an important determinant of the long-term performance of bonds and bills, and the nominal performance of both assets is tied to the level of interest rates. Despite the additional tendency for bonds to occasionally perform poorly due to increasing interest rates or domestic default, the estimated correlation is 0.81 such that the two fixed income classes are very closely related.

An alternative approach to studying the joint behavior of asset classes is to examine distributions that condition on outcomes in another asset class. Table VI shows statistics for distributions of international stocks (Panel A), bonds (Panel B), and bills (Panel C) conditional on a loss in domestic stocks. That is, in each case we summarize the distribution of the set of bootstrap draws for which the real payoff of domestic stocks is less than \$1.00. We report results for horizons ranging from one month to 30 years.

The conditional distributions for international stocks in Panel A of Table VI show lower average payoffs and higher loss probabilities compared with the marginal distributions in Table III. At a one-month horizon, the conditional loss probability is 58.0% versus the unconditional loss probability of 42.7%, consistent with positive short-term return correlation for domestic and international stocks. The correlated outcomes persist as the horizon grows. With a 30-year horizon, the low unconditional loss probability of 4.1% for international stocks increases to 12.8% when we condition on a loss in domestic stocks. As such, investors face a heightened risk of joint losses in the two equity asset classes.

Panels B and C of Table VI indicate that the performance of bonds and bills are even more sensitive to domestic stock losses, especially at long horizons. Focusing on the 30-year horizon, the average real bond payoff conditional on a loss in domestic stocks is only $1.07 compared with $2.34 in the marginal distribution from Table III. Bills similarly suffer poor average performance with a conditional mean payoff of $0.93 versus the unconditional mean of $1.32. Conditional loss probabilities are elevated at 61.0% and 60.4% for bonds and bills, respectively, compared with the unconditional probabilities of 26.8% and 36.9%. These findings imply that investors who focus on domestic asset markets are subject to the potential for joint losses in each asset class. In untabulated results, we estimate the probability that domestic stocks, bonds, and bills all realize real losses over a 30-year horizon to be 6.4%, and these cases occur in over half of the bootstrap draws with losses in domestic stocks.

Table VII expands our analysis of conditional loss probabilities by reporting the probabilities for all asset pairs. The table first shows the unconditional loss probabilities [$\mathbb{P}(W_{H,A}^{(m)} < 1)$], which are repeated from Table III for convenience. The first column of conditional loss probabilities [$\mathbb{P}(W_{H,A}^{(m)} < 1 | W_{H,B}^{(m)} < 1)$] corresponds to the results in Table VI for international stocks, bonds, and bills conditional on a loss in domestic stocks. The remaining three columns show loss probabilities for each asset conditional on losses in international stocks, bonds, or bills. Figure 10 also plots the unconditional and conditional loss probabilities as a function of horizon for each asset class.

The conditional loss probabilities for domestic stocks in Panel A of Table VII indicate substantial risk of loss in the event of a loss in another asset class. Conditional on a ten-year loss in international stocks, for example, over half of bootstrap draws also have a loss in domestic stocks. At a 30-year horizon, the conditional loss probabilities are 39.1% with a loss in international stocks, 28.8% with a loss in bonds, and 20.7% with a loss in bills. These conditional loss probabilities, which are all high compared with the unconditional probability of 12.6%, indicate an elevated risk of joint tail outcomes.

The remaining asset classes in Table VII also show indications of correlated losses. Consistent with the visual appearance of the joint distributions in Figure 9, the conditional loss probabilities in Panel B show that international stocks are most closely related to domestic stocks. The loss probabilities for bonds and bills in Panels C and D are high conditional on a loss in any other asset class. Bonds have an unconditional 26.8% chance of loss at a horizon of 30 years, but the conditional loss probabilities are 61.0% (loss in domestic stocks), 52.5% (international stocks), and 61.0% (bills). Similarly, the 36.9% unconditional loss probability for bills increases to 60.4%, 63.8%, and 83.9% when we condition on a loss in domestic stocks, international stocks, or bonds.

To further characterize the joint performance of assets, Table VIII presents a decomposition of the 30-year conditional loss probabilities from Table VII. We specifically decompose each conditional loss probability as the sum of the unconditional loss probability and the additional probabilities of loss that arise from short-term correlation, long-term correlation, and joint tail dependence. The decomposition of the conditional loss probability in each row begins with the unconditional loss probability. To estimate the influence of correlation on joint loss probability, we model payoffs using lognormal distributions and construct bivariate normal distributions for log payoffs,

$$\begin{bmatrix} \log W_{360,A} \\ \log W_{360,B} \end{bmatrix} \sim N\left(\begin{bmatrix} \hat{\mu}_{360,A} \\ \hat{\mu}_{360,B} \end{bmatrix}, \begin{bmatrix} \hat{\sigma}^2_{360,A} & \hat{\rho}\hat{\sigma}_{360,A}\hat{\sigma}_{360,B} \\ \hat{\rho}\hat{\sigma}_{360,A}\hat{\sigma}_{360,B} & \hat{\sigma}^2_{360,B} \end{bmatrix} \right) \tag{15}$$

where $\hat{\mu}_{360,A}$ and $\hat{\mu}_{360,B}$ are the mean 30-year log payoffs across bootstrap draws and $\hat{\sigma}_{360,A}$ and $\hat{\sigma}_{360,B}$ are the standard deviations of 30-year log payoffs. To consider the impact of short-term correlation, we insert the estimated correlation from one-month log payoffs, $\text{Corr}(\log W^{(m)}_{1,A}, \log W^{(m)}_{1,B})$, for $\hat{\rho}$ in equation (15). We then compute the proportion of the bivariate normal distribution that produces a loss for both assets A and B (i.e., the log payoffs are less than zero in both dimensions). The difference between this loss probability and the unconditional loss probability is attributed to short-term correlation in Table VIII.

Next, we consider the additional effect of long-term correlation in payoffs on conditional loss probabilities. Long-term correlations can differ from short-term correlations if, for example, the prices of two assets are cointegrated. Such a statistical link could exist between two assets in a given country if they are jointly affected by long-term macroeconomic performance relative to ex ante expectations. To estimate the incremental effect of long-term correlation, we construct a distribution according to equation (15) with $\hat{\rho} = \text{Corr}(\log W^{(m)}_{360,A}, \log W^{(m)}_{360,B})$, such that this distribution is fitted to the 30-year log payoffs. We compute the probability of a joint loss, and the excess of this probability relative to the probability from the short-term analysis is attributed to long-term correlation in the decomposition. Finally, we observe the actual conditional loss probability from the bootstrap distribution. Any excess loss probability is attributable to the bootstrap distribution having different tail properties compared with the distribution from equation (15).

We note that most studies consider measures of asset class comovement that are measured with relatively short implied holding periods (e.g., monthly return correlations). These measures are most closely related to the short-term correlation component of conditional loss probabilities in

Table VIII. The remaining two terms in the decomposition capture additional relations across asset outcomes that may be missed with a focus on short-term performance, such that we contribute to the literature by quantifying these effects.

The conditional loss decompositions for domestic stocks in Panel A of Table VIII show varying roles for short-term and long-term effects depending on the other asset class. The high loss probability of 39.1% conditional on a loss in international stocks is heavily influenced by short-term correlation, which has a 19.5% incremental effect. After accounting for short-term correlation, long-term correlation and joint tail dependence contribute 3.2% and 3.9% to the conditional loss probability, respectively. When conditioning on a loss in bonds or bills, the short-term correlations have relatively smaller effects. The 28.8% chance of loss in domestic stocks conditional on a loss in bonds, for example, is decomposed into a 12.6% unconditional probability, a 5.1% effect of short-term correlation, a 6.6% effect of long-term correlation, and a 4.5% effect of tail dependence. As such, these findings indicate longer-term and non-linear dependencies across stocks and bonds within a given country.

For many of the remaining asset pairs in Table VIII, short-term correlations are an important determinant of conditional loss probabilities. There are three additional patterns of note. First, there is evidence of joint tail dependencies between international stocks and both bonds and bills. Second, the long-term correlation components are important determinants of the loss probabilities of bonds and bills conditional on a loss in domestic stocks (18.6% and 13.0% effects, respectively), providing further evidence of important long-term connections across these assets. Third, the long-term correlation component is particularly important for the joint outcomes of bonds and bills (17.7% incremental loss probability for bonds and 23.0% for bills), which likely reflects the effects of interest rate and inflation regimes over long horizons.

4.3 Distributions conditional on current market states

Our final analysis considers payoff distributions that condition on an aspect of the current market state. We consider two state variables to measure current market conditions in a country: the aggregate dividend-price ratio and the short-term interest rate. We study distributions of real payoffs with horizons ranging from one month to 30 years. Each distribution conditions on a given value of the state variable as of the beginning of the first month of the holding period, but we design our method to allow the state variables to fluctuate during the holding period. Importantly, the distributions do not condition on any information that is not available when the initial investment is made.

Our bootstrap design for estimating the conditional distributions differs from that in Section 3. We continue to draw return blocks with randomly determined lengths and an average of 120 months per block. Our approach to computing buy-and-hold payoffs given a full bootstrap draw also mirrors that in Section 3. Two aspects of the bootstrap in this section are different:

1. We require the first block in the bootstrap draw to be from a country and period in which the state variable under consideration fits within a given range at the beginning of the period. As an example, we study bootstrap distributions of cumulative payoffs that condition on the initial annual short-term interest rate falling between 2% and 4%. As we form a bootstrap draw $R^{(m)} = \{R_1^{(m)}, R_2^{(m)}, \ldots, R_{360}^{(m)}\}$, we require that $R_1^{(m)}$ come from a country and period in which the short-term interest rate at the beginning of the month is between 2% and 4%.

2. When we reach the end of a block, we require that the next block begin in a country and period in which the state variable is close to its ending value from the previous block. We form a finer grid of state variable values for this requirement. In particular, we define dividend-price ratio bins of $[0.0000, 0.0025]$, $(0.0025, 0.0050]$, $\cdots$, $(0.0775, 0.0800]$, $(0.0800, 0.0900]$, $(0.0900, 0.1000]$, and $(0.1000, \infty)$. We define short-term interest rate bins of $(-\infty, -0.75\%]$, $(-0.75\%, -0.50\%]$, $(-0.50\%, -0.25\%]$, $\cdots$, $(9.75\%, 10.00\%]$, $(10.00\%, 11.00\%]$, $(11.00\%, 12.00\%]$, $\cdots$, $(19.00\%, 20.00\%]$, and $(20.00, \infty)$. If a block draw ends, for example, when the end-of-month dividend-price ratio is in the bin $(0.0250, 0.0275]$, we require the next block to begin with a beginning-of-month dividend-price ratio that also falls within this bin. We repeat this process and draw new blocks until the bootstrap draw has 360 months of returns.

Our bootstrap approach is designed to condition on the observable state variable at the beginning of the holding period but preserve the time-series behavior of the state variables within the holding period. If a state variable increases (decreases) during a given block draw, the next block will begin in a period with a higher (lower) value of the state variable. The state variables can, thus, drift substantially over our longest horizon of 30 years. The draws also preserve the natural relations between changes in the state variables and realized returns in a given month. For domestic stocks, for example, the dividend-price ratio is highly likely to decrease in a month with a large positive return realization. If a bootstrap block ends in this month, our use of the end-of-month dividend-price ratio to link to the beginning-of-month dividend-price ratio in the next block ensures that the state variable reflects this month's outcome. Similarly, a large increase in interest rates in a given month is likely to be associated with a negative bond return. We link the end-of-month short-term interest rate from the last month in a block to the beginning-of-month rate for the next block.

Tables IX and X summarize bootstrap distributions that condition on initial values of the dividend-price ratio, DP_0, and the short-term interest rate, SR_0, respectively. The horizon is 30 years for each distribution, and each panel provides summary statistics for the marginal distributions of a given asset class. We consider six initial state variable ranges for each state variable. The ranges for DP_0 are $[0.00, 0.02]$, $(0.02, 0.03]$, $(0.03, 0.04]$, $(0.04, 0.05]$, $(0.05, 0.06]$, and $(0.06, \infty)$. The ranges for SR_0 are $(-\infty, 2\%]$, $(2\%, 4\%]$, $(4\%, 6\%]$, $(6\%, 8\%]$, $(8\%, 10\%]$, and $(10\%, \infty)$. The widths of some ranges differ to more evenly split the sample observations into the specified ranges. Figures 11 and 12 plot the 30-year payoff distributions for each asset. The top row shows the unconditional marginal distribution for a given asset, and the remaining rows show distributions conditional on a given range of DP_0 (Figure 11) or SR_0 (Figure 12).

We begin with the 30-year real payoff distributions that condition on dividend-price ratio in Table IX. Panel A shows results for domestic stocks. The average payoff is nearly monotonically increasing across the dividend-price ranges. The distribution that conditions on a high DP_0 (above 0.06) has a mean payoff of \$10.03 compared with only \$5.96 for a low initial value (0.02 or below). Given that the long-horizon payoff distributions are highly right skewed (as can be seen in Figure 11), the means are positively influenced by uncertainty, and the standard deviation of payoffs is largest for the lowest and highest categories of dividend-price ratios. The median payoff monotonically increases with DP_0, and the median payoff of \$5.96 with high DP_0 is almost twice the median of \$3.11 with low DP_0.

The results for mean and median payoffs in Panel A are consistent with a positive relation between expected stock return and the dividend-price ratio. This relation is the subject of numerous studies on return predictability [e.g., Fama and French (1988), Cochrane (2008), and Binsbergen and Koijen (2010)]. Fama and French (1988) emphasize the economic importance of longer-term predictability when expected returns are persistent [see also Boudoukh, Richardson, and Whitelaw (2008)]. Our findings show that investment outcomes over very long horizons of 30 years show economically meaningful dependencies on the dividend-price ratio at the beginning of the holding period.

In addition to providing information about the expected outcome, Panel A of Table IX shows that the dividend-price ratio is informative about the probability of a real loss. The loss probability nearly monotonically declines with DP_0. With a high initial value of DP_0, the probability of losing relative to inflation over a 30-year horizon is 7.3%. This loss probability continues to be high relative to estimates from the literature considering US stocks [e.g., Fama and French (2018)], but it is much lower than the corresponding unconditional probability of 12.6% in Table III. When valuations are high (i.e., DP_0 is low), the chances of loss are even more pronounced than in the unconditional distribution. Our estimated loss probabilities are 16.2% for the lowest DP_0 range and 14.0% for the second lowest. These results suggest that a young investor today in the US, for example, who is beginning to save for retirement in a current high-valuation environment may face a substantial risk of real loss over her savings window.

Panels B to D of Table IX summarize distributions for international stocks, bonds, and bills. Perhaps surprisingly, the median payoff of international stocks is also monotonically increasing in the domestic dividend-price ratio, DP_0, ranging from \$4.51 to \$5.92. Loss probabilities are somewhat higher at low levels of DP_0 compared with high, but international stocks continue to have a much lower loss probability compared with domestic stocks within each range of DP_0. Bonds and bills show somewhat weaker, but opposing, relations with DP_0. The median bond payoff nearly monotonically declines with DP_0 (\$2.17 to \$1.69), whereas the median bill payoff monotonically increases (\$1.15 to \$1.26). The risk of loss in bonds is lower when DP_0 is low, but the loss probabilities are otherwise similar across states.

Table X summarizes distributions that condition on the initial short-term interest rate, SR_0. The results for domestic and international stocks in Panels A and B display non-monotonic patterns. At very low interest rates (2% and below), the conditional distributions have relatively high median payoffs (\$4.99 for domestic stocks and \$10.33 for international stocks) and low loss probabilities (6.4% for domestic and 1.0% for international). At intermediate values of 4% to 6% for SR_0, median payoffs are only \$3.72 and \$4.88 for domestic and international stocks, respectively, and loss probabilities are elevated at 13.6% and 4.6%. Finally, payoffs are high and loss probabilities are low with very high short-term interest rates above 10%. The median payoffs are \$7.40 for domestic stocks and \$6.41 for international stocks, and the conditional loss probabilities are 6.2% and 1.3%.

Panels C and D of Table X show that the long-horizon real performance of bonds and bills is highly dependent on the initial short-term interest rate. The mean and median payoffs are monotonically increasing in SR_0 for both bonds and bills. The median payoff ranges from \$1.39 to \$4.22 for bonds and from \$0.68 to \$1.97 for bills, indicating economically large differences in performance across states. The risk of real losses is also highly dependent on SR_0. When short-term interest rates are 2% or below, the loss probabilities are 27.5% for bonds and 83.1% for bills. With rates above 10%, the loss probabilities are only 7.9% and 10.5% for bonds and bills, respectively. These results demonstrate that the current interest rate environment has economically large effects on fixed income investment outcomes even over a long 30-year horizon.

Finally, Figures 13 and 14 shows loss probabilities as a function of horizon conditional on DP_0 and SR_0, respectively. One way to interpret the probabilities associated with domestic or international stocks is to consider the length of horizon necessary to achieve a real gain in stocks with high probability. Using this idea, we consider the investment period necessary to have a three-in-four chance of a gain in domestic or international stocks.

Figure 13 shows that the time required to ensure a gain with high probability can vary greatly across dividend-price states. In the highest range of DP_0, an investment in domestic stocks has a three-in-four chance of gaining with a holding period of just 26 months, and international stocks reach this benchmark with a 33-month horizon. In contrast, for the lowest DP_0 range, long horizons are necessary. Domestic stocks do not reach a three-fourths gain probability until the horizon is 190 months (i.e., nearly 16 years). International stocks reach the benchmark probability with a horizon of 87 months (i.e., just over seven years), which is short compared with domestic stocks in this market state but long compared with international stocks in other states. A similar analysis for the distributions in Figure 14 that condition on SR_0 produces relatively short needed horizons of 40 to 49 months for domestic stocks in low or high interest rate environments and a long horizon of 157 months (over 13 years) for short-term rates between 4% and 6%. International stocks show a similar pattern with likely gains over short horizons of eight to 26 months when SR_0 is low or high and a long 128-month horizon in the intermediate range.

The patterns of loss probabilities for bonds and bills in Figure 14 demonstrate sensitivity to the short-term interest rate. When the rate is below 4%, loss probabilities on bonds are relatively high and stable at all horizons longer than five years. For the two lowest ranges of SR_0, these loss probabilities are all between 27.5% and 33.7%. When the short rate is below 2%, the probability of real loss in bills is particularly high. The loss probability reaches as high as 84.4% with a horizon of about 23 years. There is a clear pattern across SR_0 ranges of lower real loss probabilities in bonds and bills associated with higher rates. In the two highest ranges of SR_0, loss probabilities for bonds and bills quickly dip below 25.0%. This benchmark is achieved at horizons of 23 to 30 months for bonds and three to four months for bills in these market states.

In sum, the results in Tables IX and X and Figures 11 to 14 show that the return distributions of each asset class are highly sensitive to current market conditions. Both expected performance and the probability of a real loss critically depend on price levels at the beginning of one's saving period. Given that long-term investors such as retirement savers have little control over the timing of their savings period and the market conditions when they begin to save, these patterns could create large cohort effects in realized retirement savings outcomes.

5 Conclusion

Quantitative evidence on long-horizon asset returns is important for retirement savers and other long-term investors. We draw upon a broad sample of developed countries with data spanning nearly 2,500 years to characterize joint distributions of domestic stocks, international stocks, bonds, and bills with horizons ranging from one month to 30 years. In addition to these unconditional joint distributions, we develop distributions of asset returns that condition on the current market state. The marginal, joint, and conditional distributions we estimate provide investors with a wealth of information about potential outcomes from long-horizon investments in domestic stocks, international stocks, bonds, and bills.

Perhaps the most striking feature of our results is the substantial uncertainty about investment performance in each asset class over long horizons. Each asset class generates real wealth on average and carries strong upside potential. However, investors with a 30-year horizon also face non-trivial chances of losing relative to inflation in domestic stocks (12.6%), bonds (26.8%), and bills (36.9%). International stocks appear to provide a safer haven with a lower risk of loss (4.1%). We also find evidence of correlated losses and joint tail risk, such that investors could be hit with real losses in multiple asset classes during their savings period. These potential losses are even more pronounced for investors who begin saving in periods of high asset values (as measured by low dividend-price ratios and low interest rates). Given these relatively high risks of losses, investors may need to adopt a high savings rate to achieve a high probability of building adequate retirement savings, particularly when asset prices are high.

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Table I

Developed country sample periods.

The table shows developed countries, initial development dates, classification reasons for development, sample eligibility details, and sample coverage. The development year classifications are based on agricultural labor share or organizational membership in the Organisation for European Economic Co-operation (OEEC) or the Organisation for Economic Co-operation and Development (OECD). Sample eligibility for a given developed country requires that the country has opened its first stock exchange and has issued long-term government bonds. The sample period start date is the later of the development date and the first date with return data for stocks, bonds, and bills.

	Development details		Sample eligibility details		Sample coverage		
Country	Year	Reason for classification	Year	Reason for delayed sample eligibility	Start date	End date	Coverage (%)
United Kingdom	1841	Agricultural labor share	1890	Sample for study starts in 1890	1890:01	2019:12	100.0
Netherlands	1849	Agricultural labor share	1890	Sample for study starts in 1890	1914:01	2019:12	81.5
Belgium	1856	Agricultural labor share	1890	Sample for study starts in 1890	1897:01	2019:12	94.6
France	1866	Agricultural labor share	1890	Sample for study starts in 1890	1890:01	2019:12	100.0
Norway	1875	Agricultural labor share	1890	Sample for study starts in 1890	1914:02	2019:12	81.5
Germany	1882	Agricultural labor share	1890	Sample for study starts in 1890	1890:01	2019:12	100.0
Denmark	1890	Agricultural labor share	1890	n/a	1890:01	2019:12	100.0
Switzerland	1890	Agricultural labor share	1890	n/a	1914:01	2019:12	81.5
United States	1890	Agricultural labor share	1890	n/a	1890:01	2019:12	100.0
Canada	1891	Agricultural labor share	1891	n/a	1891:01	2019:12	100.0
Argentina	1895	Agricultural labor share	1895	n/a	1947:02	1966:12	27.7
New Zealand	1896	Agricultural labor share	1896	n/a	1896:01	2019:12	100.0
Australia	1901	Agricultural labor share	1901	n/a	1901:01	2019:12	100.0
Sweden	1910	Agricultural labor share	1910	n/a	1910:01	2019:12	100.0
Austria	1920	Agricultural labor share	1920	n/a	1925:02	2019:12	94.9
Chile period I	1920	Agricultural labor share	1920	n/a	1927:01	1970:12	86.3
Greece	1920	Agricultural labor share	1920	n/a	1981:02	2019:12	38.9
Czechoslovakia	1921	Agricultural labor share	1921	n/a	1926:01	1945:05	79.5
Japan	1930	Agricultural labor share	1930	n/a	1930:01	2019:12	100.0
Portugal	1930	Agricultural labor share	1930	n/a	1934:01	2019:12	95.6
Italy	1931	Agricultural labor share	1931	n/a	1931:01	2019:12	100.0
Ireland	1936	Agricultural labor share	1936	n/a	1936:01	2019:12	100.0
Singapore	1947	Agricultural labor share	1998	Long-term bonds first available in 1998	1998:07	2019:12	100.0
Iceland	1948	OEEC membership	1992	Long-term bonds first available in 1992	2002:01	2019:12	64.3
Luxembourg	1948	OEEC membership	1948	n/a	1982:01	2019:12	52.8
Turkey	1948	OEEC membership	2010	Long-term bonds first available in 2010	2010:02	2019:12	100.0

(*continued on next page*)

Table I (*continued*)

	Development details		Sample eligibility details		Sample coverage		
Country	Year	Reason for classification	Year	Reason for delayed sample eligibility	Start date	End date	Coverage (%)
Spain	1959	OEEC membership	1959	n/a	1959:01	2019:12	100.0
Finland	1969	OECD membership	1969	n/a	1969:01	2019:12	100.0
Mexico	1994	OECD membership	2001	Long-term bonds first available in 2001	2001:08	2019:12	100.0
Czechia	1995	OECD membership	2000	Long-term bonds first available in 2000	2000:05	2019:12	100.0
Hungary	1996	OECD membership	1999	Long-term bonds first available in 1999	1999:02	2019:12	100.0
Poland	1996	OECD membership	1999	Long-term bonds first available in 1999	1999:06	2019:12	100.0
South Korea	1996	OECD membership	2000	Long-term bonds first available in 2000	2000:11	2019:12	100.0
Slovakia	2000	OECD membership	2000	n/a	2000:01	2019:12	100.0
Chile period II	2010	OECD membership	2010	n/a	2010:01	2019:12	100.0
Estonia	2010	OECD membership	—	No qualifying long-term bonds	—	—	—
Israel	2010	OECD membership	2010	n/a	2010:01	2019:12	100.0
Slovenia	2010	OECD membership	2010	n/a	2010:01	2019:12	100.0
Latvia	2016	OECD membership	2016	n/a	2016:01	2019:12	100.0
Lithuania	2018	OECD membership	2018	n/a	2018:01	2019:12	100.0

Table II

Summary statistics.

