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THE WORLDWIDE EQUITY PREMIUM: A SMALLER PUZZLE

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Abstract: We use a new database of long-run stock, bond, bill, inflation, and currency returns to estimate the equity risk premium for 17 countries and a world index over a 106-year interval. Taking U.S. Treasury bills (government bonds) as the risk-free asset, the annualised equity premium for the world index was 4.7% (4.0%). We report the historical equity premium for each market in local currency and US dollars, and decompose the premium into dividend growth, multiple expansion, the dividend yield, and changes in the real exchange rate. We infer that investors expect a premium on the world index of around 3–3½% on a geometric mean basis, or approximately 4½–5% on an arithmetic basis.

JEL classifications: G12, G15, G23, G31, N20.

Keywords: Equity risk premium; long run returns; survivor bias; financial history; stocks, bonds, bills, inflation.

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THE WORLDWIDE EQUITY PREMIUM: A SMALLER PUZZLE

Abstract: We use a new database of long-run stock, bond, bill, inflation, and currency returns to estimate the equity risk premium for 17 countries and a world index over a 106-year interval. Taking U.S. Treasury bills (government bonds) as the risk-free asset, the annualised equity premium for the world index was 4.7% (4.0%). We report the historical equity premium for each market in local currency and US dollars, and decompose the premium into dividend growth, multiple expansion, the dividend yield, and changes in the real exchange rate. We infer that investors expect a premium on the world index of around 3–3½% on a geometric mean basis, or approximately 4½–5% on an arithmetic basis.

In their seminal paper on the equity premium puzzle, Mehra and Prescott (1985) showed that the historical equity premium in the United States—measured as the excess return on stocks relative to the return on relatively risk-free Treasury bills—was much larger than could be justified as a risk premium on the basis of standard theory. Using the accepted neoclassical paradigms of financial economics, combined with estimates of the mean, variance and auto-correlation of annual consumption growth in the U.S. economy and plausible estimates of the coefficient of risk aversion and time preference, they argued that stocks should provide at most a 0.35% annual risk premium over bills. Even by stretching the parameter estimates, they concluded that the premium should be no more than 1% (Mehra and Prescott (2003)). This contrasted starkly with their historical mean annual equity premium estimate of 6.2%.

The equity premium puzzle is thus a quantitative puzzle about the magnitude, rather than the sign, of the risk premium. Ironically, since Mehra and Prescott wrote their paper, this puzzle has grown yet more quantitatively puzzling. Over the 27 years from the end of the period they examined to the date of completing this contribution, namely over 1979–2005, the mean annual U.S. equity premium relative to bills using Mehra-Prescott's definition and data sources was 8.1%.

Logically, there are two possible resolutions to the puzzle: either the standard models are wrong, or else the historical premium is misleading and we should expect a lower premium in the future. Over the last two decades, researchers have tried to resolve the puzzle by generalising and adapting the Mehra-Prescott (1985) model. Their efforts have focused on alternative assumptions about preferences, including risk aversion, state separability, leisure, habit formation and precautionary saving; incomplete markets and uninsurable income shocks; modified probability distributions to admit rare, disastrous events; market imperfections, such as borrowing constraints and transactions costs; models of limited participation of consumers in the stock market, and behavioural explanations. There are several excellent surveys of this work, including Kocherlakota (1996), Cochrane (1997), Mehra and Prescott (2003), and most recently, Mehra and Prescott (2006).

While some of these models have the potential to resolve the puzzle, as Cochrane (1997) points out, the most promising of them involve "deep modifications to the standard models" and "every quantitatively successful current story…still requires astonishingly high risk aversion". This leads us back to the second possible resolution to the puzzle, namely, that the historical premium may be misleading. Perhaps U.S. equity investors simply enjoyed good fortune and the twentieth century for them represented the "triumph of the optimists" (Dimson, Marsh, and Staunton (2002)). As Cochrane (1997) puts it, maybe it was simply "100 years of good luck"—the opposite of the old joke about Soviet agriculture being the result of "100 years of bad luck."

This good luck story may also be accentuated by country selection bias, making the historical data even more misleading. To illustrate this, consider the parallel with selection bias in the choice of stocks, and the task facing a researcher who wished to estimate the required risk premium and expected return on the common stock of Microsoft. It would be foolish to extrapolate from Microsoft's stellar past performance. Its success and survival makes it non-typical of companies as a whole. Moreover, in its core business Microsoft has a market share above 50%. Since, by definition, no competitor can equal this accomplishment, we should not extrapolate expected returns from this one example of success. The past performance of individual stocks is anyway largely uninformative about their future returns, but when there is *ex post* selection bias based on past success, historical mean returns will provide an upward biased estimate of future expected returns. That is one reason why equity premium projections are usually based on the performance of the entire market, including unsuccessful as well as successful stocks.[1]

For similar reasons, we should also be uncomfortable about extrapolating from a stock market that has survived and been successful, and gained a market share of above 50%. Organized trading in marketable securities began in Amsterdam in 1602 and London in 1698, but did not commence in New York until 1792. Since then, the U.S. share of the global stock market as measured by the percentage of overall world equity market capitalization has risen from zero to around 50% (see Dimson, Marsh, and Staunton (2004)). This reflects the superior performance of the U.S. economy, as evidenced by a large volume of initial public offerings (IPOs) and seasoned equity offerings (SEOs) that enlarged the U.S. equity market, and the substantial returns from U.S. common stocks after they had gained a listing. No other market can rival this long-term accomplishment.

Mehra and Prescott's initial focus on the United States and the ready availability of U.S. data has ensured that much of the subsequent research prompted by their paper has investigated the premium within the context of the U.S. market. The theoretical work usually starts with the assumption that the equity premium is of the magnitude that has been observed historically in the United States, and seeks to show why the Mehra-Prescott observations are not (quite so much of) a puzzle. Some empirical work has looked beyond the United States, including Jorion and Goetzmann (1999) and Mehra and Prescott (2003). However, researchers have hitherto been hampered by the paucity of long-run equity returns data for other countries. Most research seeking to resolve the equity premium puzzle has thus focused on empirical evidence for the United States. In emphasizing the U.S.—a country that must be a relative outlier—this body of work may be starting from the wrong set of beliefs about the past.

The historically measured equity premium could also be misleading if the risk premium has been non-stationary. This could have arisen if, over the measurement interval, there have been changes in risk, or the risk attitude of investors, or investors' diversification opportunities. If, for example, these have caused a reduction in the risk premium, this fall in the discount rate will

[1] Another key reason is that equilibrium asset pricing theories such as the CAPM or CCAPM assign a special role to the value weighted market portfolio. However, our argument for looking beyond the United States is not dependent on the assumption that the market portfolio should necessarily be the world portfolio. Instead, we are simply pointing out that if one selects a country which is known after the event to have been unusually successful, then its past equity returns are likely to be an upward biased estimate of future returns.

have led to re-pricing of stocks, thus adding to the magnitude of historical returns. The historical mean equity premium will then overstate the prospective risk premium, not only because the premium has fallen over time, but also because historical returns are inflated by past repricings that were triggered by a *reduction* in the risk premium.

In this paper, we therefore revisit two fundamental questions: How large has the equity premium been historically, and how big is it likely to be in the future? To answer these questions, we extend our horizon beyond just the United States and use a new source of long-run returns, the Dimson-Marsh-Staunton (2006) database, to examine capital market history in 17 countries over the 106-year period from 1900 to 2005. Initially, we use the DMS database to estimate the historical equity premium around the world on the assumption that the premium was stationary. We then analyse the components of the premium to provide insights into the impact on historical returns of (i) luck and (ii) repricing resulting from changes in the underlying risk premium. This then enables us to make inferences about the likely future long-run premium.

Our paper is organized as follows. The next section reviews previous estimates and beliefs about the size of the equity premium. Section 3 describes the new DMS global database and explains why it represents a significant advance over previous data. Section 4 utilizes the database to present summary data on long-run returns, and to illustrate why we need long-run histories to estimate premiums with any precision—even if the underlying processes are non-stationary. Section 5 presents new evidence on the historical equity premium around the world, assuming stationarity. Section 6 decomposes historical equity premiums into several elements, documenting the contribution of each to historical returns. Section 7 uses this decomposition to infer expectations of the equity premium, discusses why these are lower than the historical realizations, and provides a summary and conclusion. There are two appendices, one formalising the methodology behind our decomposition, and the other documenting our data sources.

2. PRIOR ESTIMATES OF THE EQUITY PREMIUM

Prior estimates of the historical equity premium draw heavily on the United States, with most researchers and textbooks citing just the American experience. The most widely cited source is Ibbotson Associates whose U.S. database starts in 1926. At the turn of the millennium, Ibbotson's estimate of the U.S. arithmetic mean equity premium from 1926–1999 was 9.2%. In addition, before the DMS database became available, researchers such as Mehra and Prescott (2003), Siegel (2002), and Jorion and Goetzmann (1999) used the Barclays Capital (1999) and Credit Suisse First Boston (CSFB) (1999) data for the United Kingdom. In 1999, both Barclays and CSFB were using identical U.K. equity and Treasury bill indexes that started in 1919 and gave rise to an arithmetic mean equity premium of 8.8%.

In recent years, a growing appreciation of the equity premium puzzle made academics and practitioners increasingly concerned that these widely cited estimates were too high. This distrust proved justified for the historical numbers for the U.K., which were wrong. The former Barclays/CSFB index was retrospectively constructed, and from 1919–35, was based on a sample of 30 stocks chosen from the largest companies (and sectors) in 1935. As we show in Dimson, Marsh and Staunton (2001), the index thereby suffered from *ex post* bias. It represented a potential investment strategy only for investors with perfect foresight in 1919 about which companies were destined to survive (survivorship bias). Even more seriously, it incorporated hindsight on which stocks and sectors were destined in 1919 subsequently to perform well and grow large (success bias).[2]

After correcting for this *ex post* selection bias, the arithmetic mean equity premium from 1919–35 fell from 10.6% to 5.2%. The returns on this index were also flattered by the choice of start-date. By starting in 1919, it captured the post-World War I recovery, while omitting wartime losses and the lower pre-war returns. Adding in these earlier years gave an arithmetic mean U.K. equity premium over the entire twentieth century of 6.6%, some 2¼% lower than might have been inferred from the earlier, incorrect data for 1919–99.