The table reports summary statistics for monthly real returns for each developed country and for the pooled sample of all observations. For each country, the table shows the number of sample months, the arithmetic average return ($\bar{R}_a$), the geometric average return ($\bar{R}_g$), the standard deviation of return (SD), return skewness (Skew), return kurtosis (Kurt), and the minimum (Min) and the maximum (Max) return. Panels A, B, C, and D show results for domestic stocks, international stocks, bonds, and bills, respectively.

		Summary statistics for returns						
Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
Panel A: Real domestic stock returns								
Argentina	239	0.19	−0.18	8.53	0.09	7.65	−44.06	41.43
Australia	1,428	0.66	0.58	3.90	−0.94	16.02	−42.49	23.83
Austria	1,139	0.40	0.27	5.18	0.33	10.91	−32.63	38.96
Belgium	1,476	0.35	0.22	5.01	−0.90	16.90	−55.91	24.72
Canada	1,548	0.57	0.48	4.24	−0.53	7.20	−27.26	23.60
Chile period I	528	0.32	0.13	6.15	0.31	6.91	−32.81	30.28
Chile period II	120	0.05	−0.03	4.06	0.13	3.07	−10.54	11.05
Czechia	236	1.11	0.86	7.07	−0.00	5.40	−29.25	29.90
Czechoslovakia	233	0.16	−0.45	6.89	−9.09	119.91	−88.59	16.66
Denmark	1,560	0.39	0.33	3.54	−0.03	6.60	−18.38	18.89
Finland	612	0.98	0.78	6.31	0.26	6.38	−27.28	32.01
France	1,560	0.44	0.30	5.40	1.61	27.89	−22.01	75.61
Germany	1,560	0.64	0.26	8.35	3.38	76.04	−91.10	128.82
Greece	467	0.95	0.45	10.36	1.47	9.89	−27.83	65.50
Hungary	251	0.67	0.46	6.44	−0.37	4.54	−28.71	18.24
Iceland	216	0.37	−0.07	7.66	−4.45	40.76	−72.12	18.18
Ireland	1,008	0.57	0.46	4.67	−0.29	7.23	−27.26	25.54
Israel	120	0.06	−0.06	4.81	−0.17	3.33	−14.50	12.55
Italy	1,068	0.44	0.17	7.41	1.08	10.39	−34.89	58.61
Japan	1,080	0.52	0.30	6.67	0.57	16.81	−48.14	60.74
Latvia	48	1.03	0.97	3.54	1.11	5.47	−5.47	13.73
Lithuania	24	0.21	0.18	2.61	−0.06	3.29	−6.16	4.86
Luxembourg	456	0.74	0.58	5.50	−0.67	6.25	−26.69	18.01
Mexico	221	0.79	0.67	4.75	−0.49	4.12	−18.35	12.85
Netherlands	1,272	0.53	0.40	5.09	0.12	13.43	−33.15	50.24
New Zealand	1,488	0.56	0.50	3.65	−0.11	9.69	−28.76	23.61
Norway	1,271	0.52	0.39	5.06	−0.32	6.77	−27.49	25.26
Poland	247	0.50	0.32	5.98	−0.11	4.44	−24.32	19.85
Portugal	1,032	0.50	0.13	7.92	2.03	51.00	−89.24	86.10
Singapore	258	0.70	0.53	5.94	−0.19	6.67	−26.06	24.71
Slovakia	240	0.50	0.37	5.33	1.34	10.58	−18.87	33.34
Slovenia	120	0.37	0.29	4.03	0.29	4.61	−10.37	16.19
South Korea	230	0.89	0.70	6.15	0.20	4.73	−20.91	25.35
Spain	732	0.49	0.34	5.48	−0.01	4.90	−25.71	26.52
Sweden	1,320	0.59	0.47	4.82	−0.19	6.32	−27.01	28.01
Switzerland	1,272	0.48	0.39	4.31	−0.04	8.17	−24.95	32.66
Turkey	119	0.26	0.05	6.44	−0.04	2.27	−14.03	14.56
United Kingdom	1,560	0.47	0.38	4.28	0.54	17.46	−26.87	50.05
United States	1,560	0.64	0.52	4.99	0.39	12.86	−29.47	42.52
Full sample	29,919	0.53	0.37	5.59	0.90	39.91	−91.10	128.82

(*continued on next page*)

Table II (*continued*)

Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
		Summary statistics for returns						
Panel B: Real international stock returns								
Argentina	239	1.32	0.64	15.34	8.57	86.15	−17.20	159.12
Australia	1,428	0.49	0.42	3.76	0.68	9.70	−13.71	31.56
Austria	1,139	0.95	0.57	12.43	17.54	376.11	−26.96	299.72
Belgium	1,476	0.49	0.38	4.54	0.49	13.27	−24.47	41.31
Canada	1,548	0.48	0.42	3.47	−0.08	6.19	−15.08	20.06
Chile period I	528	0.92	0.62	8.49	4.50	47.87	−27.62	100.08
Chile period II	120	0.84	0.78	3.54	−0.17	2.95	−8.69	11.34
Czechia	236	0.09	−0.00	4.18	−0.76	4.21	−14.07	10.08
Czechoslovakia	233	0.44	0.25	6.23	0.64	12.26	−28.07	38.41
Denmark	1,560	0.46	0.38	3.90	0.10	9.40	−20.61	32.01
Finland	612	0.51	0.41	4.31	−0.25	4.86	−19.01	20.53
France	1,560	0.60	0.42	6.67	7.48	129.69	−26.19	132.72
Germany	1,560	0.81	0.56	10.30	22.47	609.84	−23.68	303.75
Greece	467	0.65	0.54	4.71	−0.25	5.14	−21.27	19.02
Hungary	251	0.34	0.26	4.08	−0.35	3.45	−12.50	11.35
Iceland	216	0.43	0.31	4.86	−0.23	4.70	−16.63	18.00
Ireland	1,008	0.55	0.47	4.03	0.04	7.35	−19.49	30.68
Israel	120	0.72	0.66	3.36	0.30	4.18	−6.88	13.94
Italy	1,068	0.81	0.44	13.15	22.13	604.69	−22.10	371.89
Japan	1,080	1.06	0.49	16.21	16.96	343.45	−48.25	373.05
Latvia	48	0.66	0.61	2.96	−0.73	3.71	−7.59	7.34
Lithuania	24	0.67	0.61	3.52	−0.69	3.28	−7.34	7.67
Luxembourg	456	0.68	0.58	4.47	−0.50	4.47	−19.97	17.38
Mexico	221	0.60	0.53	3.53	−0.38	3.61	−10.68	9.32
Netherlands	1,272	0.51	0.41	4.37	0.47	12.22	−22.70	40.22
New Zealand	1,488	0.51	0.43	4.09	2.51	39.26	−19.60	60.90
Norway	1,271	0.52	0.44	4.21	0.22	7.64	−17.07	33.81
Poland	247	0.30	0.23	3.66	−0.59	3.56	−11.21	9.43
Portugal	1,032	0.53	0.45	4.04	−0.31	4.49	−18.75	17.46
Singapore	258	0.35	0.27	3.99	−0.85	4.79	−18.22	9.99
Slovakia	240	0.03	−0.06	4.13	−0.62	4.00	−15.06	12.62
Slovenia	120	0.91	0.86	3.18	−0.35	3.65	−8.14	9.31
South Korea	230	0.34	0.27	3.73	−0.70	4.39	−15.91	9.09
Spain	732	0.48	0.39	4.22	−0.30	4.65	−20.73	16.98
Sweden	1,320	0.53	0.44	4.14	0.05	10.10	−23.36	31.74
Switzerland	1,272	0.48	0.38	4.46	0.07	10.47	−24.23	40.78
Turkey	119	1.25	1.13	5.04	1.10	12.48	−17.48	30.38
United Kingdom	1,560	0.53	0.45	4.10	0.47	12.04	−20.00	40.25
United States	1,560	0.40	0.33	3.78	−0.44	6.79	−22.80	17.00
Full sample	29,919	0.58	0.43	6.74	24.20	1,097.93	−48.25	373.05

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Table II (*continued*)

Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
		Summary statistics for returns						
Panel C: Real bond returns								
Argentina	239	−1.62	−1.66	2.84	−0.69	5.09	−14.63	7.30
Australia	1,428	0.18	0.16	1.68	0.34	11.05	−11.48	12.74
Austria	1,139	0.20	0.16	2.67	−3.47	39.75	−30.05	18.00
Belgium	1,476	0.06	0.04	1.76	−0.03	6.82	−10.39	8.45
Canada	1,548	0.21	0.19	1.62	0.09	10.85	−11.90	12.62
Chile period I	528	−0.87	−0.92	3.38	0.24	19.09	−22.65	25.11
Chile period II	120	0.15	0.14	1.37	−0.78	8.64	−6.34	4.54
Czechia	236	0.27	0.25	2.16	−0.09	4.23	−8.47	6.80
Czechoslovakia	233	0.34	0.30	3.03	8.60	108.62	−5.16	38.47
Denmark	1,560	0.24	0.23	1.85	0.42	9.88	−8.95	14.96
Finland	612	0.34	0.32	2.21	−0.36	6.01	−10.77	8.91
France	1,560	−0.04	−0.06	2.27	−1.24	13.23	−21.05	10.06
Germany	1,560	1.41	−0.12	46.30	36.04	1,372.53	−90.26	1,771.67
Greece	467	0.52	0.36	5.55	−0.21	9.46	−30.84	26.45
Hungary	251	0.46	0.40	3.31	−0.10	3.62	−9.83	12.42
Iceland	216	0.41	0.36	3.30	−1.76	19.18	−24.03	15.62
Ireland	1,008	0.23	0.20	2.38	0.04	9.81	−15.75	15.45
Israel	120	0.60	0.59	1.86	0.80	8.38	−5.73	9.52
Italy	1,068	−0.09	−0.12	2.54	−1.31	11.74	−19.67	10.26
Japan	1,080	−0.11	−0.18	3.47	−4.76	53.45	−48.20	19.60
Latvia	48	0.06	0.05	1.33	−0.70	4.08	−3.74	2.74
Lithuania	24	0.17	0.16	1.31	0.83	3.79	−1.74	3.90
Luxembourg	456	0.40	0.39	1.76	−0.14	6.42	−9.77	7.53
Mexico	221	0.42	0.39	2.55	−0.12	3.68	−7.18	7.97
Netherlands	1,272	0.18	0.16	1.66	0.10	7.33	−9.14	10.17
New Zealand	1,488	0.17	0.15	1.80	−0.62	50.36	−24.19	22.90
Norway	1,271	0.17	0.15	1.70	−0.54	8.45	−11.26	8.60
Poland	247	0.47	0.44	2.48	0.06	4.53	−7.69	9.71
Portugal	1,032	0.09	0.05	2.80	0.43	7.92	−13.23	14.98
Singapore	258	0.24	0.22	1.99	−0.52	5.89	−8.86	7.75
Slovakia	240	0.52	0.49	2.89	4.37	40.68	−6.60	28.50
Slovenia	120	0.50	0.45	2.98	−0.35	4.81	−10.01	8.82
South Korea	230	0.39	0.37	1.90	0.50	7.20	−5.15	11.16
Spain	732	0.22	0.20	2.17	0.17	5.10	−9.92	9.47
Sweden	1,320	0.19	0.17	1.81	−1.24	19.23	−20.51	9.27
Switzerland	1,272	0.17	0.16	1.38	0.39	5.36	−5.07	7.48
Turkey	119	0.12	0.00	4.88	−0.14	3.96	−15.21	13.70
United Kingdom	1,560	0.18	0.16	1.93	0.71	8.84	−9.11	12.99
United States	1,560	0.16	0.14	1.73	0.55	8.40	−9.20	11.71
Full sample	29,919	0.21	0.10	10.81	148.03	24,163.53	−90.26	1,771.67

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Table II (*continued*)

Country	Months	Summary statistics for returns $\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
Panel D: Real bill returns								
Argentina	239	−1.52	−1.56	2.73	−0.87	5.64	−14.67	6.98
Australia	1,428	0.07	0.07	0.54	−0.92	7.35	−2.60	1.93
Austria	1,139	0.01	−0.00	1.50	−8.76	122.85	−27.20	3.26
Belgium	1,476	−0.02	−0.03	1.14	−0.20	15.04	−10.42	9.69
Canada	1,548	0.12	0.12	0.57	0.17	8.25	−2.80	3.62
Chile period I	528	−0.83	−0.86	2.34	0.37	7.47	−10.43	12.77
Chile period II	120	0.03	0.03	0.36	−0.19	7.79	−1.62	1.48
Czechia	236	−0.04	−0.04	0.43	−1.50	9.62	−2.61	1.34
Czechoslovakia	233	0.13	0.10	2.87	10.09	135.91	−5.22	38.37
Denmark	1,560	0.18	0.18	0.72	−1.03	16.82	−5.06	4.71
Finland	612	0.06	0.06	0.46	−1.08	7.60	−2.72	2.23
France	1,560	−0.15	−0.16	1.77	−2.88	30.50	−21.03	10.17
Germany	1,560	0.17	0.17	0.86	1.14	38.28	−5.95	12.10
Greece	467	0.17	0.16	1.27	−0.03	2.78	−3.17	4.37
Hungary	251	0.18	0.18	0.40	−0.65	3.67	−1.40	1.00
Iceland	216	0.23	0.23	0.53	−0.23	5.06	−2.25	2.01
Ireland	1,008	0.03	0.03	0.59	−0.80	7.27	−3.18	2.78
Israel	120	0.12	0.11	0.85	4.94	32.27	−0.89	6.07
Italy	1,068	−0.24	−0.25	1.71	−4.56	41.65	−20.31	7.94
Japan	1,080	−0.28	−0.33	2.67	−8.99	129.17	−48.21	12.30
Latvia	48	−0.21	−0.21	0.47	0.24	3.12	−1.26	0.89
Lithuania	24	−0.21	−0.21	0.49	−0.48	2.47	−1.32	0.62
Luxembourg	456	0.14	0.13	0.58	−0.64	4.51	−1.85	1.98
Mexico	221	0.15	0.15	0.38	0.06	3.49	−1.25	1.21
Netherlands	1,272	0.03	0.02	0.78	−0.80	8.36	−4.43	3.09
New Zealand	1,488	0.16	0.15	0.59	−0.36	11.62	−3.80	3.77
Norway	1,271	0.03	0.02	0.86	−0.06	11.83	−6.85	6.05
Poland	247	0.22	0.22	0.41	0.53	3.98	−0.93	1.64
Portugal	1,032	−0.05	−0.06	1.36	−0.00	12.28	−7.17	11.86
Singapore	258	−0.02	−0.02	0.47	−0.48	4.22	−1.84	1.51
Slovakia	240	−0.04	−0.04	0.58	−3.81	25.81	−4.51	1.03
Slovenia	120	−0.01	−0.02	0.76	1.33	5.74	−1.44	3.10
South Korea	230	0.09	0.09	0.34	−0.03	3.10	−0.92	1.17
Spain	732	0.02	0.02	0.69	−0.70	5.24	−3.84	2.37
Sweden	1,320	0.10	0.09	0.97	−8.51	171.12	−20.38	4.78
Switzerland	1,272	0.03	0.03	0.62	0.92	12.77	−2.84	4.55
Turkey	119	0.06	0.06	0.94	−0.60	6.93	−4.27	3.31
United Kingdom	1,560	0.07	0.07	0.87	1.50	24.03	−4.26	10.58
United States	1,560	0.07	0.06	0.61	0.41	25.54	−5.53	7.57
Full sample	29,919	0.01	0.00	1.17	−5.15	207.38	−48.21	38.37

Table III

Bootstrap distributions of payoffs.

The table summarizes distributions of real payoffs from a \$1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for the distribution of a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
Horizon	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Real domestic stock payoffs												
1 month	1.01	0.06	0.86	0.92	0.95	0.98	1.00	1.03	1.06	1.08	1.15	0.427
1 year	1.08	0.26	0.53	0.72	0.81	0.93	1.06	1.19	1.35	1.48	1.85	0.371
5 years	1.45	0.92	0.17	0.52	0.68	0.94	1.28	1.72	2.35	2.86	4.36	0.290
10 years	2.01	1.77	0.14	0.45	0.67	1.06	1.63	2.44	3.62	4.64	8.79	0.223
20 years	3.89	5.56	0.13	0.42	0.70	1.38	2.58	4.56	7.85	11.09	23.84	0.162
30 years	7.45	16.82	0.14	0.46	0.82	1.87	4.06	8.23	15.76	23.88	56.16	0.126
Panel B: Real international stock payoffs												
1 month	1.01	0.07	0.88	0.93	0.96	0.98	1.01	1.03	1.05	1.07	1.11	0.416
1 year	1.07	0.23	0.62	0.75	0.84	0.96	1.06	1.17	1.29	1.37	1.64	0.333
5 years	1.42	0.71	0.48	0.64	0.75	0.99	1.31	1.72	2.14	2.48	3.61	0.259
10 years	2.01	1.70	0.44	0.64	0.79	1.17	1.68	2.46	3.39	4.10	6.88	0.181
20 years	4.00	5.97	0.48	0.82	1.08	1.70	2.79	4.67	7.35	9.71	21.02	0.084
30 years	7.83	17.09	0.58	1.09	1.51	2.61	4.69	8.49	14.83	21.45	54.59	0.041
Panel C: Real bond payoffs												
1 month	1.00	0.11	0.93	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.06	0.429
1 year	1.03	0.46	0.68	0.85	0.91	0.97	1.02	1.07	1.14	1.19	1.33	0.380
5 years	1.14	0.81	0.19	0.59	0.76	0.95	1.11	1.30	1.52	1.67	2.09	0.309
10 years	1.32	1.29	0.08	0.41	0.64	0.93	1.24	1.59	2.01	2.34	3.03	0.300
20 years	1.76	2.49	0.03	0.19	0.48	0.93	1.50	2.25	3.18	3.91	5.65	0.283
30 years	2.34	4.16	0.02	0.12	0.35	0.94	1.79	3.03	4.66	5.96	9.47	0.268
Panel D: Real bill payoffs												
1 month	1.00	0.01	0.96	0.99	0.99	1.00	1.00	1.00	1.01	1.01	1.03	0.402
1 year	1.00	0.07	0.76	0.89	0.94	0.99	1.01	1.03	1.06	1.08	1.17	0.379
5 years	1.04	0.22	0.27	0.66	0.79	0.94	1.04	1.15	1.28	1.37	1.60	0.382
10 years	1.09	0.36	0.11	0.50	0.69	0.90	1.07	1.28	1.52	1.68	2.11	0.384
20 years	1.20	0.59	0.03	0.28	0.52	0.84	1.14	1.50	1.92	2.24	3.02	0.376
30 years	1.32	0.81	0.03	0.16	0.40	0.80	1.21	1.72	2.31	2.76	3.97	0.369

Table IV

First-order stochastic dominance across asset classes.

The table shows results for an analysis of first-order stochastic dominance of each asset class relative to each other asset class across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The real payoff for asset A in bootstrap iteration m at the H-month horizon is $W_{H,A}^{(m)}$. For each horizon, the table reports the minimum of the difference in inverse CDFs of log real cumulative wealth for asset A and asset B. We operationalize this calculation by sorting the 10,000,000 bootstrap draws of log cumulative wealth and computing the minimum paired difference in draws across assets A and B. A positive value of this minimum indicates first-order stochastic dominance. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

		$\min_\alpha \left[F^{-1}_{\log\left(W_{H,A}^{(m)}\right)}(\alpha) - F^{-1}_{\log\left(W_{H,B}^{(m)}\right)}(\alpha)\right]$			
		Asset class B			
Horizon	Asset class A	Domestic stocks	International stocks	Bonds	Bills
Panel A: Domestic stocks					
1 month	Domestic stocks	0.00	−2.07	−2.21	−2.05
1 year	Domestic stocks	0.00	−1.60	−2.71	−1.50
5 years	Domestic stocks	0.00	−3.72	−1.31	−1.17
10 years	Domestic stocks	0.00	−3.56	−2.33	−0.30
20 years	Domestic stocks	0.00	−5.02	−0.42	0.24
30 years	Domestic stocks	0.00	−6.05	0.67	0.23
Panel B: International stocks					
1 month	International stocks	−0.04	0.00	−1.38	−0.15
1 year	International stocks	−0.42	0.00	−2.98	−0.21
5 years	International stocks	−0.83	0.00	−1.96	−0.14
10 years	International stocks	−0.69	0.00	−3.02	0.14
20 years	International stocks	−0.43	0.00	−0.85	0.66
30 years	International stocks	−0.77	0.00	0.78	1.18
Panel C: Bonds					
1 month	Bonds	−0.22	−1.98	0.00	−1.96
1 year	Bonds	−1.70	−2.33	0.00	−2.23
5 years	Bonds	−3.59	−5.65	0.00	−3.53
10 years	Bonds	−5.68	−9.06	0.00	−4.94
20 years	Bonds	−5.47	−10.50	0.00	−5.23
30 years	Bonds	−5.20	−10.82	0.00	−4.55
Panel D: Bills					
1 month	Bills	−0.71	−1.44	−2.81	0.00
1 year	Bills	−2.01	−2.04	−4.72	0.00
5 years	Bills	−3.41	−2.95	−4.54	0.00
10 years	Bills	−4.11	−4.12	−6.43	0.00
20 years	Bills	−5.24	−5.26	−5.66	0.00
30 years	Bills	−7.12	−6.35	−4.77	0.00

Table V

Bootstrap distributions of payoffs for US data.

The table summarizes distributions of real payoffs from a $1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the US sample. Each panel shows statistics for the distribution of a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
Horizon	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Real domestic stock payoffs												
1 month	1.01	0.05	0.87	0.93	0.95	0.98	1.01	1.03	1.06	1.08	1.12	0.407
1 year	1.08	0.20	0.62	0.76	0.84	0.96	1.08	1.20	1.32	1.40	1.56	0.318
5 years	1.47	0.59	0.55	0.71	0.81	1.04	1.39	1.77	2.24	2.57	3.32	0.218
10 years	2.12	1.15	0.59	0.77	0.92	1.31	1.86	2.68	3.68	4.26	5.84	0.128
20 years	4.37	3.32	0.70	1.11	1.41	2.16	3.46	5.55	8.53	10.65	16.39	0.036
30 years	8.89	8.48	0.95	1.69	2.29	3.76	6.45	11.00	18.02	24.20	41.90	0.012
Panel B: Real international stock payoffs												
1 month	1.00	0.04	0.89	0.94	0.96	0.99	1.00	1.02	1.04	1.06	1.10	0.426
1 year	1.06	0.18	0.61	0.80	0.87	0.96	1.04	1.14	1.25	1.35	1.74	0.365
5 years	1.32	0.50	0.42	0.69	0.78	0.98	1.18	1.49	1.99	2.44	3.66	0.275
10 years	1.70	0.98	0.36	0.66	0.82	1.09	1.44	2.02	3.06	3.62	4.98	0.195
20 years	2.81	2.26	0.39	0.71	0.93	1.44	2.16	3.50	5.36	6.76	11.36	0.117
30 years	4.60	4.68	0.44	0.83	1.15	1.93	3.26	5.73	9.24	12.52	22.69	0.076
Panel C: Real bond payoffs												
1 month	1.00	0.02	0.96	0.98	0.98	0.99	1.00	1.02	1.04	1.06	1.10	0.451
1 year	1.02	0.08	0.84	0.89	0.92	0.96	1.04	1.14	1.25	1.35	1.74	0.361
5 years	1.11	0.24	0.62	0.77	0.85	0.98	1.18	1.49	1.99	2.44	3.66	0.309
10 years	1.25	0.40	0.60	0.72	0.79	1.09	1.44	2.02	3.06	3.62	4.98	0.380
20 years	1.57	0.75	0.54	0.64	0.79	1.44	2.16	3.50	5.36	6.76	11.36	0.243
30 years	1.95	1.16	0.51	0.65	0.82	1.93	3.26	5.73	9.24	12.52	22.69	0.185
Panel D: Real bill payoffs												
1 month	1.00	0.01	0.98	0.99	1.00	1.00	1.00	1.00	1.01	1.01	1.02	0.391
1 year	1.01	0.04	0.86	0.93	0.97	0.99	1.01	1.03	1.05	1.07	1.13	0.354
5 years	1.05	0.15	0.69	0.78	0.87	0.96	1.06	1.13	1.23	1.30	1.44	0.342
10 years	1.11	0.24	0.61	0.72	0.79	0.94	1.11	1.25	1.42	1.50	1.70	0.337
20 years	1.22	0.37	0.54	0.64	0.76	0.97	1.19	1.45	1.70	1.85	2.22	0.276
30 years	1.35	0.49	0.49	0.65	0.76	1.00	1.30	1.62	1.98	2.21	2.75	0.250

Table VI

Bootstrap distributions of payoffs conditional on loss in domestic stocks.

The table summarizes conditional distributions of real payoffs from a $1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at various return horizons. Each distribution is conditional on a loss in domestic stocks in the bootstrap simulation. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for the conditional distribution of a given asset class: international stocks (Panel A), bonds (Panel B), and bills (Panel C). The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
Horizon	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Real international stock payoffs												
1 month	0.99	0.06	0.87	0.91	0.94	0.97	0.99	1.01	1.03	1.05	1.09	0.580
1 year	0.98	0.22	0.58	0.67	0.74	0.86	0.97	1.07	1.18	1.27	1.60	0.575
5 years	1.12	0.62	0.40	0.53	0.61	0.76	0.98	1.32	1.74	2.04	3.13	0.520
10 years	1.60	2.23	0.34	0.48	0.58	0.78	1.15	1.75	2.63	3.47	9.35	0.414
20 years	3.22	7.16	0.32	0.53	0.69	1.06	1.75	3.06	5.61	8.68	31.16	0.224
30 years	5.89	20.88	0.35	0.64	0.88	1.50	2.73	5.25	10.69	17.83	59.03	0.128
Panel B: Real bond payoffs												
1 month	1.00	0.03	0.92	0.96	0.97	0.99	1.00	1.01	1.02	1.03	1.06	0.505
1 year	0.99	0.12	0.55	0.79	0.86	0.94	1.00	1.05	1.11	1.15	1.26	0.489
5 years	1.00	0.36	0.06	0.37	0.56	0.79	1.01	1.22	1.41	1.54	1.83	0.482
10 years	0.96	0.55	0.02	0.10	0.28	0.60	0.93	1.29	1.62	1.85	2.40	0.555
20 years	0.99	0.95	0.01	0.03	0.06	0.35	0.81	1.42	2.10	2.56	3.74	0.595
30 years	1.07	1.34	0.00	0.02	0.04	0.19	0.70	1.52	2.58	3.39	5.51	0.610
Panel C: Real bill payoffs												
1 month	1.00	0.01	0.95	0.98	0.99	1.00	1.00	1.00	1.01	1.01	1.02	0.452
1 year	0.99	0.09	0.67	0.85	0.91	0.97	1.00	1.03	1.06	1.09	1.16	0.455
5 years	0.96	0.27	0.10	0.49	0.64	0.84	0.99	1.10	1.27	1.38	1.56	0.516
10 years	0.91	0.38	0.03	0.18	0.40	0.71	0.95	1.12	1.35	1.55	1.92	0.582
20 years	0.90	0.59	0.02	0.04	0.11	0.48	0.87	1.23	1.64	1.92	2.62	0.599
30 years	0.93	0.77	0.01	0.03	0.05	0.35	0.80	1.33	1.91	2.34	3.41	0.604

Table VII

Unconditional and conditional loss probabilities.

The table shows unconditional and conditional loss probabilities across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for the distribution of a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). For each horizon, the table reports the unconditional loss probability (repeated from Table III) and loss probabilities conditional on losses in one of the other asset classes. The reported unconditional loss probabilities are the proportions of payoff draws that are less than one given a $1.00 buy-and-hold investment, and the conditional loss probabilities are the proportions of payoff draws that are less than one conditional on a payoff draw of less than one for the other asset class. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

			$\mathbb{P}(W_{H,A}^{(m)} < 1 \mid W_{H,B}^{(m)} < 1)$			
			Asset class B			
Horizon	Asset class A	$\mathbb{P}(W_{H,A}^{(m)} < 1)$	Domestic stocks	International stocks	Bonds	Bills
Panel A: Domestic stocks						
1 month	Domestic stocks	0.427	1.000	0.595	0.503	0.481
1 year	Domestic stocks	0.371	1.000	0.642	0.478	0.447
5 years	Domestic stocks	0.290	1.000	0.583	0.452	0.392
10 years	Domestic stocks	0.223	1.000	0.511	0.414	0.339
20 years	Domestic stocks	0.162	1.000	0.433	0.342	0.259
30 years	Domestic stocks	0.126	1.000	0.391	0.288	0.207
Panel B: International stocks						
1 month	International stocks	0.416	0.580	1.000	0.474	0.479
1 year	International stocks	0.333	0.575	1.000	0.423	0.395
5 years	International stocks	0.259	0.520	1.000	0.389	0.337
10 years	International stocks	0.181	0.414	1.000	0.342	0.279
20 years	International stocks	0.084	0.224	1.000	0.162	0.140
30 years	International stocks	0.041	0.128	1.000	0.081	0.072
Panel C: Bonds						
1 month	Bonds	0.429	0.505	0.489	1.000	0.667
1 year	Bonds	0.380	0.489	0.483	1.000	0.670
5 years	Bonds	0.309	0.482	0.465	1.000	0.641
10 years	Bonds	0.300	0.555	0.567	1.000	0.648
20 years	Bonds	0.283	0.595	0.547	1.000	0.629
30 years	Bonds	0.268	0.610	0.525	1.000	0.610
Panel D: Bills						
1 month	Bills	0.402	0.452	0.462	0.624	1.000
1 year	Bills	0.379	0.455	0.450	0.667	1.000
5 years	Bills	0.382	0.516	0.498	0.792	1.000
10 years	Bills	0.384	0.582	0.591	0.830	1.000
20 years	Bills	0.376	0.599	0.630	0.836	1.000
30 years	Bills	0.369	0.604	0.638	0.839	1.000

Table VIII

Decompositions of 30-year conditional loss probabilities.

The table shows components of conditional loss probabilities across 10,000,000 bootstrap simulations at a 30-year return horizon. The underlying sample is the pooled sample of all developed countries. Each panel shows loss probabilities for a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). For each combination of two asset classes (A and B), the table reports the unconditional loss probability for asset class A (repeated from Table III), the components of the conditional loss probability attributable to short-term and long-term correlations between the assets, the component of the conditional loss probability attributable to joint tail dependence, and the conditional loss probability. The reported unconditional loss probabilities are the proportions of payoff draws that are less than one given a $1.00 buy-and-hold investment in asset class A, and the conditional loss probabilities are the proportions of payoff draws for asset class A that are less than one conditional on a payoff draw of less than one for asset class B.

		Components of conditional loss probability								
Asset class A	Asset class B	$\mathbb{P}(W_{H,A}^{(m)} < 1)$	+	ST correlation	+	LT correlation	+	Tail dependence	=	$\mathbb{P}(W_{H,A}^{(m)} < 1 \vert W_{H,B}^{(m)} < 1)$
Panel A: Domestic stocks										
Domestic stocks	International stocks	0.126	+	0.195	+	0.032	+	0.039	=	0.391
Domestic stocks	Bonds	0.126	+	0.051	+	0.066	+	0.045	=	0.288
Domestic stocks	Bills	0.126	+	0.036	+	0.036	+	0.009	=	0.207
Panel B: International stocks										
International stocks	Domestic stocks	0.041	+	0.066	+	0.011	+	0.010	=	0.128
International stocks	Bonds	0.041	+	0.007	+	0.002	+	0.030	=	0.081
International stocks	Bills	0.041	+	0.019	+	−0.011	+	0.022	=	0.072
Panel C: Bonds										
Bonds	Domestic stocks	0.268	+	0.228	+	0.186	+	−0.072	=	0.610
Bonds	International stocks	0.268	+	0.137	+	0.021	+	0.099	=	0.525
Bonds	Bills	0.268	+	0.220	+	0.177	+	−0.056	=	0.610
Panel D: Bills										
Bills	Domestic stocks	0.369	+	0.224	+	0.130	+	−0.119	=	0.604
Bills	International stocks	0.369	+	0.284	+	−0.115	+	0.100	=	0.638
Bills	Bonds	0.369	+	0.265	+	0.230	+	−0.024	=	0.839

Table IX

Bootstrap distributions of 30-year payoffs conditional on dividend-price ratio.

The table summarizes conditional distributions of real payoffs from a \$1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at a 30-year return horizon. The distributions are conditional on an initial value of the dividend-price ratio, DP_0. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for the distribution of a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each initial range of DP_0 values, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
DP_0 condition	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Real domestic stock payoffs												
$DP_0 \in [0.00, 0.02]$	5.96	13.51	0.10	0.36	0.65	1.48	3.11	6.41	12.62	19.40	46.55	0.162
$DP_0 \in (0.02, 0.03]$	5.83	10.76	0.12	0.42	0.75	1.67	3.37	6.50	12.16	18.11	41.40	0.140
$DP_0 \in (0.03, 0.04]$	5.95	10.22	0.16	0.51	0.88	1.88	3.69	6.79	12.10	17.75	39.83	0.117
$DP_0 \in (0.04, 0.05]$	6.82	11.38	0.16	0.55	0.97	2.15	4.30	7.85	13.85	20.29	45.01	0.104
$DP_0 \in (0.05, 0.06]$	7.55	12.33	0.13	0.52	0.96	2.34	4.79	8.81	15.37	22.35	49.66	0.104
$DP_0 \in (0.06, \infty)$	10.03	19.32	0.22	0.75	1.29	2.86	5.96	11.29	20.33	30.52	71.65	0.073
Panel B: Real international stock payoffs												
$DP_0 \in [0.00, 0.02]$	7.23	13.80	0.61	1.14	1.56	2.60	4.51	7.95	13.85	19.94	47.09	0.037
$DP_0 \in (0.02, 0.03]$	7.54	16.08	0.65	1.20	1.65	2.75	4.67	8.11	13.91	19.96	51.10	0.032
$DP_0 \in (0.03, 0.04]$	8.70	22.38	0.63	1.17	1.63	2.80	4.89	8.66	15.28	23.16	75.51	0.034
$DP_0 \in (0.04, 0.05]$	8.36	18.02	0.61	1.16	1.62	2.83	5.07	9.07	15.54	22.27	59.19	0.036
$DP_0 \in (0.05, 0.06]$	8.72	18.04	0.64	1.22	1.70	3.00	5.48	9.73	16.59	23.41	56.93	0.032
$DP_0 \in (0.06, \infty)$	9.53	19.45	0.71	1.34	1.88	3.26	5.92	10.51	17.98	25.53	66.09	0.025
Panel C: Real bond payoffs												
$DP_0 \in [0.00, 0.02]$	2.64	4.68	0.04	0.20	0.43	1.16	2.17	3.40	4.89	6.10	9.56	0.213
$DP_0 \in (0.02, 0.03]$	2.57	9.88	0.03	0.18	0.45	1.07	1.98	3.24	4.84	6.10	9.61	0.230
$DP_0 \in (0.03, 0.04]$	2.32	5.27	0.03	0.14	0.37	0.91	1.72	2.98	4.54	5.78	9.06	0.280
$DP_0 \in (0.04, 0.05]$	2.23	4.03	0.02	0.09	0.31	0.84	1.61	2.90	4.63	5.99	9.65	0.306
$DP_0 \in (0.05, 0.06]$	2.22	3.87	0.01	0.05	0.22	0.82	1.58	2.89	4.77	6.10	9.75	0.317
$DP_0 \in (0.06, \infty)$	2.37	4.33	0.01	0.08	0.26	0.84	1.69	3.09	5.12	6.58	10.42	0.302
Panel D: Real bill payoffs												
$DP_0 \in [0.00, 0.02]$	1.21	0.63	0.04	0.22	0.44	0.83	1.15	1.53	1.97	2.30	3.15	0.374
$DP_0 \in (0.02, 0.03]$	1.24	0.70	0.04	0.23	0.45	0.81	1.16	1.57	2.08	2.47	3.48	0.383
$DP_0 \in (0.03, 0.04]$	1.25	0.74	0.03	0.20	0.40	0.77	1.17	1.63	2.16	2.53	3.59	0.392
$DP_0 \in (0.04, 0.05]$	1.32	0.84	0.03	0.15	0.40	0.78	1.20	1.73	2.35	2.82	4.12	0.381
$DP_0 \in (0.05, 0.06]$	1.39	0.93	0.02	0.08	0.36	0.79	1.24	1.84	2.53	3.06	4.46	0.367
$DP_0 \in (0.06, \infty)$	1.42	0.96	0.02	0.09	0.33	0.78	1.26	1.91	2.59	3.11	4.52	0.362

Table X

Bootstrap distributions of 30-year payoffs conditional on short-term interest rate.

The table summarizes conditional distributions of real payoffs from a $1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at a 30-year return horizon. The distributions are conditional on an initial value of the short-term interest rate, SR_0. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for the distribution of a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each initial range of SR_0 values, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
SR_0 condition	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Real domestic stock payoffs												
$SR_0 \in (-\infty, 0.02]$	6.42	6.84	0.24	0.83	1.39	2.74	4.99	8.26	12.59	16.21	27.53	0.064
$SR_0 \in (0.02, 0.04]$	5.68	9.85	0.10	0.39	0.73	1.76	3.64	6.74	11.67	16.61	35.90	0.139
$SR_0 \in (0.04, 0.06]$	6.46	13.91	0.12	0.44	0.77	1.75	3.72	7.20	13.15	19.69	47.50	0.136
$SR_0 \in (0.06, 0.08]$	8.05	20.20	0.18	0.63	1.12	2.43	4.81	9.01	16.03	23.71	56.43	0.087
$SR_0 \in (0.08, 0.10]$	11.21	26.24	0.22	0.80	1.49	3.28	6.47	12.32	22.88	34.34	79.11	0.064
$SR_0 \in (0.10, \infty)$	15.52	70.67	0.21	0.82	1.54	3.54	7.40	14.81	29.33	47.10	135.66	0.062
Panel B: Real international stock payoffs												
$SR_0 \in (-\infty, 0.02]$	11.99	12.55	1.02	2.08	2.99	5.41	10.33	16.49	21.75	25.61	38.09	0.010
$SR_0 \in (0.02, 0.04]$	9.54	30.43	0.58	1.13	1.60	2.90	5.44	9.82	16.46	24.02	84.17	0.039
$SR_0 \in (0.04, 0.06]$	7.72	16.32	0.53	1.04	1.49	2.65	4.88	8.74	14.93	20.81	47.84	0.046
$SR_0 \in (0.06, 0.08]$	7.78	14.03	0.62	1.20	1.67	2.92	5.15	8.81	14.93	20.87	46.58	0.033
$SR_0 \in (0.08, 0.10]$	8.95	14.65	0.77	1.50	2.10	3.58	6.05	10.17	17.22	23.95	51.75	0.019
$SR_0 \in (0.10, \infty)$	9.62	13.46	0.91	1.71	2.38	3.91	6.41	11.19	19.12	26.43	52.43	0.013
Panel C: Real bond payoffs												
$SR_0 \in (-\infty, 0.02]$	1.43	0.92	0.06	0.26	0.55	0.95	1.39	1.82	2.29	2.66	3.62	0.275
$SR_0 \in (0.02, 0.04]$	1.60	1.31	0.02	0.08	0.25	0.84	1.52	2.19	2.86	3.40	4.79	0.306
$SR_0 \in (0.04, 0.06]$	1.91	1.73	0.02	0.08	0.27	0.95	1.76	2.60	3.53	4.22	6.01	0.264
$SR_0 \in (0.06, 0.08]$	2.69	3.70	0.04	0.29	0.68	1.44	2.40	3.50	4.72	5.65	8.35	0.152
$SR_0 \in (0.08, 0.10]$	3.48	6.49	0.06	0.47	1.04	2.02	3.17	4.48	5.88	6.95	9.91	0.096
$SR_0 \in (0.10, \infty)$	5.01	12.00	0.10	0.61	1.27	2.60	4.22	6.05	8.06	9.76	15.90	0.079
Panel D: Real bill payoffs												
$SR_0 \in (-\infty, 0.02]$	0.76	0.39	0.05	0.24	0.41	0.58	0.68	0.87	1.19	1.46	2.16	0.831
$SR_0 \in (0.02, 0.04]$	1.06	0.66	0.02	0.11	0.34	0.67	0.94	1.37	1.88	2.26	3.22	0.547
$SR_0 \in (0.04, 0.06]$	1.25	0.81	0.02	0.11	0.34	0.73	1.11	1.64	2.22	2.66	3.99	0.429
$SR_0 \in (0.06, 0.08]$	1.57	0.89	0.04	0.35	0.66	1.00	1.43	2.00	2.64	3.18	4.51	0.251
$SR_0 \in (0.08, 0.10]$	1.75	0.90	0.06	0.50	0.79	1.15	1.62	2.22	2.85	3.34	4.63	0.172
$SR_0 \in (0.10, \infty)$	2.10	1.04	0.10	0.66	0.98	1.41	1.97	2.62	3.37	3.94	5.39	0.105

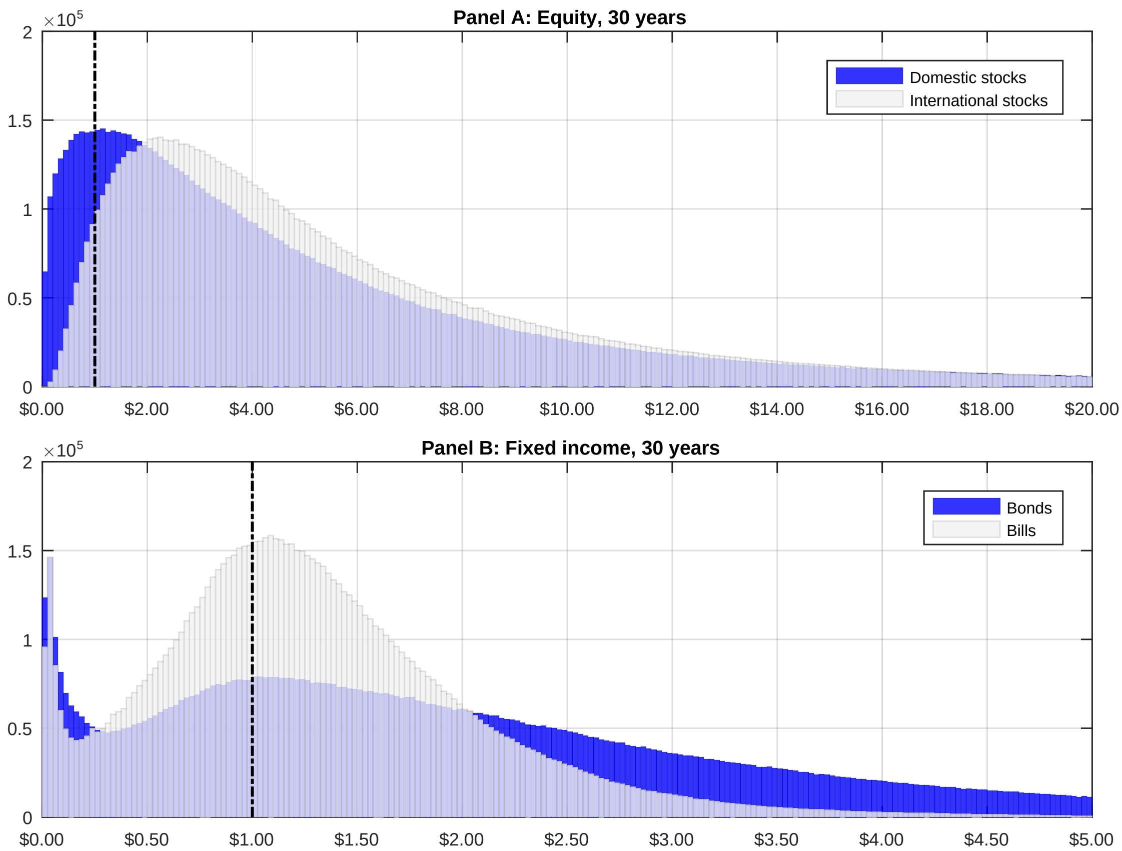

Figure 1. Cumulative 30-year payoffs. The figure shows histograms of real payoffs across 10,000,000 bootstrap simulations at a 30-year return horizon. Panel A shows results for domestic stocks and international stocks, and Panel B shows results for bonds and bills. The underlying sample for the simulated returns is the pooled sample of all developed countries. The dashed line in each plot separates the regions of real loss and gain on a $1.00 initial investment. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

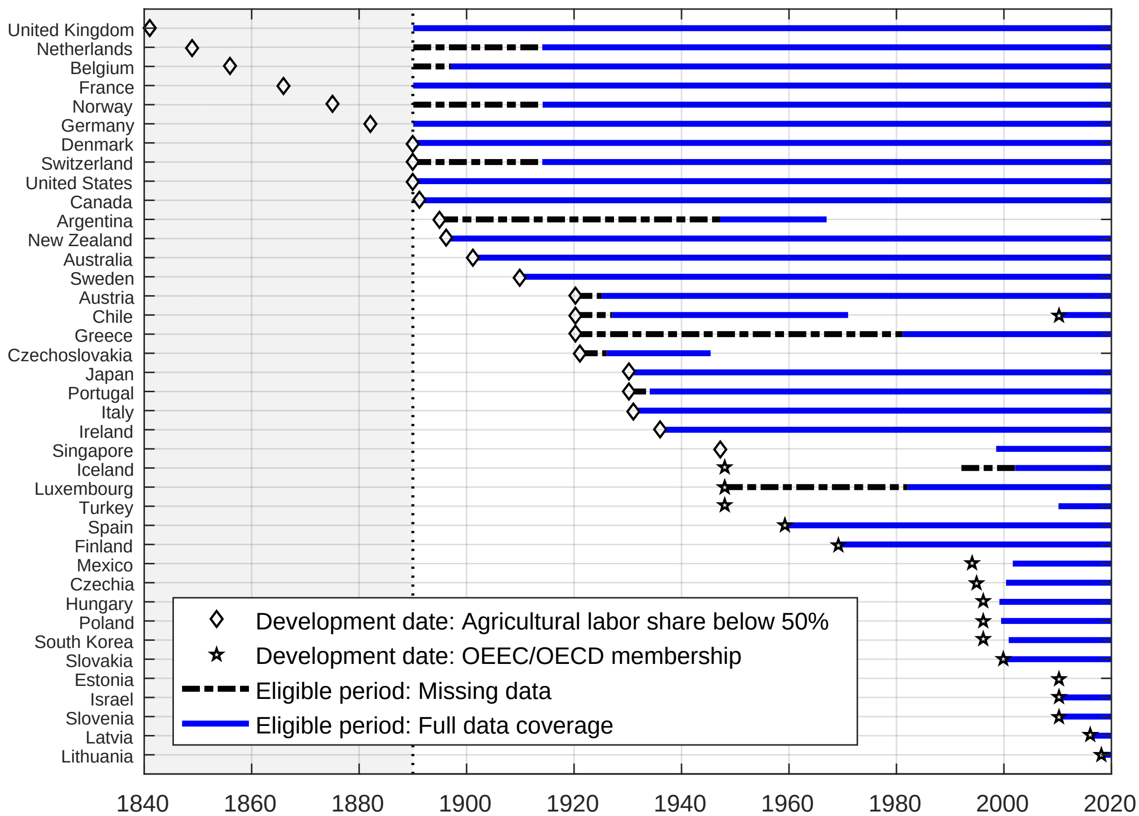

Figure 2. Development periods and data availability by country. The figure details the development date, the eligible sample period, and the period with data coverage for each country in the sample. The development year classifications are based on agricultural labor share, organizational membership in the Organisation for European Economic Co-operation (OEEC), or organizational membership in the Organisation for Economic Co-operation and Development (OECD). The line for each country shows the period over which that country is eligible to be included in the sample. The earliest possible sample eligibility for any country is 1890, and the shaded area of the plot denotes the pre-eligibility period. Sample eligibility on a given date also requires that a country is classified as developed, has commenced operations of a stock exchange, and has issued ten-year government bonds. The dashed portion of each line denotes the eligible period over which some returns data are missing, and the solid portion denotes the period with valid returns data for stocks, bonds, bills, and inflation.