The data used by Ibbotson Associates to compute the historical U.S. equity premium is of higher quality and does not suffer from the problems that afflicted the old U.K. indexes. Those believing that the premium is "too good to be true" have therefore pointed their finger of suspicion mainly at success bias—a choice of market that was influenced by that country's record of success. Bodie (2002) argued that high U.S. and U.K. premiums are likely to be anomalous, and underlined the need for comparative international evidence. He pointed out that long-run studies are almost always of U.S. or U.K. premiums: "There were 36 active stock markets in 1900, so why do we only look at two? I can tell you—because many of the others don't have a 100-year history, for a variety of reasons."

There are indeed relatively few studies extending beyond the United States and the United Kingdom. Mehra and Prescott (2003) report comparative premiums for France, Japan, and Germany. They find a similar pattern to the United States, but their premiums are based on post-1970 data and periods of 30 years or less. Ibbotson Associates (2005) compute equity premiums for 16 countries, but only from 1970. Siegel (2002) reports premiums for Germany and Japan since 1926, finding magnitudes similar to those in the United States. Jorion and Goetzmann (1999) provide the most comprehensive long-run global study by assembling a database of capital gain indexes for 39 markets, 11 of which started as early as 1921. However, they were able to identify only four markets, apart from the United States and the United Kingdom, with pre-1970 dividend information. They concluded that, "the high equity premium obtained for U.S. equities appears to be the exception rather than the rule." But in the absence of reliable dividend information, this assertion must be treated with caution. We therefore return to this question using comprehensive total returns data in section 5 below.

Expert Opinion

The equity premium has thus been a source of controversy, even among experts. Welch (2000) studied the opinions of 226 financial economists who were asked to forecast the average annual equity premium over the next 30 years. Their forecasts ranged from 1% to 15%, with a mean and median of 7%. No clear consensus emerged: the cross-sectional dispersion of the forecasts was as large as the standard error of the mean historical equity premium.

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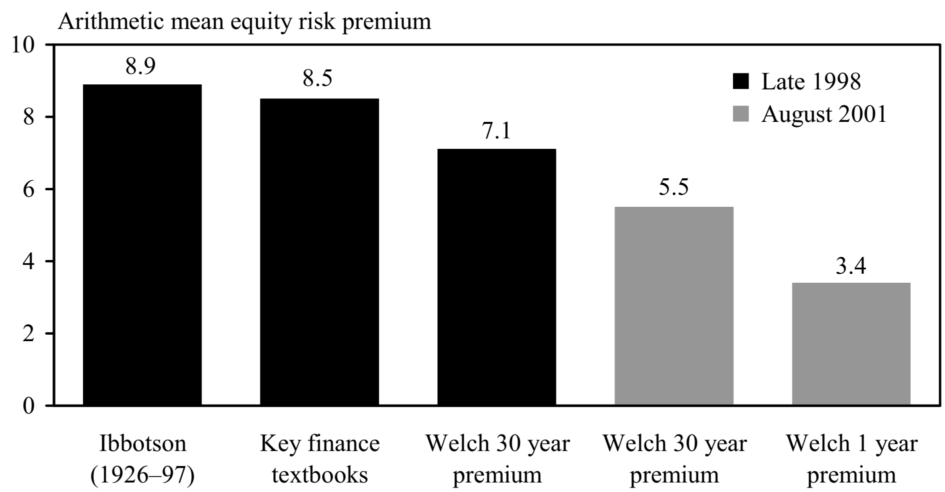
[2] After becoming aware of our research, Barclays Capital (but not CSFB) corrected their pre-1955 estimates of U.K. equity returns for bias and extended their index series back to 1900.

Most respondents to the Welch survey would have viewed the Ibbotson Associates Yearbook as the definitive study of the historical U.S. equity premium. At that time, the most recent Yearbook was the 1998 edition, covering 1926–1997. The first bar of **Figure 1** shows that the arithmetic mean equity premium based on the Yearbook data was 8.9% per annum.[3] The second bar shows that the key finance textbooks were on average suggesting a slightly lower premium of 8.5%. This may have been based on earlier, slightly lower, Ibbotson estimates, or perhaps the authors were shading the estimates down. The Welch survey mean is in turn lower than the textbook figures, but since the respondents claimed to lower their forecasts when the equity market rises, this may reflect the market's strong performance in the 1990s.

Figure 1: Estimated Arithmetic Equity Premiums Relative to Bills, 1998 and 2001



At the time of this survey, academics' forecasts of the long-run premium thus seemed strongly influenced by the historical record. Certainly, leading textbooks advocated the use of the historical mean, including Bodie, Kane, and Marcus (1999) and Brealey and Myers (2000). The latter states, "Many financial managers and economists believe that long-run historical returns are the best measure available." This was supported by researchers such as Goyal and Welch (2006) who could not identify a single predictive variable that would have been of robust use for forecasting the equity premium, and recommended "assuming that the equity premium is 'like it always has been'." Even Mehra and Prescott (2003) state, "…over the long horizon the equity premium is likely to be similar to what it has been in the past and the returns to investment in equity will continue to dominate that in T-bills for investors with a long planning horizon."

The survey and textbook figures shown in the second and third bars of Figure 1 indicate what was being taught at the end of the 1990s in the world's top business schools and economics departments. But by 2001, longer-term estimates were gaining publicity. Our own estimate (Dimson, Marsh, and Staunton (2000)) of the U.S. arithmetic mean premium over the entire twentieth century of 7.7% was 1.2% lower than Ibbotson's estimate of 8.9% for 1926–1997.

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[3] This is the arithmetic mean of the one-year geometric risk premiums. The arithmetic mean of the one-year arithmetic risk premiums, i.e., the average annual difference between the equity return and the Treasury bill return, was slightly higher at 9.1%.

In August 2001, Welch (2001) updated his survey, receiving 510 responses. Respondents had revised their estimates downward by an average of 1.6%. They now estimated an equity premium averaging 5.5% over a 30-year horizon, and 3.4% over a one-year horizon (see Figure 1). Those taking part for the first time estimated the same mean premiums as those who had participated in the earlier survey. While respondents to the earlier survey had indicated that, on average, a bear market would raise their equity premium forecast, Welch reports that "this is in contrast with the observed findings: it appears as if the recent bear market correlates with lower equity premium forecasts, not higher equity premium forecasts."

The academic consensus now appears to be lower still (e.g., see Jagannathan, McGrattan and Scherbina (2000) and Fama and French (2002)). Investment practitioners typically agree (see Arnott and Ryan (2001) and Arnott and Bernstein (2002), and the latest editions of many textbooks have reduced their equity premium estimates (for a summary of textbook prescriptions, see Fernandez (2004)). Meanwhile, surveys by Graham and Harvey (2005) indicate that U.S. CFOs have reduced their forecasts of the equity premium from 4.65% in September 2000 to 2.93% by September 2005. Yet predictions of the long-term premium should not be so sensitive to short-term market fluctuations. Over this period, the long-run historical mean premium—which just a few years earlier had been the anchor of beliefs—has fallen only modestly, as adding in the years 2000–05 reduces the long-run mean by just 0.4%, despite the bear market of 2000–02. The sharp lowering of the consensus view about the future premium must therefore reflect more than this, such as new ways of interpreting the past, new approaches to forecasting the premium, or new facts about global long-term performance, such as evidence that the U.S. premium was higher than in most other countries.

3. LONG-RUN INTERNATIONAL DATA

We have seen that previous research has been hampered by the quality and availability of long-run global data. The main problems were the short time-series available and hence the focus on recent data, the absence of dividends, *ex post* selection bias, and emphasizing data that is "easy" to access.

Historically, the most widely used database for international stock market research has been the Morgan Stanley Capital International (MSCI) index series, but the MSCI data files start only in 1970. This provides a rather short history for estimating equity premiums, and spans a period when equities mostly performed well, so premiums inevitably appear large. Researchers interested in longer-term data have found no shortage of earlier stock price indexes but, as is apparent in Jorion and Goetzmann (1999), they have encountered problems over dividend availability. We show in section 6 that this is a serious drawback, because the contribution of dividends to equity returns is of the same order of magnitude as the equity premium itself, and since there have been considerable cross-country differences in average dividend yield. The absence of dividends makes it hard to generate meaningful estimates of equity premiums.

Even for countries where long-run total returns series were available, we have seen that they sometimes suffered from *ex post* selection bias, as had been the case in the U.K. Finally, the data sources that pre-dated the DMS database often suffered from "easy data" bias. This refers to the tendency of researchers to use data that is easy to obtain, excludes traumatic intervals such as wars and their aftermath, and typically relates to more recent periods. Dimson, Marsh, and Staunton (2002) identify the most widely cited prior data source for each of 16 countries and show that equity returns over the periods covered are higher than the 1900–2000 returns from the DMS database by an average of 3% per year. Easy data bias almost certainly led researchers to believe that equity returns over the twentieth century were higher than was really the case.

The DMS Global Database: Composition and Start-date

These deficiencies in existing data provided the motivation for the DMS global database. This contains annual returns on stocks, bonds, bills, inflation, and currencies for 17 countries from 1900–2005, and is described in Dimson, Marsh, and Staunton (2006a and 2006b). The countries include the United States and Canada, seven markets from what is now the Euro currency area, the United Kingdom and three other European markets that have not embraced the Euro, two Asia-Pacific markets, and one African market. Together, they made up 91% of total world equity market capitalization at the start of 2006, and we estimate that they constituted 90% by value at the start of our period in 1900 (see section 5 for more details).