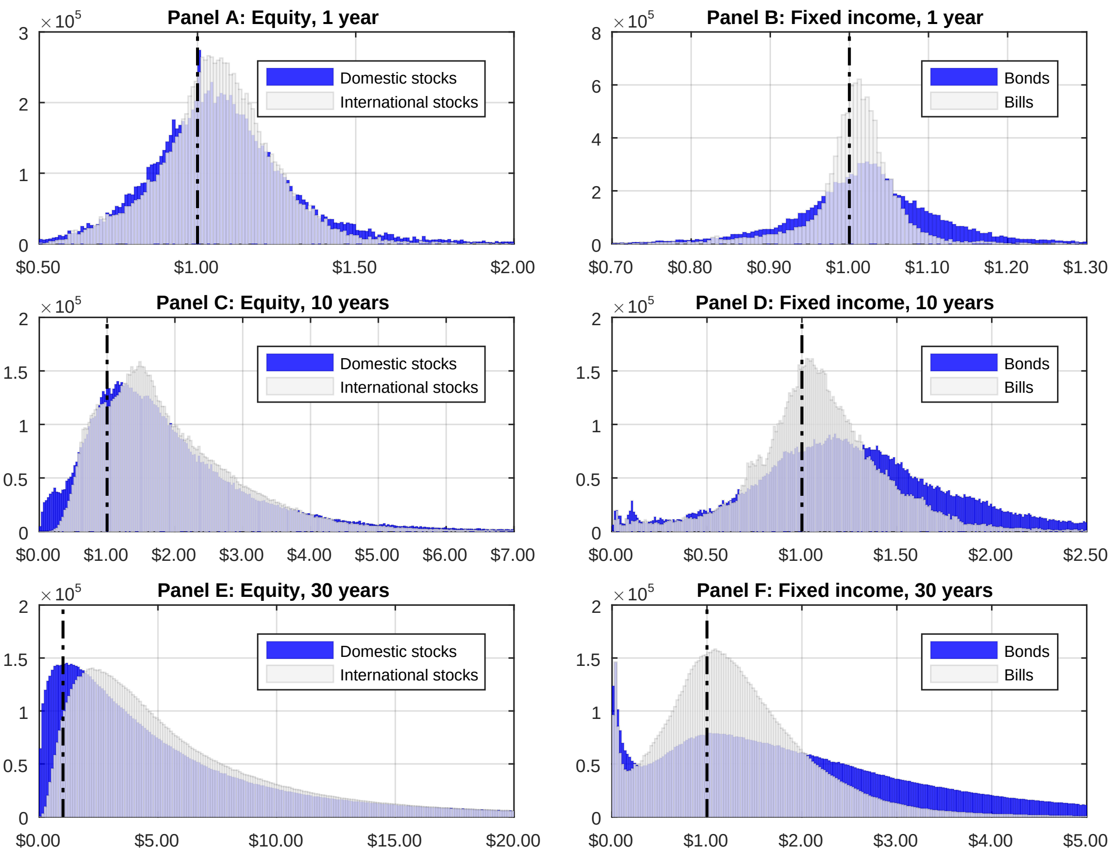

Figure 3. Cumulative payoffs. The figure shows histograms of real payoffs across 10,000,000 bootstrap simulations at various return horizons for four asset classes: domestic stocks, international stocks, bonds, and bills. The underlying sample for the simulated returns is the pooled sample of all developed countries. The dashed line in each plot separates the regions of real loss and gain on a $1.00 initial investment. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

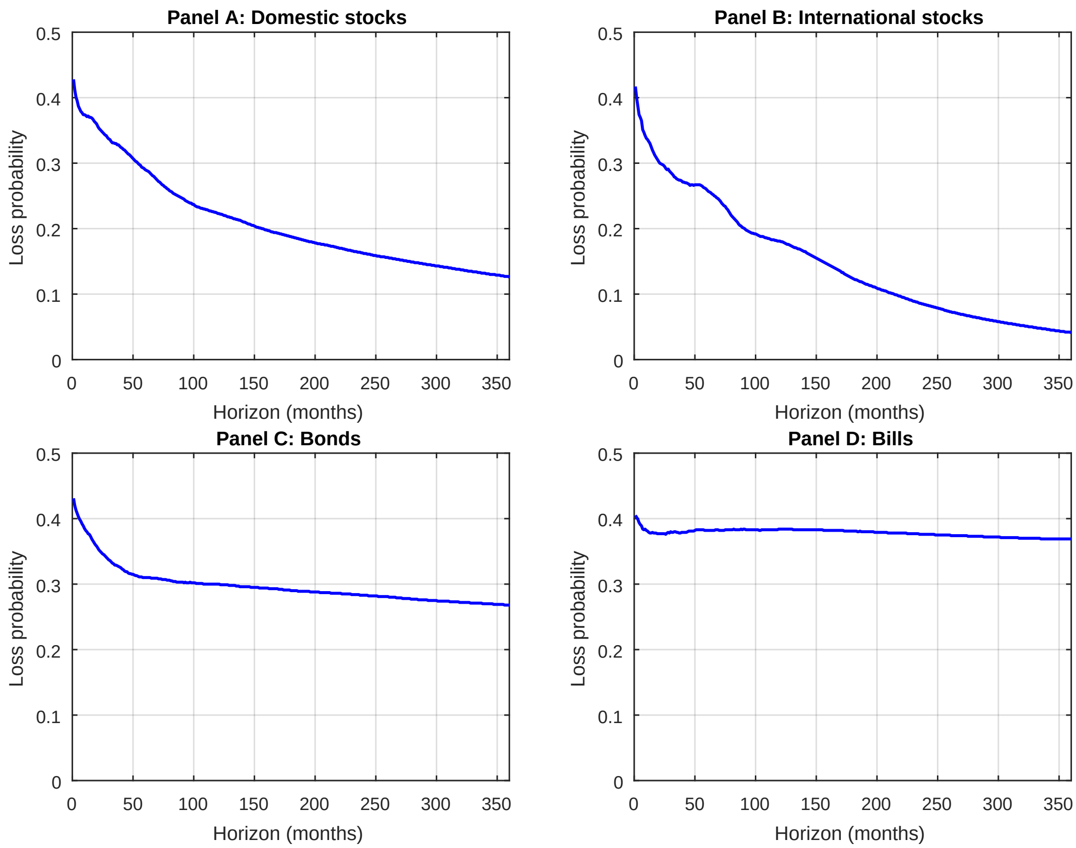

Figure 4. Loss probabilities for alternative investment horizons. The figure shows the proportion of real payoffs that are less than the initial investment across 10,000,000 bootstrap simulations at various return horizons. Each panel corresponds to a specific asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994b), as described in the text.

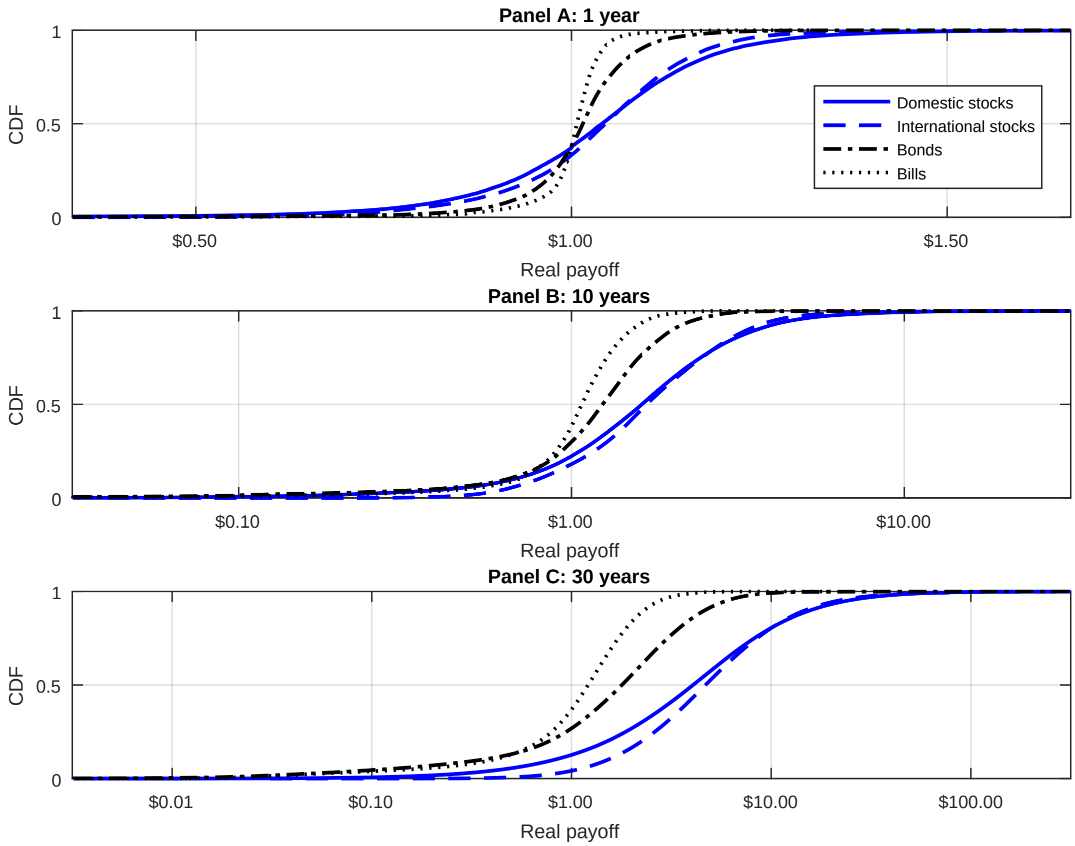

Figure 5. Cumulative wealth distributions. The figure shows empirical cumulative distribution functions of real payoffs across 10,000,000 bootstrap simulations at various return horizons for four asset classes: domestic stocks, international stocks, bonds, and bills. The underlying sample for the simulated returns is the pooled sample of all developed countries. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

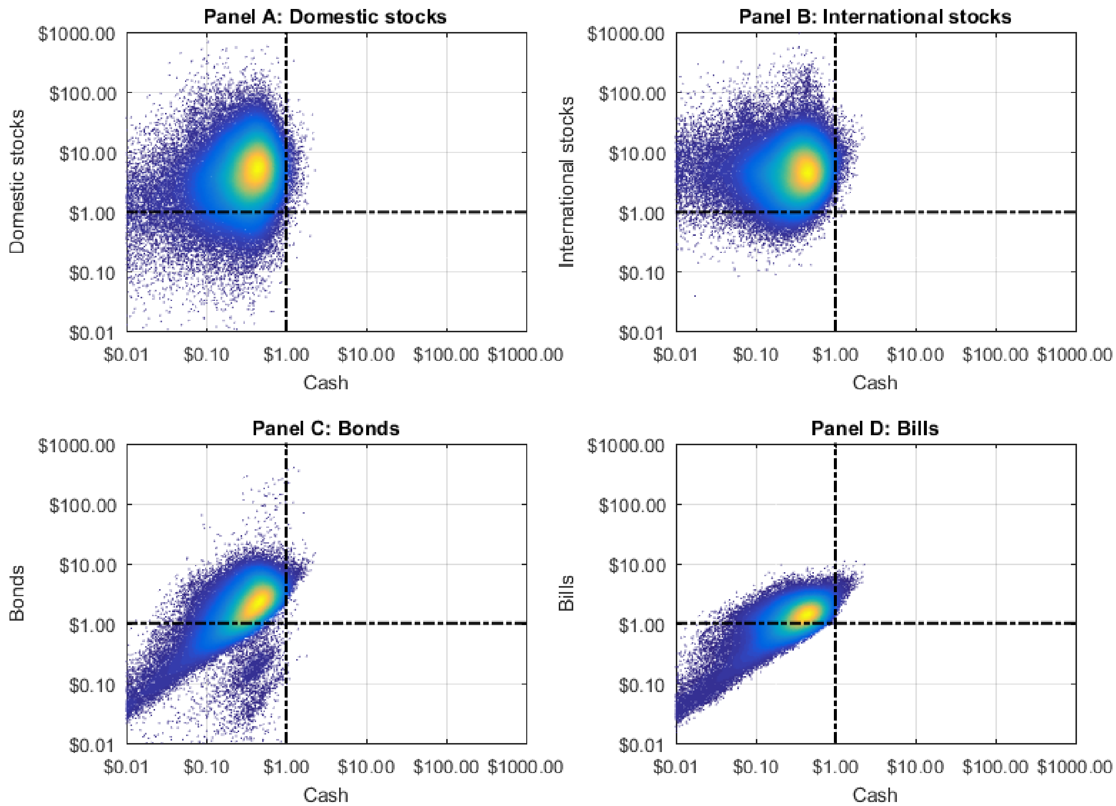

Figure 6. Inflation and cumulative 30-year payoffs. The figure shows heat maps of the joint distributions of real payoffs across 100,000 bootstrap simulations at a 30-year return horizon. Each panel corresponds to the joint distribution of real payoffs for cash and another asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The underlying sample for the simulated returns is the pooled sample of all developed countries. Each dot represents the joint payoff outcomes of cash and another asset. The dots in more (less) dense areas are shaded yellow (blue). The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

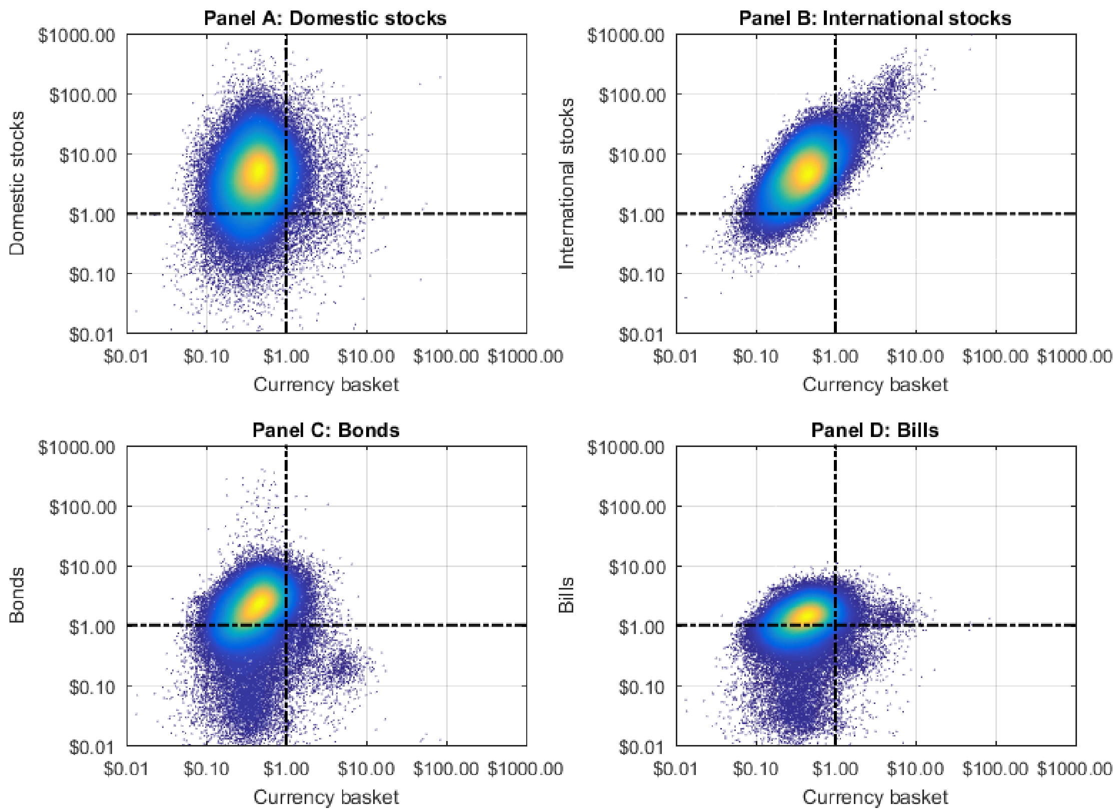

Figure 7. Currency effects and cumulative 30-year payoffs. The figure shows heat maps of the joint distributions of real payoffs across 100,000 bootstrap simulations at a 30-year return horizon. Each panel corresponds to the joint distribution of real payoffs for the basket of foreign currencies that are required to invest in the international stock portfolio and real payoffs for another asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The underlying sample for the simulated returns is the pooled sample of all developed countries. Each dot represents the joint payoff outcomes of the currency basket and another asset. The dots in more (less) dense areas are shaded yellow (blue). The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

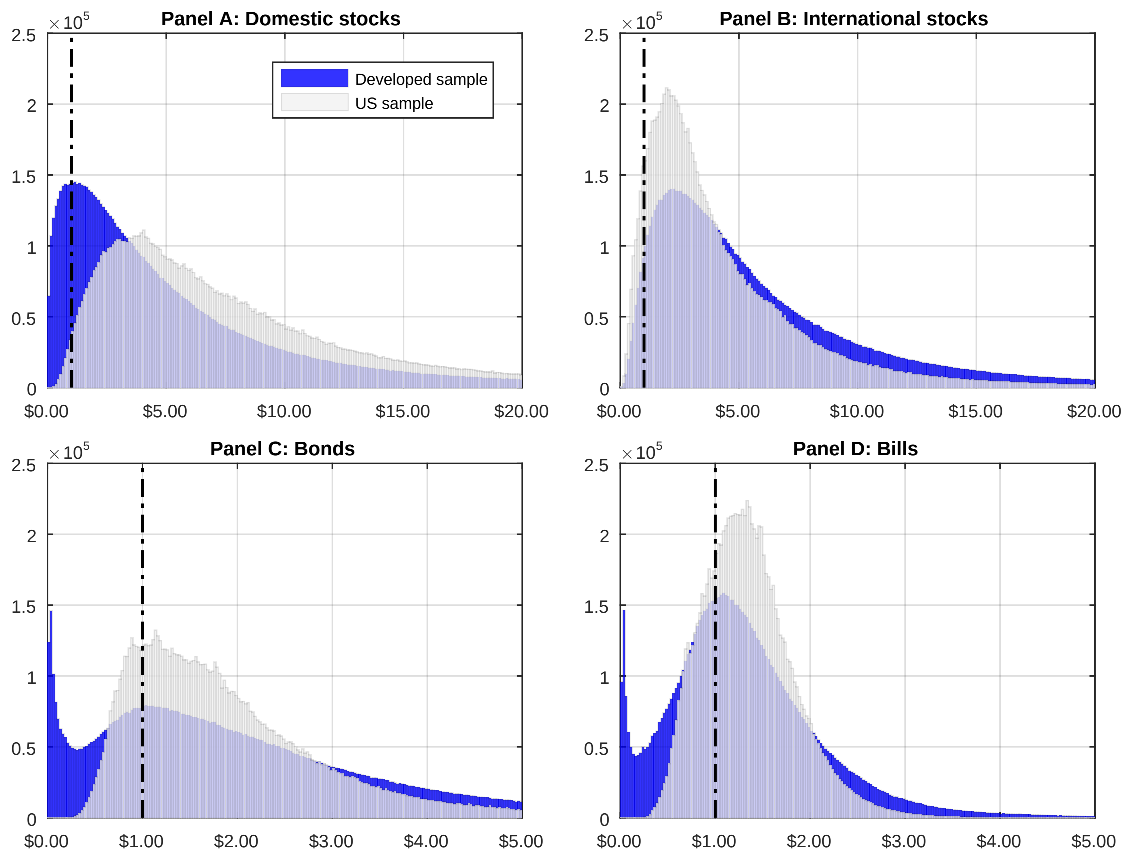

Figure 8. Comparison of cumulative 30-year payoffs for developed sample and US sample. The figure shows histograms of real payoffs across 10,000,000 bootstrap simulations at a 30-year return horizon. Each panel corresponds to a specific asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The blue (gray) plot in each panel is the histogram of simulated payoffs based on the pooled sample of all developed countries (US sample). The dashed line in each plot separates the regions of real loss and gain on a $1.00 initial investment. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

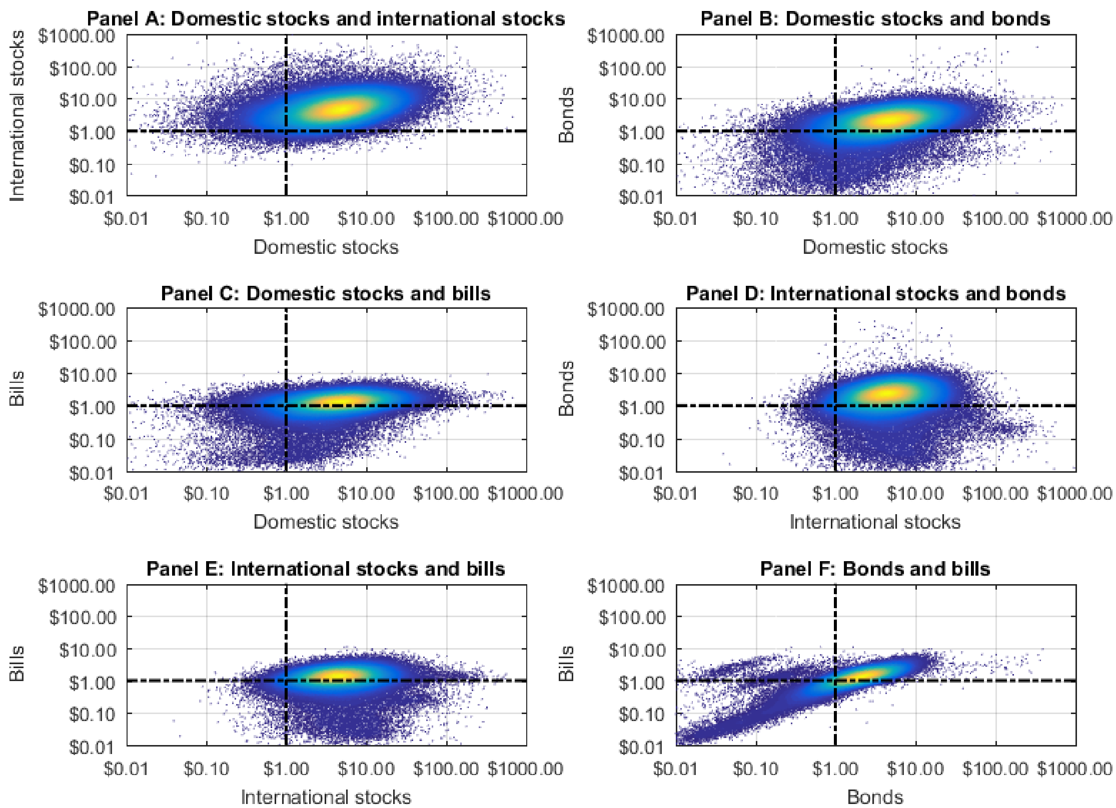

Figure 9. Joint distributions of cumulative 30-year payoffs. The figure shows heat maps of the joint distributions of real payoffs across 100,000 bootstrap simulations at a 30-year return horizon. Each panel corresponds to the joint distribution of real payoffs for two asset classes. The underlying sample for the simulated returns is the pooled sample of all developed countries. Each dot represents the joint payoff outcomes for the indicated asset classes. The dots in more (less) dense areas are shaded yellow (blue). The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

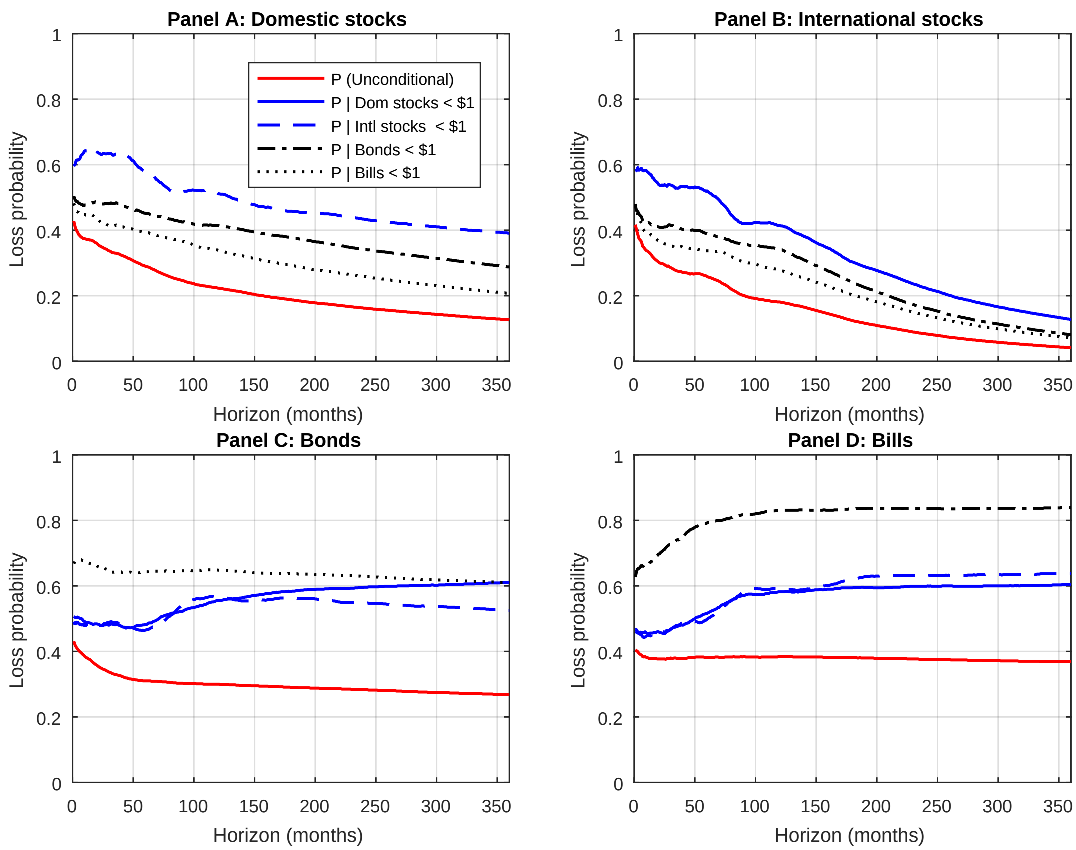

Figure 10. Conditional loss probabilities for alternative investment horizons. The figure shows unconditional and conditional loss probabilities across 10,000,000 bootstrap simulations at various return horizons. The loss probability is the proportion of real payoffs that are less than the initial investment. Each panel corresponds to a specific asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). In each panel, the solid red line corresponds to the unconditional loss probability. The other lines correspond to the loss probabilities conditional on a loss in one of the other asset classes. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994b), as described in the text.