The DMS database also includes four "world" indexes based on the countries included in the DMS dataset. There is, first, a World equity index: a 17-country index denominated in a common currency, here taken as U.S. dollars, in which each country is weighted by its starting-year equity market capitalization or, in years before capitalizations were available, by its GDP. Second, there is an analogous 16-country worldwide equity index that excludes the United States ("World ex-U.S."). Third and fourth, we compute a World bond index and a World ex-U.S. bond index, both of which are constructed in the same way, but with each country weighted by its GDP.

The DMS series all commence in 1900, and this common start-date aids international comparisons. The choice of start-date was dictated by data availability and quality. At first sight, it appears feasible to start earlier. Jorion and Goetzmann (1999) note that, by 1900, stock exchanges existed in at least 33 of today's nations, with markets in seven countries dating back another 100 years to 1800. An earlier start-date would in principle be desirable, as a very long series of stationary returns is needed to estimate the equity premium with any precision. Even with non-stationary returns, a long time-series is still helpful,[4] and it would anyway be interesting to compare nineteenth century premiums with those from later years. Indeed, some researchers report very low premiums for the nineteenth century. Mehra and Prescott (2003) report a U.S. equity premium of zero over 1802–62, based on Schwert's (1990) equity series and Siegel's (2002) risk free rate estimates, while Hwang and Song (2004) claim there was no U.K. equity premium puzzle in the nineteenth century, since bonds outperformed stocks.

These inferences, however, are unreliable due to the poor quality of nineteenth century data. The equity series used by Hwang and Song omits dividends, and before 1871, suffers from *ex post*

[4] Pástor and Stambaugh (2001) show that a long return history is useful in estimating the current equity premium even if the historical distribution has experienced structural breaks. The long series helps not only if the timing of breaks is uncertain but also if one believes that large shifts in the premium are unlikely or that the premium is associated, in part, with volatility.

bias and poor coverage. From 1871–1913, they use a broader index (Grossman (2002)), but this has problems with capital changes, omitted data, and stocks disappearing. Within the range of likely assumptions about these disappearances, Grossman shows that he can obtain a 1913 end-value of anywhere between 400 and 1700 (1871=100). Mehra and Prescott (2003) list similar weaknesses in Schwert's 1802–71 U.S. data, such as the lack of dividends, tiny number of stocks, frequent reliance on single sectors, and likelihood of *ex post* bias. These flaws undermine the reliability of equity premium estimates for the nineteenth century.

Unfortunately, better nineteenth century U.K. equity indexes do not exist, and, until recently, Schwert's series was the only source of pre-1871 U.S. data. However, most recently, Goetzmann and Ibbotson (2006) employ a new NYSE database for 1815–1925 (see Goetzmann, Ibbotson, and Peng (2001)) to estimate the nineteenth century U.S. equity premium. But they highlight two problems. First, dividend data is absent pre-1825, and incomplete from 1825–71. Equity returns for 1825–71 are thus estimated in two ways based on different assumptions about dividends, producing two widely divergent estimates of the mean annual return, namely, 6.1% and 11.5%, which are then averaged. Second, since Treasury bills or their equivalents did not yet exist, the risk free rate proves even more problematic and has to be estimated from risky bonds. These two factors make it hard to judge the efficacy of their nineteenth century equity premium estimates.

Returning to the question of the start-date for the DMS database, it is clear that, even for the United States, the world's best-documented capital market, pre-1871 data is still problematic. Wilson and Jones (2002) observe that after 1871, U.S. equity returns are of higher quality; but while a few other DMS countries also have acceptable series over this period, most, including the United Kingdom, have no suitable data prior to 1900. Before then, there are virtually no stock indexes to use as a starting point, and creating new nineteenth century indexes would be a major task, requiring hand collection of stock data from archives.[5] For practical purposes, 1900 is thus the earliest plausible common start-date for a comparative international database.

The DMS Global Database: General Methodology and Guiding Principles

The DMS database comprises annual returns, and is based on the best quality capital appreciation and income series available for each country, drawing on previous studies and other sources. Where possible, data were taken from peer-reviewed academic papers, or highly rated professional studies. From the end point of these studies, the returns series are linked into the best, most comprehensive, commercial returns indexes available. The DMS database is updated annually (see Dimson, Marsh, and Staunton (2006a and 2006b)). Appendix 2 lists the data sources used for each country.

To span the entire period from 1900 we link multiple index series. The best index is chosen for each period, switching when feasible to better alternatives, as they become available. Other factors equal, we have chosen equity indexes that afford the broadest coverage of their market.

[5] The Dow Jones Industrial Average was, we believe, the first index ever published. It began in 1884 with 11 constituents. Charles Dow had neither computer nor calculator, hence his limited coverage. While today, computation is trivial, creating indexes more than 100 years after the event poses a major data challenge. While it is often fairly easy to identify hard copy sources of stock prices, the real problems lie in identifying (i) the full population, including births, name changes, and deaths and their outcome, and (ii) data on dividends, capital changes, shares outstanding, and so on. Archive sources tend to be poorer, or non-existent, the further back one goes in time.