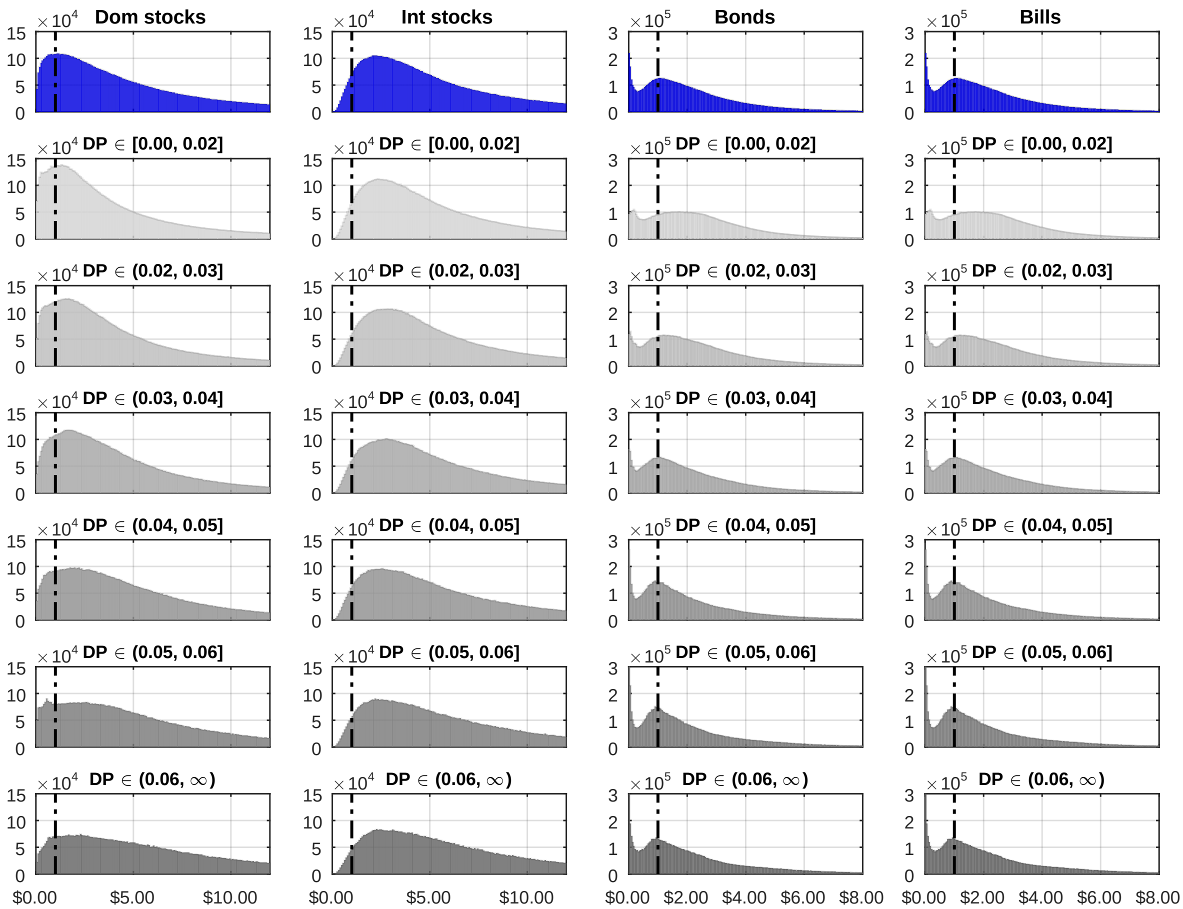

Figure 11. Cumulative 30-year payoffs conditional on initial value of dividend-price ratio. The figure shows histograms of real payoffs across 10,000,000 bootstrap simulations at a 30-year return horizon. Each column of the figure corresponds to a specific asset class: domestic stocks, international stocks, bonds, and bills. The top row (blue plots) shows unconditional payoff distributions. The remaining rows (gray plots) shows payoff distributions that condition on an initial value of the dividend-price ratio, DP_0. The underlying sample for the simulated returns is the pooled sample of all developed countries. The dashed line in each plot separates the regions of real loss and gain on a $1.00 initial investment. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

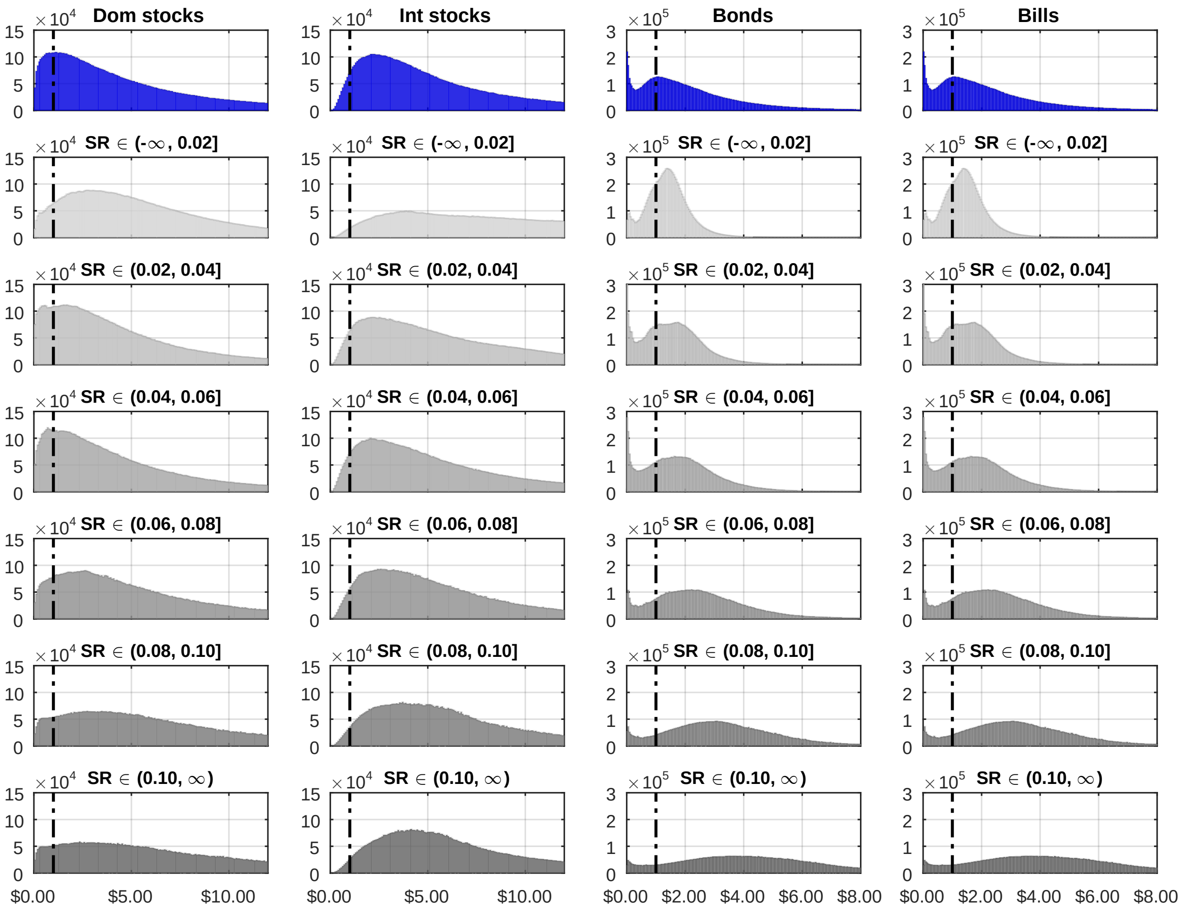

Figure 12. Cumulative 30-year payoffs conditional on initial value of short-term interest rate. The figure shows histograms of real payoffs across 10,000,000 bootstrap simulations at a 30-year return horizon. Each column of the figure corresponds to a specific asset class: domestic stocks, international stocks, bonds, and bills. The top row (blue plots) shows unconditional payoff distributions. The remaining rows (gray plots) shows payoff distributions that condition on an initial value of the short-term interest rate, SR_0. The underlying sample for the simulated returns is the pooled sample of all developed countries. The dashed line in each plot separates the regions of real loss and gain on a \$1.00 initial investment. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

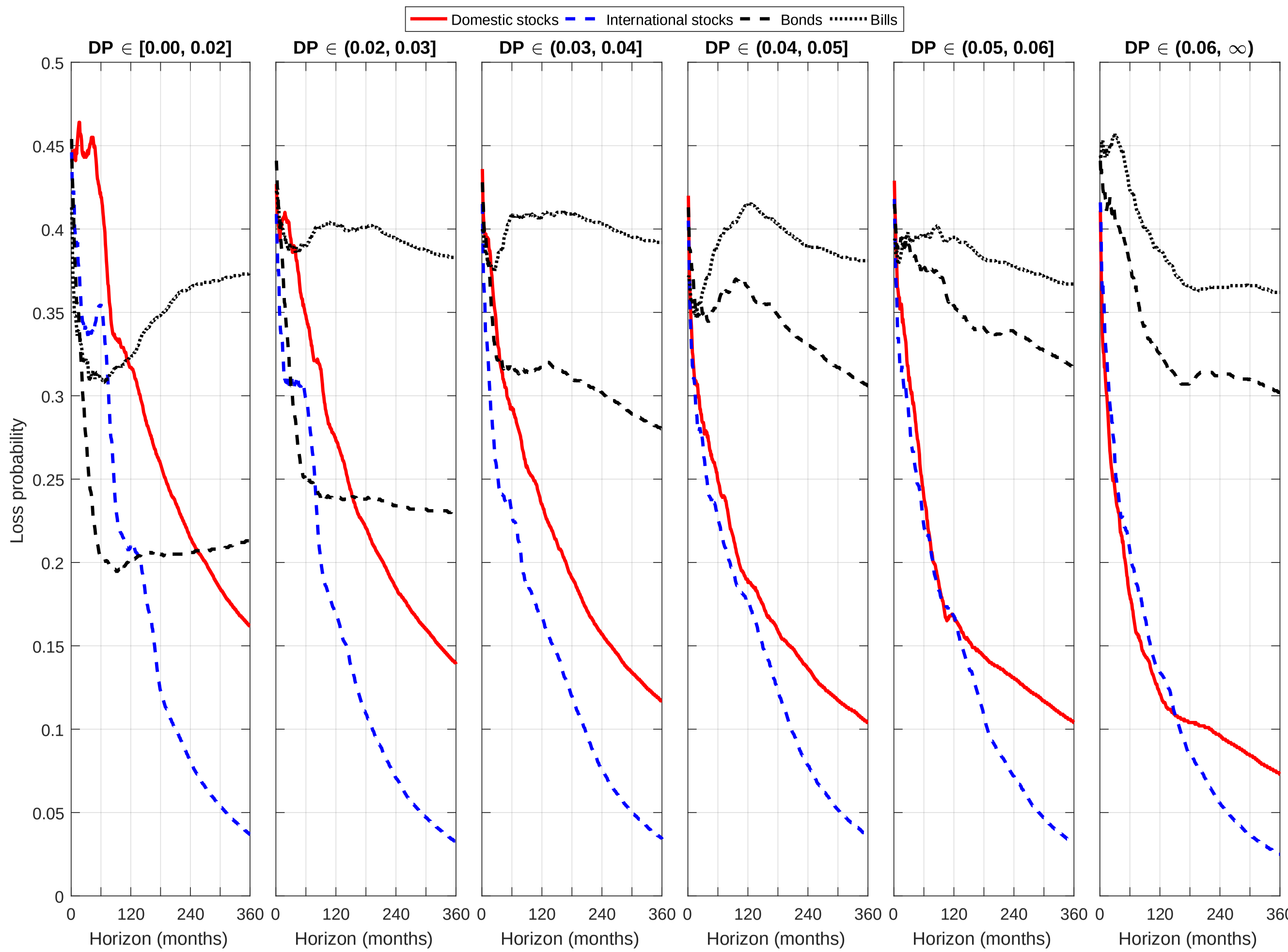

Figure 13. Loss probabilities for alternative investment horizons conditional on initial value of dividend-price ratio. The figure shows the proportion of real payoffs for domestic stocks, international stocks, bonds, and bills that are less than the initial investment across 10,000,000 bootstrap simulations at various return horizons. Each plot conditions on an initial value of the dividend-price ratio, DP_0. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

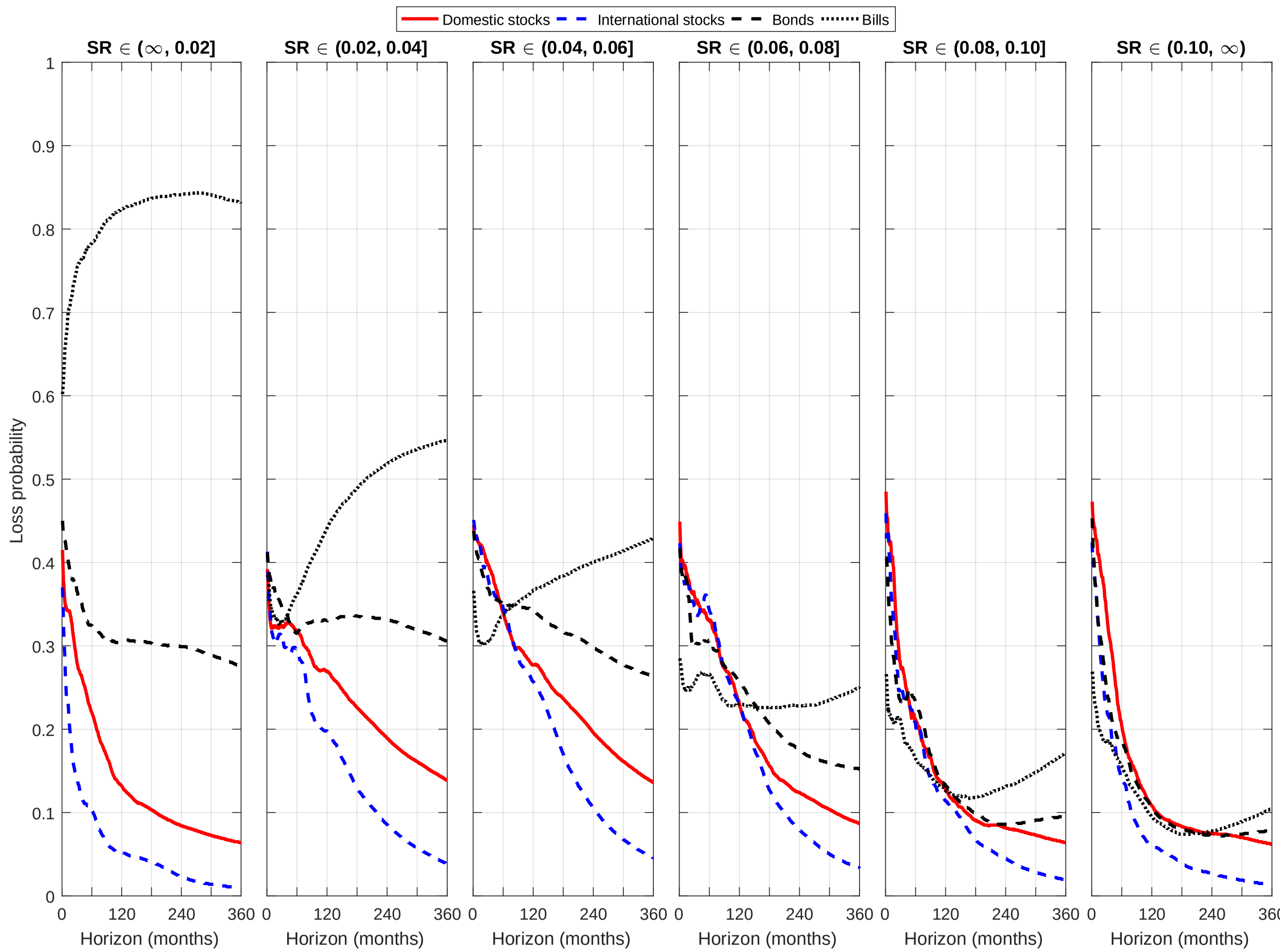

Figure 14. Loss probabilities for alternative investment horizons conditional on initial value of short-term interest rate. The figure shows the proportion of real payoffs for domestic stocks, international stocks, bonds, and bills that are less than the initial investment across 10,000,000 bootstrap simulations at various return horizons. Each plot conditions on an initial value of the short-term interest rate, SR_0. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

Internet Appendix for "The Long-Horizon Returns of Stocks, Bonds, and Bills: Evidence from a Broad Sample of Developed Markets"

A Data appendix

This appendix outlines our data sources and construction methods. The primary source of data for our study is the GFDatabase from Global Financial Data (GFD). Table A.I reports the data series we use to compute stock, bond, and bill returns for each country. As noted in the footnotes to Table A.I, we supplement the data from GFD with data from other sources. Additional details on these data sources and the required data adjustments are provided in Sections A.1 to A.4. Section A.5 compares our data on stock and bond returns with data from alternative sources.

A.1 Stock returns and dividend-price ratios

Full details on the data adjustments required to compute nominal and real stock returns for our developed country sample are available in Anarkulova, Cederburg, and O'Doherty (2021) and the corresponding internet appendix. These sources outline the approach to constructing monthly returns from data on either total return indexes or price indexes and dividend yields. They also describe adjustments for missing return and dividend-price ratio observations and the calculation of stock returns for Germany over the period of extreme inflation from 1917 to 1923.

One difference between our sample construction approach and the one in Anarkulova, Cederburg, and O'Doherty (2021) relates to the handling of multi-month return observations associated with stock market disruptions and closures. Table A.II reports cases of exchange closures or heavily restricted trading during our sample period along with the corresponding nominal and real returns. The bootstrap procedure in Anarkulova, Cederburg, and O'Doherty (2021) treats each of these events as a single return observation covering a multi-month period. This treatment reflects that most investors would have been unable to trade during these periods, such that they could only wait for the eventual realizations of the longer-period returns. This treatment is not ideal for our multi-asset analysis, however, as we would like to maintain a balanced panel of monthly asset returns for each country. At the same time, we need the data to accurately reflect the economic outcomes of stock market investors.

In our current approach to handling multi-month returns, we take the perspective on an investor in a hypothetical fund attempting to track the market index for a given country. Although this investor could not directly liquidate her stock holdings via exchange trades during times of market closure, she could sell her shares in the hypothetical fund. The fund's managers, in turn, could either rely on black market data for valuation purposes or produce an estimate of the historical event's impact on asset prices at the beginning of the closure period. Based on this perspective, we apply one of two approaches to handling multi-month returns:

1. For events in which GFD provides black market prices, we use those values to estimate stock market index returns.

2. For events without corresponding data in GFD, we assign the total multi-month real return to the first monthly observation and zero real return to the remaining monthly observations.

The two exceptions to this general approach correspond to Switzerland's 24-month return from August 1914 to July 1916 and Czechoslovakia's 26-month return from April 1943 to May 1945. For Switzerland, GFD reports limited black market data in January 1916 and July 1916. We use these intermittent values and assign the remaining part of the total real return to August 1914. For Czechoslovakia, the April 1943 to May 1945 period corresponds to an episode that starts with severe trading restrictions and price controls and ends with the permanent stock exchange closure in Prague on May 5, 1945. For this period, we assign a terminal nominal return of −90.00% to May 1945 and zero nominal returns to the other months. This treatment is consistent with the economic experience of investors over this period, as detailed in Anarkulova, Cederburg, and O'Doherty (2021).

Finally, we rely on external sources to calculate dividend-price ratios for Slovakia and Latvia. In both cases, GFD lacks comprehensive information to compute these ratios. For Slovakia, we use dividend yield data from the Bratislava Stock Exchange's official website.[8] For Latvia, we estimate dividend yields using data on total dividends paid by companies from Nasdaq Baltic and data on total market capitalization from GFD.[9]

A.2 Bond returns

Nominal and real country-level bond returns are defined in Section 2.1.3. The calculations require data on monthly yields for ten-year government bonds, and this section considers several issues related to the underlying yield data.

A.2.1 Bond data availability

For several countries in our sample, there are no ten-year government bonds in circulation at the time the country is initially classified as developed (Figure 2). For example, ten-year government bond are first issued in Iceland in 1992, Singapore in 1998, Hungary in 1999, Poland in 1999, Czechia in 2000, Korea in 2000 [Kang, Kim, and Rhee (2005)], Mexico in 2001 [Jeanneau and Verdia (2005)], and Turkey in 2010.[10] These circumstances create gaps between the development dates and the sample eligibility dates for these countries.

Estonia issued its only domestic bond in 1993, and all tranches were redeemed by 2004.[11] As a result, Estonia is excluded from our sample because the country has no domestic bond data for the developed period.

A.2.2 Data gaps and errors

Table A.III shows periods over which we are missing monthly bond yields. In these cases, we use a smoothing procedure to fill gaps in the monthly bond return series. This procedure uses the country-level yield data from before and after the missing observations to produce a series of constant monthly returns across a given period.

The bond yield data in GFD for Slovenia from December 2018 to December 2019 and Turkey in November 2019 are incorrect, so we use data from alternative sources as detailed in the footnotes to Table A.I.

[8] See http://www.bsse.sk/%C5%A0tatistika/Mesa%C4%8Dn%C3%A1.aspx.

[9] The dividend data for Latvia are available at https://nasdaqbaltic.com/statistics/en/statistics.

[10] See http://www.lanamal.is/asset/12732/special-report-markadsvidskipti_agust-2019.pdf for Iceland, https://eservices.mas.gov.sg/statistics/fdanet/BenchmarkPricesAndYields.aspx for Singapore, https://stats.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=GOV_DEBT&Coords=%5BCOU%5D.%5BHUN%5D&ShowOnWeb=true&Lang=en for Hungary, https://www.gov.pl/web/finance/transaction-database for Poland, https://www.cnb.cz/en/financial-markets/treasury-securities-market/government-bonds/ for Czechia, and https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Statistics/Markets+Data/Treasury+Auction/ for Turkey.

[11] See https://www.rahandusministeerium.ee/en/objectivesactivities/state-treasury/financial-reserves-and-liabilities/debt-management.

We also adjust an apparent error in the GFD bond yield data for Switzerland. The stated source for the GFD data is the Swiss National Bank. In comparing the GFD data to the Swiss National Bank data, however, the yields only match through December 1941. The Swiss National Bank reports yields of 3.11% in January 1942, 3.14% in February 1942, 3.12% in March 1942, and 3.08% in April 1942. GFD reports yields of 3.14%, 3.12%, and 3.07% for January through March 1942. From April 1942 to December 1990, the GFD data lead the Swiss National Bank data by one month. We adjust the GFD data by entering a 3.11% yield for January 1942 and shifting the original GFD data from January 1942 to November 1990 so that it covers February 1942 to December 1990.

A.2.3 Merging multiple sources

As shown in Table A.I, constructing a series of bond returns for a given country often requires us to combine yield data from multiple sources. We make additional adjustments in linking the data series for two sample countries. The GFD data for Chile end in March 2015, and we use data from FRED from April 2015 to December 2019. GFD reports a yield of 2.23% for March 2015, whereas the yields from FRED are 4.34% for March 2015 and 4.49% for April 2015. Merging these data series without adjustment would result in a return of −17.76% for April 2015. This return likely provides a poor characterization of investment outcomes, given the relative stability in yields in the FRED data. To address this issue, we use March 2015 and April 2015 yields from FRED to compute the April 2015 bond return. We make an analogous adjustment for Iceland in March 2004.

A.2.4 Bond conversion in Argentina

Argentina issued a 3% bond in 1955 that was subsequently exchanged for an 8% bond in August 1960. The reported yield in the data from the Central Bank of Argentina increases from 3.88% in July 1960 to 8.68% in August 1960. When the government issued the 8% bonds in 1960, they allowed for voluntary conversion of the old bonds. The conversion was favorable for bondholders, as they could receive bonds with higher interest payments. According to Duggan (1963), the 3% bonds were exchanged at 79 pesos for the nominal value of 100 pesos. Because the terms of the conversion were favorable, the majority of existing bondholders took the offer. In constructing our bond series for Argentina, we assume conversion at the 79 to 100 rate. We compute the bond price at the beginning of August 1960 using the 3% bond yield and the dirty price at the end of August 1960 using the 8% bond yield. The ending price is then adjusted by multiplying by 0.79 to reflect the conversion.

A.2.5 Germany in 1919 to 1924 and 1948

To maintain consistency with our treatment of stock returns in Germany in 1923 (see Section A.1), we also compute bond returns in gold marks. We use bond prices in paper marks from Fischer (1923, 1924, 1925) and convert paper mark prices to gold marks by using the USD exchange rate because the United States was on the gold standard during that period. The change in gold mark bond prices provides an estimate of the capital appreciation of the bonds. We add an annual 3% interest payment to compute the total bond return. We use this approach from February 1919 to January 1924.

Germany exchanged Reichsmarks for Deutschemarks in June 1948. For government bonds, the exchange was 10:1 [Schnabl (2019)]. To reflect the economic value of the currency exchange, we adjust the bond price at the end of June 1948 by dividing the price of the bond by 10. The resulting bond return in June 1948 is −90.0%.

A.3 Bill returns

We compute monthly nominal bill returns from annual yields or rates as

$$R_{i,t}^{Nominal\ bills} = (1 + R_{i,t-1}^{Annual\ rate})^{1/12}, \tag{A1}$$

where $R_{i,t-1}^{Annual\ rate}$ is the annualized short-term government bill yield, central bank rate, or interbank rate reported at the end of month $t-1$.

We have a few periods over which there are no bill data from GFD or alternative sources, and we are required to make assumptions to fill these gaps in the data. For Canada, we use a yield of 5.75% for the seven-month period from January 1914 to July 1914. This value is an average of the 6.50% interbank rate for December 1913 from GFD and the 5.00% advance rate for August 1914 from Shearer and Clark (1984). For Chile, the central bank rate series ends in September 2019, and we use the September 2019 value of 2.00% for October 2019 to December 2019. The Netherlands is missing data for February 2014, so we average the short-term government bill yields from GFD of 0.09% for January 2014 and 0.13% for March 2014. Similarly, Turkey is missing data for September 1995. The GFD bill yield is 68.52% for August 1995 and 92.24% for October 1995, so we use the average value of 80.38% for September 1995.

For New Zealand from January 1896 to December 1914, we use short-term yields on bills held by the Post Office Savings Bank Fund. The Post Office Savings Bank Fund did not hold Treasury bills in 1913, so we are missing data for that year. The yields are 3.00% in December 1912 and 4.00% in January 1914, and we use the average of 3.50% to fill in the data gap. We are also missing yield data for New Zealand from January 1915 to December 1919. The yields for December 2014 and January 2020 are both 4.00%, however, so we assume a 4.00% yield over the adjoining period with missing data.

A.4 Inflation and exchange rate changes

We follow the data adjustments noted in Anarkulova, Cederburg, and O'Doherty (2021) to estimate country-level inflation and exchange rate changes.

A.5 External validation tests

This section details the external validation tests for our stock and bond return data.

A.5.1 Comparison of stock data from GFD and Jordà et al.

Anarkulova, Cederburg, and O'Doherty (2021) compare their data on stock returns from GFD with the stock returns from the overlapping periods in Jordà, Knoll, Kuvshinov, Schularick, and Taylor (2019). They find that the data from these two sources have very similar characteristics in terms of country-level average returns, standard deviations, and extreme returns. They also show that the return correlation across the two datasets exceeds 0.90 for nearly all countries. Given that our approach to constructing country-level stock returns closely follows the approach in Anarkulova, Cederburg, and O'Doherty (2021), these tests also provide external validation of our stock data.

A.5.2 Comparison of bond data from GFD and Datastream

As described in Section 2 of the paper, we calculate bond returns using bond yield data from GFD and other sources. In this section, we perform an external validation exercise by comparing our bond returns with those from Datastream over the periods and countries for which they are available. This analysis serves to both ensure that our approach to converting bond yields to returns is empirically accurate and assess whether our bond return data and the bond data from a popular alternative source exhibit common characteristics.

Table A.IV shows results from the external validation analysis. Panel A reports statistics for nominal returns and Panel B for real returns. Our sample overlaps with Datastream for 27 countries. Datastream data begin in 1989 for several countries and more recently for others. The table reports the sample size, the arithmetic and geometric means, standard deviation, and minimum and maximum returns for our data, the corresponding statistics for Datastream data, and the correlation between our returns and those from Datastream. The table also shows pooled statistics across countries.

Table A.IV indicates a close correspondence between our bond return data and those from Datastream. For nearly all countries, the means, standard deviations, and extreme returns are highly similar across the two data sources. In both Panels A and B, 24 of the 27 countries have return correlations above 0.90. Only Hungary, Mexico, and Singapore have correlations below 0.90. Of the 24 countries with high correlations, Greece is unique in Table A.IV as the only country with economically meaningful differences in the remaining summary statistics. We proceed to discuss these four exceptions.

Hungary and Singapore appear to be the simplest cases. We examine bond yields and returns across the two datasets. The GFDatabase and Datastream bond yields differ, sometimes substantially, for these two countries. To reconcile the differences, we collect ten-year historical bond yield data from the Magyar Nemzeti Bank (the central bank of Hungary) and the Monetary Authority of Singapore.[12] For Hungary, the correlation in yield changes from the central bank data and our data is 0.997, whereas the correlation between yield changes from the central bank and Datastream is only 0.817. For Singapore, the GFDatabase and Singaporean government data exactly match. The large deviations between Datastream and these other sources primarily occur in the first seven months of the sample, and the reported returns in the database are consistent with changes in yields that are not reflected in the data from the Monetary Authority. Excluding the first seven months, the correlation between returns in our data and Datastream is 0.97. Our data appear reliable for these countries.

The bond yields for Mexico in our data and in Datastream are relatively similar. For several months in the sample, the reported Datastream return seems inconsistent with the reported yield change. For example, the reported yield increases by 0.08% in June 2015, but the reported return is 8.12%. We compare our calculated returns and the reported Datastream returns with the returns on the S&P/BMV Mexico Sovereign Bond Index in these months.[13] The S&P/BMV index tracks bonds with several maturities, and its duration is low compared with the other two series. Nonetheless, the returns from this index are much more consistent with our data versus Datastream. In June 2015, for example, the S&P/BMV index reports a return of −0.15%, which is close to our return calculation of −0.10% but far from the 8.12% reported return in Datastream. Given the consistency between the GFDatabase and the S&P/BMV index, the deviations between our data and Datastream appear to be reporting errors for returns in Datastream.

The largest deviations in bond returns for Greece are related to the Greek bond default in 2012. As discussed in Section 2 of the paper, we calculate a bond return in March 2012 that accounts for the bond exchange and the associated haircut. Our return calculation, which reflects information from ten-year bond yields and the default, is −22.80% in this month, which differs substantially from the −4.16% return reported by Datastream. Our study focuses on domestic debt, so we take the perspective of a hypothetical domestic investor. Participation rates in the exchange were

[12]See https://www.mnb.hu/en/statistics/statistical-data-and-information/statistical-time-series/xi-money-and-capital-marketsandhttps://eservices.mas.gov.sg/statistics/fdanet/BenchmarkPricesAndYields.aspx.

[13]See https://www.spglobal.com/spdji/en/indices/fixed-income/sp-bmv-mexico-sovereign-bond-index/.

higher among domestic investors compared with international investors [Zettelmeyer, Trebesch, and Gulati (2013)]. We do not have information on Datastream's return calculation for this month, but the difference could arise from a different assumption about participation in the exchange. Late in 2012, Greece announced a voluntary bond buyback to be executed in December 2012, and the buyback led to an increase in market prices [Zettelmeyer, Trebesch, and Gulati (2013)]. We observe a 4.32% decrease in bond yield in December 2012 and calculate a return of 26.12%. Datastream reports a 3.21% decrease in bond yield and reports a return of 41.47%, such that the return is much larger than that implied by the yield change. Given that the buyback occurred at prevailing market prices, our view is that any effect of the buyback should be reflected in the change in yields. The return differences for these two months account for much of the difference in average returns for Greece in Table A.IV.

Table A.I
Data sources.

The table summarizes the data series used to compute returns for each developed country in the sample. For each country and asset class (i.e., stocks, bonds, and bills), the table reports the data series used to construct returns, along with the corresponding start and end dates. The data series symbols correspond to those in the GFDatabase from Global Finance Data. For stocks and bills, the table also indicates the data series type. Stock returns are based on either total return indexes (TRI) or combinations of price indexes and dividend yields (PI/DY). Bill returns are based on short-term Treasury yields (TBY), central bank interest rates (CBR), interbank interest rates (IIR), one-year government bond yields (GBY-1), deposit interest rates (DIR), interest rates on advances (IRA), overnight interest rates (OIR), or time money rates (TMR). All bond returns correspond to returns on ten-year government bonds. We provide details on alternative data sources in the footnotes.

	Stocks				Bonds			Bills			
Country	Series	Type	Start	End	Series	Start	End	Series	Type	Start	End
Argentina	_IBGD, SYARGYM	PI/DY	1947:02	1966:12	❸	1947:02	1966:12	IDARGD	CBR	1947:02	1966:12
Australia	_AORDAD	TRI	1901:01	2019:12	IGAUS10D	1901:01	2019:12	❷	TBY	1901:01	1920:06
								IDAUSD	CBR	1920:07	1928:06
								ITAUS3D	TBY	1928:07	2019:12
Austria	_WBKID, SYAUTYM	PI/DY	1925:02	1969:12	IGAUT10D	1925:02	2019:12	IDAUTD	CBR	1925:02	1959:12
	_ATXTRD	TRI	1970:01	2019:12				ITAUT3M	TBY	1960:01	1990:12
								IGAUT1D	GBY-1	1991:01	2019:12
Belgium	_BCSHD	TRI	1897:01	2019:12	IGBEL10D	1897:01	2019:12	IDBELD	CBR	1897:01	1947:12
								ITBEL3D	TBY	1948:01	2019:12
Canada	_TRGSPTSE	TRI	1891:01	2019:12	IGCAN10D	1891:01	2019:12	✚	DIR	1891:01	1901:12
								IMCANMOM	OIR	1902:01	1913:12
								✲	IRA	1914:08	1934:02
								ITCAN3D	TBY	1934:03	2019:12
Chile period I	_IGPAD, SYCHLYM	PI/DY	1927:01	1970:12	❹	1927:01	1929:09	IDCHLD	CBR	1927:01	1970:12
					❺	1929:10	1930:12				
					IGCHLCM	1931:01	1956:02				
					❻	1956:03	1970:12				
Chile period II	_IPSAD	TRI	2010:01	2019:05	IGCHLIM	2010:01	2015:03	ITCHL3D	TBY	2010:01	2012:09
	_IGPAD, SYCHLYM	PI/DY	2019:06	2019:12	❼	2015:04	2019:12	IDCHLD	CBR	2012:10	2019:12
Czechoslovakia	CZINDXM, SYCZEYM	PI/DY	1926:01	1937:11	❹	1926:01	1927:01	IDCZED	CBR	1926:01	1945:05
	CZINDEXM, SYCZEYM	PI/DY	1937:12	1943:03	❺	1927:02	1944:06				
Czechia	_PXTRD	TRI	2000:05	2019:12	IGCZE10D	2000:05	2019:12	ITCZE3D	TBY	2000:05	2017:02
								IDCZED	CBR	2017:03	2019:11
								❼	IIR	2019:12	2019:12

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Table A.I (*continued*)

Country	Stocks Series	Type	Start	End	Bonds Series	Start	End	Bills Series	Type	Start	End
Denmark	_OMXCGID	TRI	1890:01	2019:12	IGDNK10D	1890:01	2019:12	IDDNKD	CBR	1890:01	1975:12
								ITDNK3D	TBY	1976:01	2019:12
Finland	_OMXHGID	TRI	1969:01	2019:12	IGFIN10D	1969:01	2019:12	IDFIND	CBR	1969:01	1996:08
								IGFIN1D	GBY-1	1996:09	2012:01
								ITFIN1D	TBY	2012:02	2013:05
								IGFIN1D	GBY-1	2013:06	2014:07
								IDFIND	CBR	2014:08	2019:12
France	TRSBF250D	TRI	1890:01	2019:12	IGFRA10D	1890:01	2019:12	IDFRAD	CBR	1890:01	1930:12
								ITFRA3D	TBY	1931:01	2019:12
Germany	_CDAXD	TRI	1890:01	2019:12	IGDEU10D	1890:01	2019:12	IDDEUD	CBR	1890:01	1952:12
								ITDEU3D	TBY	1953:01	2019:12
Greece	_RETMD	TRI	1981:02	2019:12	IGGRC10D	1981:02	2014:01	ITGRC3D	TBY	1981:02	2019:12
					❼	2014:02	2014:02				
					IGGRC10D	2014:03	2019:12				
Hungary	_BUXD	TRI	1999:02	2019:12	IGHUN10D	1999:02	2019:12	ITHUN3D	TBY	1999:02	2019:12
Iceland	_OMXIPID, SYISLYM	PI/DY	2002:01	2002:06	❼	2002:01	2004:02	ITISL3D	TBY	2002:01	2013:01
	_OMXIGID	TRI	2002:07	2019:12	IGISL10D	2004:03	2019:12	IDISLD	CBR	2013:02	2019:12
Ireland	_IVRTD	TRI	1936:01	2019:12	IGIRL10D	1936:01	2019:12	IDIRLD	CBR	1936:01	1969:11
								ITIRL3M	TBY	1969:12	2008:12
								❼	IIR	2009:01	2019:12
Israel	TRISRSTM	TRI	2010:01	2019:11	❼	2010:01	2014:12	ITISR3D	TBY	2010:01	2019:12
	ILTLVGD, SYISRYM	PI/DY	2019:12	2019:12	IGISR10IM	2015:01	2019:12				
Italy	_BCIPRD	TRI	1931:01	2019:12	IGITA10D	1931:01	2019:12	IDITAD	CBR	1931:01	1939:12
								ITITA3D	TBY	1940:01	2019:12
Japan	_TOPXDVD	TRI	1930:01	2019:12	IGJPN10D	1930:01	2019:12	IDJPND	CBR	1930:01	1959:12
								ITJPN3D	TBY	1960:01	2019:12
Latvia	_OMXRGID	TRI	2016:01	2019:12	❼	2016:01	2019:12	❼	IIR	2016:01	2019:12
Lithuania	_OMXVGID	TRI	2018:01	2019:12	IGLTU10D	2018:01	2019:12	❼	IIR	2018:01	2019:12
Luxembourg	_LUXXD, SYLUXYM	PI/DY	1982:01	1984:12	IGLUX10D	1982:01	2019:12	IMLUXM	OIR	1982:01	1998:12
	_LUXXRD	TRI	1985:01	2016:11				❼	IIR	1999:01	2019:12
	❶	TRI	2016:12	2019:12							
Mexico	_IRTD	TRI	2001:08	2019:12	IGMEX10D	2001:08	2019:12	ITMEX3D	TBY	2001:08	2019:12

(*continued on next page*)

Table A.I (*continued*)

Country	Stocks Series	Stocks Type	Stocks Start	Stocks End	Bonds Series	Bonds Start	Bonds End	Bills Series	Bills Type	Bills Start	Bills End
Netherlands	_AAXGRD	TRI	1914:01	2019:12	IGNLD10D	1914:01	1944:08	IDNLDBD	CBR	1914:01	1940:12
					❷	1944:09	1945:12	ITNLD3D	TBY	1941:01	2019:12
					IGNLD10D	1946:01	2019:12				
New Zealand	_NZGID	TRI	1896:01	2019:12	IGNZL10D	1896:01	2019:12	■	TBY	1896:01	1919:12
								■	DIR	1920:01	1922:12
								IDNZLD	CBR	1923:01	1978:02
								ITNZL3D	TBY	1978:03	2019:12
Norway	_OBXPD, ❷	PI/DY	1914:02	1969:12	IGNOR10D	1914:02	2019:12	IDNORD	CBR	1914:02	1941:11
	_OSEAXD	TRI	1970:01	2019:12				ITNOR3D	TBY	1941:12	2019:12
Poland	_WIGD	TRI	1999:06	2019:12	IGPOL10D	1999:06	2019:12	ITPOL3D	TBY	1999:06	2019:12
Portugal	_IBTAD, ❷	PI/DY	1934:01	1988:01	IGPRT10D	1934:01	1974:04	IDPRTD	CBR	1934:01	1988:12
	_BVLGD	TRI	1988:02	2019:12	❷	1974:05	1975:12	ITPRT6D	TBY	1989:01	1999:01
					IGPRT10D	1976:01	2019:12	IDPRTD	CBR	1999:02	2001:12
								❷	TBY	2002:01	2010:09
								ITPRT6D	TBY	2010:10	2019:12
Singapore	_TFTFSTD	TRI	1998:07	2019:12	IGSGP10D	1998:07	2019:12	ITSGP3D	TBY	1998:07	2019:12
Slovakia	_SAXD	TRI	2000:01	2019:12	IGSVK10D	2000:01	2019:12	IDSVKD	CBR	2000:01	2008:12
								❼	IIR	2009:01	2019:12
Slovenia	_SBITOPD, SYSVNYM	PI/DY	2010:01	2019:12	IGSVN10D	2010:01	2018:11	ITSVN3M	TBY	2010:01	2019:12
					❽	2018:12	2019:12				
South Korea	TRKORSTM	TRI	2000:11	2019:12	IGKOR10D	2000:11	2019:12	IGKOR1D	GBY-1	2000:11	2019:12
Spain	_BCNPR30	TRI	1959:01	2019:12	IGESP10D	1959:01	2019:12	IDESPD	CBR	1959:01	1978:12
								ITESP12D	TBY	1979:01	2019:12
Sweden	_OMXSBGI	TRI	1910:01	2019:12	IGSWE10D	1910:01	2018:12	IDSWED	CBR	1910:01	1954:12
					❼	2018:12	2019:12	ITSWE3D	TBY	1955:01	2019:12
					IGSWE10D	2019:02	2019:12				
Switzerland	_SSHID	TRI	1914:01	2019:12	IGCHE10D	1914:01	1941:12	IDCHED	CBR	1914:01	1979:12
					❾	1942:01	1942:01	ITCHE3D	TBY	1980:01	2019:12
					IGCHE10D	1942:02	2019:12				
Turkey	TRRBILED	TRI	2010:02	2019:12	IGTUR10D	2010:02	2019:10	ITTUR3D	TBY	2010:02	2014:09
					❿	2019:11	2019:11	IGTUR1D	GBY-1	2014:10	2019:12
					IGTUR10D	2019:12	2019:12				
United Kingdom	_TFTASD	TRI	1890:01	2019:12	IGGBR10D	1890:01	2019:12	IDGBRD	CBR	1890:01	1899:12
								ITGBR3D	TBY	1900:01	2019:12

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Table A.I (*continued*)

	Stocks				Bonds			Bills			
Country	Series	Type	Start	End	Series	Start	End	Series	Type	Start	End
United States	_SPXTRD	TRI	1890:01	2019:12	IGUSA10D	1890:01	2019:12	▲	TMR	1890:01	1914:10
								IDUSAD	CBR	1914:11	1919:12
								ITUSA3CMD	TBY	1920:01	2019:12

Footnotes:

❶ Stock returns for Luxembourg for the period from 2016:12 to 2019:12 are from the Luxembourg Stock Exchange. See https://www.bourse.lu/home.

❷ Dividend yields, bond returns, and bill returns for several countries are from Jordà, Knoll, Kuvshinov, Schularick, and Taylor (2019).

❸ Bond returns for Argentina for the period from 1947:02 to 1966:12 are based on data from the Central Bank of Argentina. See http://www.bcra.gov.ar/PublicacionesEstadisticas/Boletin_estadistico.asp.

❹ Bond returns for select periods in Chile and Czechoslovakia are based on London quotes from the International Center for Finance at Yale. See https://som.yale.edu/faculty-research/our-centers-initiatives/international-center-finance/data/historical-financial-research-data/london-stock-exchange.

❺ Bond returns for select periods in Chile and Czechoslovakia are based on London quotes from the League of Nations reports.

❻ Bond returns for Chile for the period from 1956:03 to 1970:12 are based on data from the Central Bank of Chile. See https://repositoriodigital.bcentral.cl/xmlui/handle/20.500.12580/26/browse?type=dateissued.

❼ Bond and bill returns for several countries are based on data from Federal Reserve Economic Data (FRED) at the Federal Reserve Bank of St. Louis. See https://fred.stlouisfed.org/.

❽ Bond returns for Slovenia for the period from 2018:12 to 2019:12 are based on data from http://www.worldgovernmentbonds.com/bond-historical-data/slovenia/10-years/.

❾ The bond return in Switzerland for 1942:01 is based on data from the Swiss National Bank (https://www.snb.ch/de/iabout/stat/statrep/statpubdis/id/statpub_histz_arch#t2). We also shift a portion of the series IGCHE10D from GFD, which originally covers the period from 1942:01 to 1990:11, to cover the period from 1942:02 to 1990:12.

❿ The bond return in Turkey for 2019:11 is based on data from http://www.worldgovernmentbonds.com/bond-historical-data/turkey/10-years/.

✚ Bill returns for Canada for the period from 1891:01 to 1901:12 are based on interest rates on deposits in government savings banks. See p. 363 of https://www66.statcan.gc.ca/eng/1901-eng.htm.

✲ Bill returns for Canada for the period from 1914:08 to 1934:02 are based on data from Shearer and Clark (1984).

■ Bill returns for New Zealand for the period from 1896:01 to 1922:12 are based on data from the annual New Zealand Official Year-book. See, for example, https://www3.stats.govt.nz/New_Zealand_Official_Yearbooks/1896/NZOYB_1896.html.

▲ Bill returns for the United States for the period from 1890:01 to 1914:10 are based on data from Macaulay (1938).

Table A.II

Multi-month stock returns.