The evolution of the U.S. equity series illustrates these principles. From 1900–25, we use the capitalization weighted Cowles Index of all NYSE stocks (as modified by Wilson and Jones (2002)); from 1926–61, we use the capitalization weighted CRSP Index of all NYSE stocks; from 1962–70, we employ the extended CRSP Index, which over this period also includes Amex stocks; and from 1971 on, we utilize the Wilshire 5000 Index, which contains over 7,000 U.S. stocks, including those listed on Nasdaq.

The creation of the DMS database was in large part an investigative and assembly operation. Most of the series needed already existed, but some were long forgotten, unpublished, or came from research in progress. In other cases, the task was to estimate total returns by linking dividends to existing capital gains indexes. But for several countries, there were periods for which no adequate series existed. For example, U.K. indexes were of poor quality before 1962, and far from comprehensive thereafter. To remedy this, we compiled an index spanning the entire U.K. equity market for 1955–2005 (Dimson and Marsh (2001)), while for 1900–1955, we built a 100-stock index by painstaking data collection from archives. Similarly, we used archive data to span missing sub-periods for Canada, Ireland, Norway, Switzerland, and South Africa.

Virtually all of the DMS countries experienced trading breaks at some point in their history, often in wartime. Jorion and Goetzmann (1999) provide a list and discuss the origins of these interruptions. In assembling our database, we needed to span these gaps. The U.K. and European exchanges, and even the NYSE, closed at the start of World War I, but typically reopened 4–6 months later. Similarly, the Danish, Norwegian, Belgian, Dutch and French markets were closed for short periods when Germany invaded in 1940, and even the Swiss market closed from May to July 1940 for mobilization. There were other temporary closures, notably in Japan after the Great Tokyo Earthquake of 1923. These relatively brief breaks were easy to bridge.[6] But three longer stock exchange closures proved more difficult: Germany and Japan from towards the end of World War II, and Spain during the Civil War. We were able to bridge these gaps,[7] but as markets were closed or prices were controlled, the end-year index levels recorded for Germany for 1943–47, Japan for 1945, and Spain for 1936–38 cannot be regarded as market-determined values. This needs to be borne in mind when reviewing arithmetic means, standard deviations, and other statistics relating to annual returns computed using these values. Over each of these stock exchange closures, more reliance can be placed on the starting and ending values than on the intermediate index levels. We are therefore still able to compute changes in investors' wealth and geometric mean returns over periods spanning these closures.

Finally, there was one unbridgeable discontinuity, namely, bond and bill (but not equity) returns in

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[6] Since the DMS database records annual returns, trading breaks pose problems only when they span a calendar year boundary. For example, at the start of World War I, the NYSE was closed from 31 July until 11 December 1914, so it was still possible to calculate equity and bond returns for 1914. However, the London Stock Exchange closed in July 1914 and did not reopen until 5 January 1915, so prices for the latter date were used as the closing prices for 1914 and the opening prices for 1915. A similar approach was adopted for French returns during the closure of the Paris Exchange from June 1940 until April 1941.

[7] Wartime share dealing in Germany and Japan was subject to strict controls. In Germany, stock prices were effectively fixed after January 1943; the market closed in 1944 with the Allied invasion, and did not reopen until July 1948. Both Gielen (1944) and Ronge (2002) provide data that bridges the gap between 1943 and 1948. In Japan, stock market trading was suspended in August 1945, and although it did not officially reopen until May 1949, over-the-counter trading resumed in May 1946, and the Oriental Economist Index provides relevant stock return data. In Spain, trading was suspended during the Civil War from July 1936 to April 1939, and the Madrid exchange remained closed through February 1940; over the closure we assume a zero change in nominal stock prices and zero dividends.

Germany during the hyperinflation of 1922–23, when German bond and bill investors suffered a total loss of –100%. This episode serves as a stark reminder that, under extreme circumstances, bonds and bills can become riskier than equities. When reporting equity premiums for Germany, whether relative to bonds or bills, we thus have no alternative but to exclude the years 1922–23.

All DMS index returns are computed as the arithmetic average of the individual security returns, and not as geometric averages (an inappropriate method encountered in certain older indexes); and all the DMS security returns include reinvested gross (pre-tax) income as well as capital gains. Income reinvestment is especially important, since, as we saw above, many early equity indexes measure just capital gains and ignore dividends, thus introducing a serious downward bias. Similarly, many early bond indexes record only yields, ignoring price movements. Virtually all DMS equity indexes are capitalization weighted, and are calculated from year-end stock prices, but in the early years, for a few countries, we were forced to use equally weighted indexes or indexes based on average- or mid-December prices (see Appendix 2).