The table reports periods of multi-month stock returns associated with exchange closures and details our approach to converting each return to a series of monthly returns. For each multi-month return observation, the table reports the number of months, the start and end dates of the period, the nominal and real stock market returns earned over the period, and the adjustment method. For adjustment method 1, we use alternative data sources from GFD (e.g., black market trading data) to fill in a complete series of monthly returns. For adjustment method 2, we assign the full multi-month real return to the first month of the period and assign zero real returns to the remaining months. The cases marked with a ✚ are discussed in Section A.1. Panels A and B show events corresponding to World War I and World War II, respectively, Panel C shows periods with revolutions, Panel D shows financial and banking crises, and Panel E shows labor strikes.

Country	Months	Start date	End date	Nominal return (%)	Real return (%)	Adjustment
Panel A: World War I						
Australia	6	1914:08	1915:01	−0.45	−0.39	Method 1
Belgium	52	1914:08	1918:11	25.12	−55.91	Method 2
Canada	7	1914:08	1915:02	1.38	−3.59	Method 1
Denmark	4	1914:08	1914:11	−2.42	−3.37	Method 2
France	6	1914:08	1915:01	−3.68	−21.68	Method 2
Germany	42	1914:08	1918:01	20.03	−38.87	Method 1
Netherlands	7	1914:08	1915:02	−1.23	−3.50	Method 1
Norway	3	1914:08	1914:10	−3.26	−3.81	Method 2
Sweden	4	1914:08	1914:11	−5.91	−8.96	Method 2
Switzerland	24	1914:08	1916:07	0.17	−18.71	✚
United Kingdom	6	1914:08	1915:01	−0.26	−3.30	Method 1
United States	5	1914:08	1914:12	−2.14	−3.11	Method 1
Panel B: World War II						
Austria	2	1938:04	1938:05	6.34	5.62	Method 2
Austria	113	1939:07	1948:11	300.73	−19.66	Method 2
Belgium	5	1940:06	1940:10	22.38	12.54	Method 2
Belgium	11	1944:08	1945:06	−0.29	−17.08	Method 2
Czechoslovakia	16	1938:10	1940:01	31.95	16.66	Method 2
Czechoslovakia	4	1942:01	1942:04	20.59	12.25	Method 2
Denmark	2	1940:05	1940:06	−7.64	−10.67	Method 2
France	2	1939:09	1939:10	−2.96	0.53	Method 1
France	10	1940:06	1941:03	94.57	75.61	Method 2
Germany	67	1943:01	1948:07	−87.62	−91.10	Method 2
Japan	45	1945:09	1949:05	449.38	−87.15	Method 1
Netherlands	5	1940:05	1940:09	20.63	15.21	Method 2
Netherlands	21	1944:09	1946:05	−14.33	−33.15	Method 2
Norway	2	1940:04	1940:05	−16.75	−17.98	Method 2
Switzerland	2	1940:06	1940:07	−3.57	−5.11	Method 1
Panel C: Revolution						
Czechoslovakia	26	1943:04	1945:05	−90.00	−88.95	✚
Portugal	35	1974:05	1977:03	−80.39	−89.24	Method 2

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Table A.II (*continued*)

Country	Months	Start date	End date	Nominal return (%)	Real return (%)	Adjustment
Panel D: Financial or banking crisis						
Austria	2	1931:10	1931:11	6.86	6.20	Method 2
Germany	2	1931:08	1931:09	−24.58	−23.01	Method 2
Germany	7	1931:10	1932:04	−8.22	1.78	Method 2
Greece	2	2015:07	2015:08	−21.53	−20.13	Method 2
Panel E: Labor strike						
France	2	1974:04	1974:05	−6.17	−8.76	Method 2
France	2	1979:03	1979:04	12.79	10.69	Method 2

Table A.III

Bond return smoothing.

The table summarizes periods over which we are missing bond yield data. In each case, we use the country-level yield data from before and after the missing observations to produce a series of constant monthly returns across the period noted in the table. For each period with missing bond data, the table reports the country, the number of missing observations, and the start and end dates of the period.

Country	Months	Start date	End date
Argentina	4	1948:08	1948:11
	11	1949:01	1949:11
	11	1950:01	1950:11
	11	1951:01	1951:11
	11	1952:01	1952:11
	11	1953:01	1953:11
	11	1954:01	1954:11
	24	1955:01	1956:12
	1	1958:02	1958:02
	1	1958:08	1958:08
	1	1959:05	1959:05
	1	1959:08	1959:08
Belgium	3	1940:05	1940:07
Czechia	15	1938:10	1939:12
Finland	1	1991:06	1991:06
Germany	8	1931:08	1932:03
	25	1943:12	1945:12
Greece	44	1989:01	1992:08
Netherlands	2	1940:05	1940:06
	3	1944:09	1944:11
	11	1945:01	1945:11
Portugal	7	1974:05	1974:11
	11	1975:01	1975:11
	1	2014:02	2014:02
Switzerland	5	1914:08	1914:12

Table A.IV

External validation test results.

The table reports summary statistics for monthly bond returns for each developed country with a return sample that overlaps with the sample from Datastream. For each country, the table shows the number of sample months. The table also shows the following summary statistics for our sample and for the Datastream sample: the arithmetic average return ($\bar{R}_a$), the geometric average return ($\bar{R}_g$), the standard deviation of return (SD), the minimum (Min) and the maximum (Max) return, and the correlation between the return samples (Corr). Statistics for the pooled sample of all observations are also reported. Panel A (Panel B) shows results for nominal returns (real returns).

		Summary statistics for returns										
		Global Financial Data					Datastream					
Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Min (%)	Max (%)	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Min (%)	Max (%)	Corr
Panel A: Nominal returns												
Australia	372	0.73	0.71	2.08	−5.52	7.42	0.75	0.73	2.06	−5.34	7.93	0.96
Austria	372	0.51	0.50	1.59	−5.05	5.66	0.55	0.54	1.45	−3.47	5.21	0.95
Belgium	366	0.57	0.55	1.77	−5.92	7.51	0.62	0.61	1.73	−5.41	8.38	0.98
Canada	372	0.58	0.57	1.86	−6.33	6.01	0.60	0.59	1.84	−5.20	6.32	0.96
Czechia	236	0.27	0.25	2.16	−8.47	6.80	0.34	0.32	2.04	−8.49	7.41	0.94
Denmark	371	0.59	0.57	1.93	−5.56	6.76	0.60	0.59	1.80	−4.95	6.19	0.98
Finland	340	0.61	0.59	1.99	−5.93	8.75	0.64	0.62	1.79	−7.35	8.17	0.96
France	372	0.56	0.54	1.73	−3.97	5.59	0.59	0.58	1.64	−4.39	4.73	0.96
Germany	372	0.50	0.49	1.65	−6.23	5.39	0.52	0.51	1.55	−5.99	5.04	0.96
Greece	249	0.57	0.38	6.08	−31.06	26.12	0.81	0.53	7.41	−41.54	41.47	0.93
Hungary	251	0.78	0.73	3.28	−9.47	13.20	0.76	0.72	3.09	−15.97	12.84	0.83
Ireland	372	0.64	0.60	2.52	−14.96	15.57	0.64	0.61	2.35	−14.34	14.66	0.97
Italy	345	0.73	0.70	2.41	−7.67	10.36	0.75	0.73	2.24	−10.93	8.93	0.94
Japan	372	0.30	0.28	1.48	−8.13	5.67	0.33	0.32	1.34	−6.53	5.67	0.95
Mexico	114	0.55	0.52	2.26	−6.58	5.74	0.62	0.59	2.20	−6.50	8.12	0.85
Netherlands	372	0.51	0.49	1.66	−4.04	6.33	0.54	0.53	1.57	−3.59	5.09	0.97
New Zealand	345	0.68	0.66	1.95	−5.96	7.11	0.70	0.68	1.83	−5.81	6.76	0.95
Norway	325	0.57	0.55	1.86	−5.75	5.97	0.57	0.55	1.73	−6.40	5.71	0.97
Poland	228	0.74	0.71	2.27	−7.01	9.80	0.72	0.70	2.22	−6.10	11.17	0.91
Portugal	317	0.72	0.67	3.12	−12.81	15.07	0.77	0.72	3.12	−14.43	20.23	0.95
Singapore	132	0.21	0.19	1.66	−5.96	4.13	0.41	0.40	1.78	−4.07	12.08	0.81
South Korea	93	0.42	0.41	1.35	−4.04	4.37	0.43	0.42	1.25	−3.27	4.14	0.97
Spain	349	0.72	0.69	2.30	−9.43	9.62	0.77	0.74	2.17	−9.27	9.79	0.95

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Table A.IV (*continued*)

		Summary statistics for returns										
		Global Financial Data					Datastream					
Country	SMonths	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Min (%)	Max (%)	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Min (%)	Max (%)	Corr
Panel A: Nominal returns (continued)												
Sweden	372	0.65	0.62	2.10	−5.60	6.51	0.68	0.66	1.90	−5.63	5.99	0.97
Switzerland	372	0.35	0.34	1.49	−4.19	5.63	0.39	0.38	1.39	−3.82	5.30	0.92
United Kingdom	372	0.63	0.61	2.03	−5.38	7.26	0.64	0.62	1.92	−4.45	7.45	0.97
United States	372	0.54	0.52	2.09	−7.24	9.57	0.52	0.50	2.04	−5.88	9.55	0.98
Full sample	8,525	0.58	0.55	2.28	−31.06	26.12	0.61	0.59	2.31	−41.54	41.47	0.94
Panel B: Real returns												
Australia	372	0.51	0.49	2.09	−5.63	6.80	0.53	0.51	2.07	−5.57	7.84	0.96
Austria	372	0.34	0.32	1.65	−5.14	5.99	0.38	0.37	1.51	−3.65	4.99	0.96
Belgium	366	0.40	0.39	1.81	−6.06	7.47	0.46	0.44	1.78	−5.56	8.33	0.98
Canada	372	0.42	0.40	1.90	−6.24	6.47	0.43	0.42	1.88	−6.11	6.36	0.96
Czechia	236	0.27	0.25	2.16	−8.47	6.80	0.34	0.32	2.04	−8.49	7.41	0.94
Denmark	371	0.44	0.42	1.98	−6.00	6.40	0.45	0.44	1.86	−5.40	5.83	0.98
Finland	340	0.49	0.47	2.04	−6.13	8.59	0.52	0.50	1.84	−7.55	8.01	0.96
France	372	0.43	0.41	1.79	−4.44	5.86	0.46	0.45	1.69	−4.62	5.19	0.97
Germany	372	0.35	0.34	1.72	−6.62	5.31	0.37	0.36	1.62	−6.39	4.94	0.96
Greece	249	0.43	0.23	6.27	−30.84	26.45	0.67	0.37	7.55	−41.35	41.84	0.94
Hungary	251	0.46	0.40	3.31	−9.83	12.42	0.44	0.39	3.12	−16.31	12.81	0.83
Ireland	372	0.47	0.44	2.58	−14.79	15.45	0.47	0.44	2.41	−14.16	14.54	0.97
Italy	345	0.54	0.52	2.41	−8.03	10.26	0.57	0.54	2.24	−11.27	8.62	0.94
Japan	372	0.25	0.24	1.50	−7.77	5.29	0.28	0.28	1.37	−6.16	5.19	0.95
Mexico	114	0.22	0.19	2.33	−7.18	5.22	0.29	0.26	2.28	−7.18	7.95	0.86
Netherlands	372	0.34	0.32	1.72	−3.95	6.71	0.38	0.36	1.63	−3.97	5.21	0.97
New Zealand	345	0.52	0.50	1.96	−6.05	7.28	0.54	0.52	1.84	−6.19	6.93	0.95
Norway	325	0.40	0.38	1.89	−6.24	6.01	0.39	0.38	1.77	−6.48	5.50	0.97
Poland	228	0.56	0.54	2.33	−7.59	9.71	0.55	0.52	2.28	−6.24	10.73	0.92
Portugal	317	0.54	0.59	3.19	−13.23	14.98	0.59	0.54	3.19	−14.84	20.14	0.95
Singapore	132	0.09	0.07	1.72	−6.13	4.94	0.29	0.27	1.79	−4.24	11.07	0.82
South Korea	93	0.33	0.32	1.42	−3.90	4.57	0.34	0.33	1.32	−3.13	4.33	0.97

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Table A.IV (*continued*)

		Summary statistics for returns										
		Global Financial Data					Datastream					
Country	SMonths	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Min (%)	Max (%)	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Min (%)	Max (%)	Corr
Panel B: Real returns (continued)												
Spain	349	0.51	0.48	2.41	−9.92	9.47	0.56	0.54	2.49	−9.76	9.65	0.95
Sweden	372	0.48	0.45	2.19	−5.77	6.77	0.51	0.49	2.00	−5.83	5.62	0.98
Switzerland	372	0.26	0.24	1.57	−4.28	5.70	0.29	0.28	1.46	−4.33	5.06	0.93
United Kingdom	372	0.37	0.35	2.11	−5.98	8.23	0.38	0.36	1.99	−6.14	7.03	0.97
United States	372	0.34	0.32	2.16	−7.34	11.71	0.32	0.29	2.13	−6.24	11.69	0.98
Full sample	8,525	0.41	0.38	2.34	−30.84	26.45	0.44	0.41	2.36	−41.35	41.84	0.94

B Additional results appendix

This appendix presents supplementary empirical results.

B.1 Nominal payoffs

Our primary analysis in the paper is based on real payoffs for domestic stocks, international stocks, bonds, and bills. We choose to focus on real payoffs rather than nominal payoffs because nominal payoffs during periods of extreme inflation are often a poor reflection of true economic outcomes. For completeness, we present results based on nominal payoffs in this section. Table B.I shows summary statistics for each country's nominal returns for domestic stocks, international stocks, bonds, and bills. Table B.II summarizes the marginal bootstrap distribution of nominal payoffs for each of these four asset classes at various investment horizons.

B.2 Real cash and real currency basket payoffs

The results in the paper are based on the real returns and real payoffs for domestic stocks, international stocks, bonds, and bills. To highlight the impacts of inflation and currency appreciation on these analyses, this section presents results for real cash returns and real currency basket returns. The real returns for these assets are defined in Section 2.1.5.

Table B.III reports summary statistics for real cash returns and real currency basket returns in each sample country. Table B.IV summarizes the bootstrap distributions of real payoffs from buy-and-hold investments in cash (Panel A) and the currency basket (Panel B) at various investment horizons.

B.3 Impact of mean block length parameter

We construct bootstrap joint distributions of payoffs for domestic stocks, international stocks, bonds, and bills by resampling with replacement from the sample of returns in developed markets. We use a stationary block bootstrap approach, and our base case design draws blocks of consecutive returns, where the length of each block has a geometric distribution with a mean of 120 months. In this section, we consider the impact of using alternative values for the mean block length parameter in the bootstrap procedure. We present results for mean block lengths of one (i.e., i.i.d. resampling), 12, 120 (base case), and 240 months.

Table B.V shows estimated loss probabilities at various return horizons for each value of the block length parameter. The most pronounced differences in loss probabilities across block lengths are seen for real bill payoffs in Panel D. In particular, the loss probabilities for longer-horizon bill payoffs tend to decrease with increases in the block length parameter. The general conclusion, however, is that the choice of block length has a minor impact on the results.

B.4 Alternative construction of international stock portfolio

As described in Section 2.1.2, we construct the international stock portfolio for a given country as the weighted investment across all developed stock markets excluding the local stock market. The international stock portfolio is value weighted by total market capitalization, and we place no restriction on the maximum weight in a given foreign market. For robustness, we consider an alternative construction method for the international stock portfolio, in which we cap the weight on any individual country at 25%.

We summarize the bootstrap distributions of real payoffs using this constrained version of the international stock portfolio in Table B.VI. These results can be compared with those using the unconstrained version of the international stock portfolio in Panel B of Table III. The constrained version of the market portfolio leads to slightly lower payoff standard deviations and slightly lower loss probabilities, likely owing to greater diversification benefits to capping individual country weights at 25%. The differences in the two marginal distributions for international stocks, however, are modest, suggesting that our base case construction of the international stock portfolio is robust to reasonable alternative construction methods.

Table B.I

Summary statistics for nominal returns.

The table reports summary statistics for monthly nominal returns for each developed country and for the pooled sample of all observations. For each country, the table shows the number of sample months, the arithmetic average return ($\bar{R}_a$), the geometric average return ($\bar{R}_g$), the standard deviation of return (SD), return skewness (Skew), return kurtosis (Kurt), and the minimum (Min) and the maximum (Max) return. Panels A, B, C, and D show results for domestic stocks, international stocks, bonds, and bills, respectively.

		Summary statistics for returns						
Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
Panel A: Nominal domestic stock returns								
Argentina	239	2.11	1.79	8.12	0.44	9.68	−41.47	45.64
Australia	1,428	0.97	0.89	3.88	−0.88	16.20	−42.13	22.14
Austria	1,139	0.93	0.66	10.26	21.97	642.06	−32.56	300.73
Belgium	1,476	0.73	0.62	4.82	0.24	7.85	−31.22	26.38
Canada	1,548	0.80	0.71	4.23	−0.58	7.47	−28.07	22.87
Chile period I	528	1.83	1.63	6.38	0.69	8.36	−31.00	38.27
Chile period II	120	0.31	0.22	4.08	0.16	3.08	−10.46	11.28
Czechia	236	1.29	1.04	7.07	0.00	5.41	−29.44	30.08
Czechoslovakia	233	0.45	−0.23	7.20	−8.04	110.10	−90.00	31.95
Denmark	1,560	0.67	0.61	3.48	0.06	6.83	−18.47	18.80
Finland	612	1.34	1.15	6.31	0.20	6.41	−26.88	32.61
France	1,560	0.95	0.81	5.51	3.28	56.95	−21.82	94.57
Germany	1,560	0.81	0.45	8.25	3.47	77.43	−87.62	128.82
Greece	467	1.56	1.06	10.41	1.64	11.13	−27.83	68.46
Hungary	251	0.99	0.78	6.47	−0.34	4.49	−28.42	18.54
Iceland	216	0.72	0.29	7.61	−4.52	41.48	−71.52	18.08
Ireland	1,008	0.98	0.87	4.67	−0.22	7.84	−27.24	28.81
Israel	120	0.02	−0.10	4.73	−0.21	3.38	−14.24	12.78
Italy	1,068	1.18	0.91	7.61	1.69	13.02	−26.44	59.87
Japan	1,080	1.11	0.92	6.31	1.82	20.19	−30.24	67.39
Latvia	48	1.22	1.16	3.56	1.13	5.60	−5.38	13.95
Lithuania	24	0.39	0.36	2.62	−0.04	3.01	−5.55	5.03
Luxembourg	456	0.93	0.78	5.47	−0.72	6.47	−26.81	18.11
Mexico	221	1.14	1.03	4.77	−0.46	3.97	−17.81	13.29
Netherlands	1,272	0.80	0.67	5.05	0.45	13.69	−23.24	52.45
New Zealand	1,488	0.86	0.80	3.63	0.02	10.16	−28.29	25.00
Norway	1,271	0.85	0.72	5.07	−0.20	6.87	−27.42	26.10
Poland	247	0.71	0.53	5.99	−0.06	4.39	−24.01	20.73
Portugal	1,032	0.97	0.65	7.85	2.68	49.68	−80.39	87.83
Singapore	258	0.82	0.65	5.87	−0.18	6.92	−25.69	25.47
Slovakia	240	0.77	0.63	5.29	1.40	10.91	−18.54	33.75
Slovenia	120	0.41	0.33	3.97	0.42	5.16	−9.85	17.45
South Korea	230	1.08	0.90	6.17	0.24	4.85	−20.98	26.71
Spain	732	0.99	0.84	5.44	−0.02	5.08	−25.27	26.95
Sweden	1,320	0.89	0.78	4.76	−0.15	6.24	−27.11	27.58
Switzerland	1,272	0.66	0.57	4.26	0.02	8.81	−24.62	33.78
Turkey	119	1.03	0.83	6.38	0.01	2.17	−13.40	14.03
United Kingdom	1,560	0.75	0.66	4.24	0.92	21.97	−26.51	54.10
United States	1,560	0.87	0.75	4.95	0.31	13.11	−29.63	42.89
Full sample	29,919	0.91	0.75	5.83	5.69	269.21	−90.00	300.73

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Table B.I (*continued*)

Country	Months	Summary statistics for returns $\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
Panel B: Nominal international stock returns								
Argentina	239	3.25	2.62	15.03	8.87	89.78	−13.90	159.60
Australia	1,428	0.81	0.74	3.75	0.69	10.01	−13.48	32.38
Austria	1,139	1.33	0.96	12.55	17.64	371.31	−23.89	299.72
Belgium	1,476	0.89	0.79	4.49	0.49	13.76	−24.14	43.70
Canada	1,548	0.71	0.65	3.42	−0.12	6.33	−14.92	19.35
Chile period I	528	2.42	2.13	8.35	4.40	44.18	−23.88	95.97
Chile period II	120	1.10	1.04	3.51	−0.21	3.01	−8.36	11.42
Czechia	236	0.27	0.18	4.17	−0.77	4.19	−13.62	9.96
Czechoslovakia	233	0.63	0.47	5.51	−0.54	9.19	−27.19	23.32
Denmark	1,560	0.74	0.67	3.87	0.13	9.53	−20.26	31.50
Finland	612	0.87	0.78	4.29	−0.25	5.01	−18.85	21.08
France	1,560	1.11	0.94	6.54	7.92	129.04	−25.37	125.16
Germany	1,560	1.00	0.75	10.44	22.59	609.06	−24.01	305.18
Greece	467	1.26	1.16	4.64	−0.02	5.66	−18.79	22.79
Hungary	251	0.67	0.58	4.10	−0.33	3.48	−12.15	11.85
Iceland	216	0.78	0.67	4.83	−0.17	4.54	−14.87	17.30
Ireland	1,008	0.96	0.88	4.00	0.03	7.58	−19.47	31.09
Israel	120	0.68	0.63	3.12	−0.15	2.77	−6.52	7.61
Italy	1,068	1.56	1.18	13.94	23.99	683.91	−22.84	408.16
Japan	1,080	1.70	1.12	17.35	18.57	399.36	−27.03	423.92
Latvia	48	0.85	0.80	2.99	−0.76	4.02	−7.94	7.84
Lithuania	24	0.86	0.80	3.59	−0.76	3.38	−7.94	7.84
Luxembourg	456	0.87	0.78	4.44	−0.52	4.50	−19.96	16.78
Mexico	221	0.94	0.88	3.51	−0.37	3.58	−10.23	9.57
Netherlands	1,272	0.77	0.68	4.32	0.49	13.52	−23.73	41.53
New Zealand	1,488	0.81	0.74	4.07	2.42	37.90	−19.90	60.16
Norway	1,271	0.85	0.76	4.13	0.08	7.04	−16.99	31.42
Poland	247	0.51	0.45	3.64	−0.57	3.58	−10.93	9.56
Portugal	1,032	1.05	0.98	3.92	−0.24	5.05	−17.84	19.47
Singapore	258	0.47	0.39	3.92	−0.86	4.86	−17.82	9.87
Slovakia	240	0.29	0.21	4.04	−0.63	4.08	−14.82	12.55
Slovenia	120	0.95	0.91	3.05	−0.46	3.97	−8.05	9.42
South Korea	230	0.53	0.46	3.70	−0.74	4.59	−15.98	9.04
Spain	732	0.98	0.89	4.23	−0.23	5.15	−20.26	20.82
Sweden	1,320	0.83	0.75	4.04	0.33	9.74	−19.50	31.56
Switzerland	1,272	0.66	0.56	4.41	0.03	10.88	−24.64	40.94
Turkey	119	2.04	1.92	5.11	1.63	14.25	−15.28	33.37
United Kingdom	1,560	0.81	0.73	4.04	0.49	12.51	−19.61	40.76
United States	1,560	0.63	0.56	3.74	−0.45	7.00	−22.48	17.71
Full sample	29,919	0.96	0.81	6.88	27.41	1,347.23	−27.19	423.92

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Table B.I (*continued*)

Country	Months	Summary statistics for returns $\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
Panel C: Nominal bond returns								
Argentina	239	0.27	0.27	0.91	1.74	28.89	−5.58	6.78
Australia	1,428	0.49	0.48	1.59	0.23	11.01	−10.41	11.69
Austria	1,139	0.57	0.55	2.17	−2.96	51.86	−29.81	18.40
Belgium	1,476	0.45	0.44	1.29	0.04	7.91	−6.25	7.51
Canada	1,548	0.43	0.42	1.50	0.37	14.31	−11.51	13.54
Chile period I	528	0.59	0.56	2.45	−1.07	54.52	−23.11	24.37
Chile period II	120	0.40	0.39	1.32	−0.80	9.11	−6.00	4.84
Czechia	236	0.45	0.43	2.09	−0.04	4.36	−8.08	6.69
Czechoslovakia	233	0.53	0.52	0.97	2.74	24.62	−3.53	8.30
Denmark	1,560	0.53	0.51	1.70	0.84	12.45	−8.88	15.23
Finland	612	0.70	0.68	2.11	−0.32	6.22	−10.33	9.77
France	1,560	0.46	0.45	1.41	0.17	9.38	−9.45	9.69
Germany	1,560	1.59	0.07	46.28	36.08	1,374.67	−89.96	1,771.67
Greece	467	1.12	0.97	5.46	−0.12	10.13	−31.06	26.12
Hungary	251	0.78	0.73	3.28	−0.06	3.87	−9.47	13.20
Iceland	216	0.77	0.71	3.21	−1.45	17.57	−22.40	15.62
Ireland	1,008	0.64	0.61	2.33	−0.00	10.83	−15.47	15.57
Israel	120	0.56	0.55	1.50	−0.27	5.92	−5.44	6.40
Italy	1,068	0.63	0.61	1.83	0.40	7.66	−7.67	10.36
Japan	1,080	0.47	0.45	2.17	−2.66	49.41	−27.11	19.95
Latvia	48	0.24	0.24	1.21	−0.93	4.27	−3.55	2.20
Lithuania	24	0.35	0.34	1.12	0.63	3.87	−1.67	3.48
Luxembourg	456	0.60	0.58	1.68	−0.23	6.63	−9.15	7.13
Mexico	221	0.77	0.74	2.53	−0.13	3.76	−6.58	8.75
Netherlands	1,272	0.44	0.43	1.44	0.47	10.46	−8.15	11.35
New Zealand	1,488	0.47	0.45	1.70	−0.32	59.07	−23.42	23.15
Norway	1,271	0.49	0.47	1.49	−0.95	11.98	−11.09	8.60
Poland	247	0.68	0.65	2.40	0.19	4.66	−7.01	9.80
Portugal	1,032	0.61	0.58	2.47	1.00	12.91	−12.81	18.72
Singapore	258	0.36	0.34	1.93	−0.58	5.95	−8.69	7.54
Slovakia	240	0.79	0.75	3.04	5.12	49.20	−6.66	31.68
Slovenia	120	0.54	0.50	2.87	−0.34	5.15	−9.75	9.37
South Korea	230	0.58	0.56	1.88	0.63	7.19	−4.48	11.21
Spain	732	0.72	0.70	2.03	0.28	6.08	−9.43	9.62
Sweden	1,320	0.48	0.47	1.46	0.08	7.43	−5.99	8.25
Switzerland	1,272	0.35	0.34	1.18	0.14	5.58	−4.37	7.29
Turkey	119	0.90	0.78	4.89	0.16	4.44	−14.34	17.47
United Kingdom	1,560	0.46	0.45	1.72	1.29	12.44	−8.11	13.82
United States	1,560	0.38	0.37	1.58	0.78	9.90	−7.92	12.32
Full sample	29,919	0.58	0.48	10.74	150.82	24,771.96	−89.96	1,771.67

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Table B.I (*continued*)

Country	Months	Summary statistics for returns $\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
		Panel D: Nominal bill returns						
Argentina	239	0.38	0.38	0.10	0.19	1.04	0.29	0.49
Australia	1,428	0.38	0.38	0.28	1.44	5.12	0.06	1.49
Austria	1,139	0.39	0.39	0.20	−0.09	2.93	−0.06	1.02
Belgium	1,476	0.37	0.37	0.22	0.63	3.59	−0.08	1.10
Canada	1,548	0.35	0.35	0.25	1.25	5.44	0.01	1.59
Chile period I	528	0.63	0.63	0.39	1.09	2.43	0.33	1.53
Chile period II	120	0.28	0.28	0.10	−0.27	2.84	0.04	0.45
Czechia	236	0.14	0.31	0.13	0.80	2.66	−0.04	0.44
Czechoslovakia	233	0.32	0.32	0.08	0.94	2.73	0.25	0.53
Denmark	1,560	0.47	0.47	0.32	1.43	5.22	−0.09	1.58
Finland	612	0.42	0.42	0.27	−0.30	1.63	−0.02	0.76
France	1,560	0.35	0.35	0.26	1.22	4.43	−0.08	1.45
Germany	1,560	0.36	0.36	0.29	10.72	185.51	−0.08	5.49
Greece	467	0.77	0.77	0.53	0.68	4.48	0.08	3.90
Hungary	251	0.50	0.50	0.33	−0.06	2.04	−0.00	1.22
Iceland	216	0.58	0.58	0.29	1.24	3.39	0.23	1.46
Ireland	1,008	0.44	0.44	0.33	1.20	5.67	−0.03	2.84
Israel	120	0.08	0.08	0.08	0.77	2.27	−0.06	0.27
Italy	1,068	0.48	0.48	0.38	1.03	3.24	−0.06	1.68
Japan	1,080	0.30	0.30	0.20	−0.36	1.82	−0.03	0.67
Latvia	48	−0.03	−0.03	0.00	1.33	6.43	−0.03	−0.01
Lithuania	24	−0.03	−0.03	0.00	−1.47	3.56	−0.03	−0.03
Luxembourg	456	0.33	0.33	0.27	0.46	2.26	−0.03	1.03
Mexico	221	0.50	0.50	0.16	−0.00	1.80	0.24	0.90
Netherlands	1,272	0.29	0.29	0.20	0.77	3.95	−0.09	1.08
New Zealand	1,488	0.46	0.45	0.29	1.84	8.44	0.10	2.03
Norway	1,271	0.35	0.35	0.26	1.02	3.67	0.03	1.23
Poland	247	0.43	0.43	0.34	1.53	4.54	0.12	1.43
Portugal	1,032	0.47	0.47	0.47	1.44	3.94	−0.04	1.88
Singapore	258	0.10	0.10	0.07	0.87	2.96	0.01	0.34
Slovakia	240	0.23	0.23	0.25	0.68	2.08	−0.03	0.71
Slovenia	120	0.03	0.03	0.04	1.10	3.12	0.00	0.13
South Korea	230	0.28	0.28	0.12	0.21	1.99	0.10	0.57
Spain	732	0.52	0.52	0.40	1.04	4.18	−0.05	2.35
Sweden	1,320	0.39	0.39	0.27	0.98	3.74	−0.07	1.39
Switzerland	1,272	0.21	0.21	0.15	0.71	3.97	−0.12	0.74
Turkey	119	0.84	0.84	0.35	1.63	5.13	0.38	2.03
United Kingdom	1,560	0.35	0.35	0.28	1.05	3.69	0.01	1.26
United States	1,560	0.29	0.29	0.22	0.92	4.43	0.00	1.21
Full sample	29,919	0.38	0.38	0.30	1.96	14.75	−0.12	5.49

Table B.II
Bootstrap distributions of nominal payoffs.

The table summarizes distributions of nominal payoffs from a $1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the pooled sample of all developed countries. Each panel shows statistics for the distribution of a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The nominal payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the mean, standard deviation, and distribution percentiles of nominal payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
Horizon	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Nominal domestic stock payoffs												
1 month	1.01	0.06	0.86	0.93	0.95	0.98	1.01	1.03	1.06	1.09	1.16	0.392
1 year	1.13	0.29	0.58	0.77	0.85	0.98	1.10	1.23	1.40	1.55	2.05	0.293
5 years	1.84	1.48	0.34	0.69	0.87	1.16	1.54	2.10	2.98	3.80	6.77	0.154
10 years	3.41	4.74	0.30	0.78	1.06	1.59	2.37	3.70	5.96	8.60	20.69	0.087
20 years	12.16	35.70	0.42	1.14	1.74	3.14	5.71	10.88	21.85	36.31	122.12	0.040
30 years	42.94	223.65	0.66	1.88	3.09	6.49	13.93	31.26	73.49	135.82	513.81	0.020
Panel B: Nominal international stock payoffs												
1 month	1.01	0.07	0.89	0.94	0.96	0.99	1.01	1.03	1.05	1.07	1.12	0.370
1 year	1.13	0.29	0.66	0.80	0.89	1.01	1.10	1.21	1.34	1.43	1.89	0.240
5 years	1.95	3.06	0.60	0.82	0.95	1.21	1.57	2.03	2.74	3.63	8.00	0.123
10 years	4.24	12.44	0.73	1.03	1.25	1.69	2.38	3.60	6.03	9.38	39.84	0.046
20 years	20.98	161.56	1.16	1.82	2.30	3.42	5.83	11.45	24.37	53.42	324.83	0.006
30 years	101.12	1495.77	1.93	3.32	4.44	7.50	15.01	34.49	96.34	249.94	1554.84	0.001
Panel C: Nominal bond payoffs												
1 month	1.01	0.11	0.95	0.98	0.99	1.00	1.00	1.01	1.02	1.03	1.06	0.274
1 year	1.07	0.41	0.89	0.96	0.99	1.02	1.05	1.10	1.16	1.22	1.37	0.142
5 years	1.39	0.85	0.87	1.07	1.11	1.18	1.29	1.47	1.75	1.98	2.63	0.020
10 years	1.93	1.72	0.55	1.24	1.31	1.46	1.70	2.09	2.78	3.46	5.20	0.015
20 years	3.84	4.63	0.25	1.70	1.89	2.29	2.96	4.26	6.46	8.69	15.47	0.019
30 years	7.59	12.12	0.28	2.39	2.83	3.69	5.29	8.48	14.08	19.52	38.13	0.024
Panel D: Nominal bill payoffs												
1 month	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	0.032
1 year	1.05	0.04	1.00	1.00	1.01	1.02	1.04	1.06	1.09	1.12	1.18	0.029
5 years	1.27	0.21	0.99	1.03	1.07	1.14	1.22	1.33	1.53	1.72	2.10	0.014
10 years	1.64	0.54	1.03	1.11	1.18	1.33	1.50	1.76	2.25	2.70	3.83	0.002
20 years	2.78	1.64	1.22	1.40	1.54	1.85	2.31	3.07	4.47	5.84	9.58	0.000
30 years	4.69	3.67	1.53	1.86	2.10	2.66	3.58	5.28	8.44	11.48	20.00	0.000

Table B.III

Summary statistics for real cash returns and real currency basket returns.

The table reports summary statistics for monthly real cash returns (Panel A) and real currency basket returns (Panel B) for each developed country and for the pooled sample of all observations. For each country, the table shows the number of sample months, the arithmetic average return ($\bar{R}_a$), the geometric average return ($\bar{R}_g$), the standard deviation of return (SD), return skewness (Skew), return kurtosis (Kurt), and the minimum (Min) and the maximum (Max) return.

		Summary statistics for returns						
Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
Panel A: Real cash returns								
Argentina	239	−1.89	−1.93	2.73	−0.89	5.64	−15.08	6.46
Australia	1,428	−0.31	−0.31	0.51	−0.91	7.15	−2.86	1.44
Austria	1,139	−0.37	−0.39	1.48	−8.90	125.77	−27.41	2.96
Belgium	1,476	−0.39	−0.40	1.13	−0.16	16.30	−10.92	9.55
Canada	1,548	−0.22	−0.23	0.56	0.20	8.58	−3.19	3.20
Chile period I	528	−1.45	−1.48	2.32	0.50	7.69	−10.76	12.22
Chile period II	120	−0.25	−0.25	0.34	−0.06	8.64	−1.82	1.27
Czechia	236	−0.18	−0.18	0.43	−2.00	11.44	−2.89	0.92
Czechoslovakia	233	−0.19	−0.22	2.86	10.19	137.60	−5.49	37.97
Denmark	1,560	−0.28	−0.29	0.71	−1.26	17.25	−5.56	4.12
Finland	612	−0.36	−0.36	0.52	−1.46	7.28	−3.32	1.59
France	1,560	−0.49	−0.51	1.75	−2.81	30.12	−21.13	9.72
Germany	1,560	−0.18	−0.19	0.81	0.38	39.88	−6.33	11.21
Greece	467	−0.60	−0.61	1.33	−0.28	2.53	−4.43	2.05
Hungary	251	−0.32	−0.32	0.38	−0.73	6.14	−2.13	0.98
Iceland	216	−0.35	−0.36	0.54	−1.13	6.99	−3.30	0.91
Ireland	1,008	−0.40	−0.41	0.62	−0.78	6.33	−3.41	2.51
Israel	120	0.04	0.04	0.84	4.83	31.21	−1.04	5.88
Italy	1,068	−0.72	−0.73	1.72	−4.37	39.65	−20.65	7.50
Japan	1,080	−0.58	−0.62	2.66	−8.97	128.28	−48.35	12.00
Latvia	48	−0.19	−0.19	0.47	0.24	3.12	−1.23	0.92
Lithuania	24	−0.18	−0.18	0.49	−0.48	2.47	−1.29	0.65
Luxembourg	456	−0.19	−0.19	0.56	−0.18	4.25	−1.87	1.70
Mexico	221	−0.35	−0.35	0.36	0.22	3.95	−1.73	0.84
Netherlands	1,272	−0.26	−0.26	0.76	−0.65	8.41	−4.56	2.89
New Zealand	1,488	−0.30	−0.30	0.59	−0.29	11.29	−4.12	3.43
Norway	1,271	−0.32	−0.32	0.84	−0.19	11.98	−7.08	5.45
Poland	247	−0.21	−0.21	0.38	−0.62	3.70	−1.76	0.48
Portugal	1,032	−0.51	−0.52	1.41	0.10	11.56	−7.66	11.68
Singapore	258	−0.12	−0.12	0.46	−0.48	4.59	−2.02	1.49
Slovakia	240	−0.26	−0.26	0.60	−4.53	30.00	−5.01	0.60
Slovenia	120	−0.04	−0.04	0.75	1.26	5.49	−1.49	3.00
South Korea	230	−0.19	−0.19	0.35	−0.23	2.89	−1.17	0.66
Spain	732	−0.50	−0.50	0.71	−0.56	5.57	−4.38	2.40
Sweden	1,320	−0.30	−0.30	0.96	−8.69	171.15	−20.73	4.15
Switzerland	1,272	−0.18	−0.18	0.62	0.51	11.23	−3.16	4.21
Turkey	119	−0.77	−0.78	0.94	−1.43	9.47	−5.93	1.46
United Kingdom	1,560	−0.28	−0.28	0.88	1.33	22.82	−4.69	10.26
United States	1,560	−0.23	−0.23	0.61	0.59	25.45	−5.56	7.30
Full sample	29,919	−0.37	−0.38	1.17	−5.08	201.68	−48.35	37.97

(*continued on next page*)

Table B.III (*continued*)

Country	Months	$\bar{R}_a$ (%)	$\bar{R}_g$ (%)	SD (%)	Skew	Kurt	Min (%)	Max (%)
		Summary statistics for returns						
Panel B: Real currency basket returns								
Argentina	239	0.30	−0.31	14.30	8.59	86.43	−18.47	148.88
Australia	1,428	−0.22	−0.25	2.31	3.11	31.18	−10.43	27.98
Austria	1,139	0.12	−0.17	11.61	20.45	463.43	−27.40	295.85
Belgium	1,476	−0.24	−0.28	3.03	3.01	48.31	−21.03	39.46
Canada	1,548	−0.21	−0.22	1.62	0.53	8.99	−8.37	10.44
Chile period I	528	0.13	−0.12	8.04	7.33	86.83	−28.58	100.22
Chile period II	120	0.03	−0.01	2.73	0.34	3.07	−5.91	8.19
Czechia	236	−0.36	−0.39	2.43	0.35	3.77	−6.82	8.50
Czechoslovakia	233	−0.22	−0.30	4.14	2.62	43.30	−29.57	36.62
Denmark	1,560	−0.24	−0.27	2.09	1.22	35.83	−17.78	28.42
Finland	612	−0.26	−0.28	2.00	1.58	12.10	−5.84	15.22
France	1,560	−0.09	−0.21	5.60	11.09	210.74	−26.35	123.82
Germany	1,560	0.09	−0.10	9.76	26.35	746.11	−13.08	299.83
Greece	467	−0.17	−0.20	2.46	1.08	9.20	−8.99	15.61
Hungary	251	−0.15	−0.20	3.05	1.54	10.11	−7.64	19.17
Iceland	216	−0.17	−0.23	3.68	1.82	13.08	−11.38	23.89
Ireland	1,008	−0.28	−0.30	1.94	3.38	46.35	−10.57	27.08
Israel	120	−0.11	−0.13	1.90	2.28	15.46	−3.79	12.03
Italy	1,068	0.02	−0.31	13.18	25.31	722.58	−21.12	388.93
Japan	1,080	0.23	−0.27	15.93	19.01	407.70	−48.36	387.25
Latvia	48	−0.23	−0.23	1.12	−0.17	2.97	−3.08	2.41
Lithuania	24	0.02	0.02	0.99	0.12	2.33	−1.70	1.93
Luxembourg	456	−0.15	−0.17	2.04	0.41	4.33	−7.00	7.33
Mexico	221	0.07	0.03	2.76	0.53	4.07	−7.06	11.08
Netherlands	1,272	−0.28	−0.30	2.44	5.49	84.34	−12.86	40.94
New Zealand	1,488	−0.19	−0.23	2.80	7.42	138.05	−19.54	57.20
Norway	1,271	−0.25	−0.28	2.49	2.17	26.79	−13.87	30.16
Poland	247	−0.17	−0.22	3.01	0.79	4.77	−7.07	13.07
Portugal	1,032	−0.31	−0.34	2.13	0.71	9.26	−9.93	13.45
Singapore	258	−0.19	−0.19	1.12	0.15	3.93	−3.29	4.27
Slovakia	240	−0.42	−0.44	2.04	−0.02	3.64	−6.34	5.93
Slovenia	120	0.09	0.08	1.71	0.55	3.70	−3.56	5.39
South Korea	230	−0.11	−0.15	2.64	0.76	9.04	−10.76	14.66
Spain	732	−0.31	−0.33	2.09	2.03	15.54	−6.62	18.29
Sweden	1,320	−0.22	−0.25	2.39	0.75	35.73	−23.48	28.15
Switzerland	1,272	−0.31	−0.34	2.32	3.58	65.93	−11.45	38.47
Turkey	119	0.39	0.31	4.30	2.26	19.43	−12.70	29.37
United Kingdom	1,560	−0.19	−0.22	2.23	3.91	63.66	−16.98	36.29
United States	1,560	−0.24	−0.26	2.04	−0.72	21.41	−24.81	12.08
Full sample	29,919	−0.16	−0.24	5.84	38.85	2,103.46	−48.36	388.93

Table B.IV

Bootstrap distributions of real cash payoffs and real currency basket payoffs.

The table summarizes distributions of real cash payoffs (Panel A) and real currency basket payoffs (Panel B) from a $1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the pooled sample of all developed countries. The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
Horizon	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
Panel A: Real cash payoffs												
1 month	1.00	0.01	0.96	0.98	0.99	0.99	1.00	1.00	1.00	1.01	1.02	0.715
1 year	0.96	0.07	0.72	0.84	0.89	0.94	0.97	0.99	1.01	1.03	1.12	0.856
5 years	0.83	0.18	0.22	0.48	0.59	0.75	0.86	0.93	0.99	1.06	1.25	0.912
10 years	0.70	0.23	0.07	0.27	0.39	0.57	0.73	0.83	0.94	1.04	1.27	0.934
20 years	0.49	0.24	0.01	0.10	0.17	0.33	0.49	0.65	0.79	0.89	1.15	0.976
30 years	0.35	0.22	0.01	0.04	0.08	0.19	0.33	0.48	0.63	0.73	0.97	0.992
Panel B: Real currency basket payoffs												
1 month	1.00	0.06	0.93	0.96	0.97	0.99	1.00	1.00	1.02	1.03	1.07	0.620
1 year	0.98	0.16	0.73	0.83	0.87	0.92	0.97	1.01	1.08	1.13	1.38	0.693
5 years	0.90	0.33	0.44	0.56	0.64	0.76	0.87	0.99	1.12	1.26	1.97	0.769
10 years	0.81	0.50	0.30	0.40	0.47	0.61	0.75	0.92	1.10	1.30	2.35	0.834
20 years	0.66	0.61	0.17	0.24	0.29	0.40	0.56	0.75	1.00	1.26	2.45	0.899
30 years	0.53	0.65	0.10	0.15	0.19	0.28	0.41	0.60	0.87	1.15	2.67	0.930

Table B.V

Loss probabilities for alternative block sampling lengths.

The table shows the proportion of real payoffs that are less than the initial investment across 10,000,000 bootstrap simulations at various return horizons for alternative mean block sampling lengths. The underlying sample is the pooled sample of all developed countries. Each panel shows loss probabilities for a given asset class: domestic stocks (Panel A), international stocks (Panel B), bonds (Panel C), and bills (Panel D). The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	$\mathbb{P}(W_H^{(m)} < 1)$				
	Bootstrap block length parameter				
Horizon	1	12	60	120	240
Panel A: Real domestic stock loss probability					
1 month	0.427	0.427	0.427	0.427	0.427
1 year	0.385	0.374	0.372	0.371	0.371
5 years	0.285	0.302	0.294	0.290	0.288
10 years	0.221	0.251	0.232	0.223	0.218
20 years	0.152	0.193	0.174	0.162	0.154
30 years	0.113	0.156	0.139	0.126	0.117
Panel B: Real international stock loss probability					
1 month	0.416	0.416	0.416	0.416	0.416
1 year	0.365	0.341	0.333	0.333	0.332
5 years	0.239	0.252	0.257	0.259	0.260
10 years	0.159	0.186	0.182	0.181	0.180
20 years	0.079	0.109	0.097	0.084	0.071
30 years	0.042	0.067	0.054	0.041	0.029
Panel C: Real bond loss probability					
1 month	0.429	0.429	0.429	0.429	0.429
1 year	0.407	0.388	0.381	0.380	0.380
5 years	0.349	0.335	0.314	0.309	0.307
10 years	0.314	0.310	0.300	0.300	0.301
20 years	0.273	0.282	0.280	0.283	0.288
30 years	0.247	0.265	0.269	0.268	0.268
Panel D: Real bill loss probability					
1 month	0.402	0.402	0.402	0.402	0.402
1 year	0.434	0.385	0.379	0.379	0.378
5 years	0.449	0.391	0.382	0.382	0.382
10 years	0.452	0.399	0.384	0.384	0.384
20 years	0.454	0.407	0.383	0.376	0.371
30 years	0.454	0.411	0.383	0.369	0.355

Table B.VI

Bootstrap distributions of real international stock payoffs with alternative international stock portfolio.

The table summarizes distributions of real payoffs from a $1.00 buy-and-hold investment across 10,000,000 bootstrap simulations at various return horizons. The underlying sample is the pooled sample of all developed countries. The table shows statistics for the distribution of international stocks with a 25% cap on the weight of any individual country in the international portfolio construction. The real payoff for bootstrap iteration m at the H-month horizon is $W_H^{(m)}$. For each horizon, the table reports the mean, standard deviation, and distribution percentiles of real payoffs. The last column in the table shows the proportion of payoff draws that are less than one [$\mathbb{P}(W_H^{(m)} < 1)$]. The bootstrap sampling procedure is based on the stationary bootstrap approach of Politis and Romano (1994), as described in the text.

	Moments		Percentiles									
Horizon	Mean	SD	1%	5%	10%	25%	50%	75%	90%	95%	99%	$\mathbb{P}(W_H^{(m)} < 1)$
1 month	1.01	0.07	0.89	0.94	0.96	0.99	1.01	1.03	1.05	1.06	1.11	0.414
1 year	1.07	0.22	0.63	0.77	0.85	0.96	1.06	1.17	1.28	1.36	1.60	0.334
5 years	1.40	0.63	0.49	0.66	0.77	1.01	1.31	1.68	2.08	2.39	3.39	0.243
10 years	1.96	1.39	0.45	0.68	0.83	1.20	1.70	2.39	3.24	3.87	6.13	0.169
20 years	3.76	4.46	0.51	0.87	1.13	1.75	2.79	4.49	6.88	8.99	17.38	0.073
30 years	7.15	11.64	0.63	1.16	1.61	2.70	4.69	8.08	13.62	19.20	43.78	0.035