Our guiding principle was to avoid survivorship, success, look-ahead, or any other form of *ex post* selection bias. The criterion was that each index should follow an investment policy that was specifiable in advance, so that an investor could have replicated the performance of the index (before dealing costs) using information that would have been available at the time. The DMS database and its world indexes do, however, suffer from survivorship bias, in the sense that all 17 countries have a full 106-year history. In 1900, an investor could not have known which markets were destined to survive. Certainly, in some markets that existed in 1900, such as Russia and China, domestic equity and bond investors later experienced total losses. In section 5 below, we assess the likely impact of this survivorship bias on our worldwide equity premium estimates.

The DMS inflation rates are derived from each country's consumer price index (CPI), although for Canada (1900–10), Japan (1900), and Spain (1900–14) the wholesale price index is used, as no CPI was available. The exchange rates are year-end rates from *The Financial Times* (1907–2005) and *The Investors' Review* (1899–1906). Where appropriate, market or unofficial rates are substituted for official rates during wartime or the aftermath of World War II. DMS bill returns are in general treasury bill returns, but where these instruments did not exist, we used the closest equivalent, namely, a measure of the short-term interest rate with the lowest possible credit risk.

The DMS bond indexes are based on government bonds. They are usually equally weighted, with constituents chosen to fall within the desired maturity range. For the United States and United Kingdom, they are designed to have a maturity of 20 years, although from 1900−55, the U.K. bond index is based on perpetuals, since there were no 20-year bonds in 1900, and perpetuals dominated the market in terms of liquidity until the 1950s. For all other countries, 20-year bonds are targeted, but where these are not available, either perpetuals (usually for earlier periods) or shorter maturity bonds are used. Further details are given in Appendix 2.

In summary, the DMS database is more comprehensive and accurate than the data sources used in previous research and it spans a longer period. This allows us to set the U.S. equity premium alongside comparable 106-year premiums for 16 other countries and the world indexes, thereby helping us to put the U.S. experience in perspective.

4. LONG-RUN HISTORICAL RATES OF RETURN

In this section we use the DMS dataset to examine real equity market returns around the world. In Table **1**, we compare U.S. returns with those in 16 other countries, and long run returns with recent performance, to help show why we need long time series when analyzing equity returns.

The second column of Table 1 reports annualized real returns over the early years of the twenty-first century, from 2000–2005, the most recent 6-year period at the time of writing. It shows that real equity returns were negative in seven of the seventeen countries and that the return on the world index was -1.25%. Equities underperformed bonds and bills (not shown here) in twelve of the seventeen countries. Inferring the expected equity premium from returns over such a short period would be nonsense: investors cannot have required or expected a negative return for assuming risk. This was simply a disappointing period for equities.

It would be just as misleading to project the future equity premium from data for the previous decade. Column three of Table 1 shows that, with the exception of one country, namely, Japan, which we discuss below, real equity returns between 1990 and 1999 were typically high. Over this period, U.S. equity investors achieved a total real return of 14.2% per annum, increasing their initial stake five-fold. This was a golden age for stocks, and golden ages are, by definition, untypical, providing a poor basis for future projections.

Table 1: Real Equity Returns in 17 Countries, 1900–2005

	Annualized Returns (% p.a.)			Properties of Annual (%) Real Returns, 1900–2005					
Country	2000 to 2005	1990 to 1999	1900 to 2005	Arith. Mean	Std. Error	Std. Devn.	Skew-ness	Kurt-osis	Serial Corr.
Belgium	3.99	9.13	**2.40**	4.58	2.15	22.10	0.95	2.33	0.23
Italy	-0.73	6.42	**2.46**	6.49	2.82	29.07	0.76	2.43	0.03
Germany	-4.08	9.89	**3.09**	8.21	3.16	32.53	1.47	5.65	-0.12
France	-1.64	12.53	**3.60**	6.08	2.25	23.16	0.41	-0.27	0.19
Spain	2.48	12.16	**3.74**	5.90	2.12	21.88	0.80	2.17	0.32
Norway	10.91	8.25	**4.28**	7.08	2.62	26.96	2.37	11.69	-0.06
Switzerland	1.11	13.95	**4.48**	6.28	1.92	19.73	0.42	0.38	0.18
Japan	0.64	-5.23	**4.51**	9.26	2.92	30.05	0.49	2.36	0.19
Ireland	5.14	11.79	**4.79**	7.02	2.15	22.10	0.60	0.81	-0.04
World ex-U.S (USD)	0.11	3.41	**5.23**	7.02	1.92	19.79	0.58	1.41	0.25
Denmark	9.41	7.52	**5.25**	6.91	1.97	20.26	1.83	6.71	-0.13
Netherlands	-5.41	17.79	**5.26**	7.22	2.07	21.29	1.06	3.18	0.09
United Kingdom	-1.34	11.16	**5.50**	7.36	1.94	19.96	0.66	3.69	-0.06
World (USD)	-1.25	7.87	**5.75**	7.16	1.67	17.23	0.13	1.05	0.15
Canada	4.32	8.28	**6.24**	7.56	1.63	16.77	0.09	-0.13	0.16
United States	-2.74	14.24	**6.52**	8.50	1.96	20.19	-0.14	-0.35	0.00
South Africa	11.05	4.61	**7.25**	9.46	2.19	22.57	0.94	2.58	0.05
Australia	7.78	8.98	**7.70**	9.21	1.71	17.64	-0.25	0.06	-0.02
Sweden	-0.70	15.02	**7.80**	10.07	2.20	22.62	0.55	0.92	0.11

Extremes of History

While the 1990s and early 2000s were not typical, they are not unique. The top panel of Table **2** highlights other noteworthy episodes of world political and economic history since 1900. It shows real equity returns over the five worst episodes for equity investors, and over four "golden ages" for the world indexes and the world's five largest markets. These five markets are of interest not just because of their economic importance, but also because they experienced the most extreme returns out of all 17 countries in our database.

The five worst episodes for equity investors comprise the two World Wars and the three great bear markets—the Wall Street Crash and Great Depression, the first oil shock and recession of 1973–74, and the 2000–02 bear market after the internet bubble. While the World Wars were in

Table 2: Real Equity Returns in Key Markets over Selected Periods

		Real Rate of Return (%) over the Period						
Period	**Description**	**U.S.**	**U.K.**	**France**	**Germany**	**Japan**	**World**	**World ex-US**
Selected Episodes								
1914–18:	World War I	-18	-36	-50	-66	66	-20	-21
1919–28	Post-WWI recovery	372	234	171	18	30	209	107
1929–31	Wall Street Crash	-60	-31	-44	-59	11	-54	-47
1939–48	World War II	24	34	-41	-88	-96	-13	-47
1949–59	Post-WWII recovery	426	212	269	4094	1565	517	670
1973–74	Oil shock/recession	-52	-71	-35	-26	-49	-47	-37
1980–89	Expansionary 80s	184	319	318	272	431	255	326
1990–99	90s tech boom	279	188	226	157	-42	113	40
2000–02	Internet 'bust'	-42	-40	-46	-57	-49	-44	-46
Periods with Highest Returns								
1-year	Return	57	97	66	155	121	70	79
periods	*Period*	*1933*	*1975*	*1954*	*1949*	*1952*	*1933*	*1933*
2-year	Return	90	107	123	186	245	92	134
periods	*Period*	*1927–28*	*1958–59*	*1927–28*	*1958–59*	*1951–52*	*1932–33*	*1985–86*
5-year	Return	233	176	310	652	576	174	268
periods	*Period*	*1924–28*	*1921–25*	*1982–86*	*1949–53*	*1948–52*	*1985–89*	*1985–89*
Periods with Lowest Returns								
1-year	Return	-38	-57	-40	-91	-86	-35	-41
periods	*Period*	*1931*	*1974*	*1945*	*1948*	*1946*	*1931*	*1946*
2-year	Return	-53	-71	-54	-90	-95	-47	-52
periods	*Period*	*1930–31*	*1973–74*	*1944–45*	*1947–48*	*1945–46*	*1973–74*	*1946–47*
5-year	Return	-45	-63	-78	-93	-98	-50	-56
periods	*Period*	*1916–20*	*1970–74*	*1943–47*	*1944–48*	*1943–47*	*1916–20*	*1944–48*
Longest Runs of Negative Real Returns								
Longest	Return	-7	-4	-8	-8	-1	-9	-11
runs over	*Period*	*1905–20*	*1900–21*	*1900–52*	*1900–54*	*1900–50*	*1901–20*	*1928–50*
106 years	Number of Years	16	22	53	55	51	20	23

aggregate negative for equities, there were relative winners and losers, corresponding to each country's fortunes in war. Thus in World War I, German equities performed the worst (–66%), while Japanese stocks fared the best (+66%), as Japan was a net gainer from the war. In World War II and its aftermath,[8] Japanese and German equities were decimated (–96% and –88% respectively), while both U.S. and U.K. equities enjoyed small positive real returns.

Table 2 shows that the world wars were less damaging to world equities than the peacetime bear markets. From 1929–31, during the Wall Street Crash and ensuing Great Depression, the world index fell by 54% in real, U.S. dollar terms, compared with 20% during World War I and 13% in World War II. For the United States, Germany, and the world index this was the most savage of the three great bear markets, and from 1929–31 the losses in real terms were 60%, 59%, and 54%, respectively. From peak to trough, the falls were even greater. Table 2 records calendar year returns, but the U.S. equity market did not start falling until September 1929, reaching its nadir in June 1932, 79% (in real terms) below its 1929 peak.

British and Japanese investors, in contrast, suffered greater losses in 1973–74 than during the 1930s. This was the time of the first OPEC oil squeeze after the 1973 October War in the Middle East, which drove the world into deep recession. Over 1973–74, the real returns on U.K., U.S., Japanese, and world equities were –71%, –52%, –49%, and –47%, respectively. The last row of the top panel of Table 2 shows that the world equity index fell by almost as much (44% in real terms) in the bear market of 2000–02, which followed the late 1990s internet bubble. Table 2 shows the returns over calendar years, and from the start of 2000 until the trough of the bear market in March 2003, the real returns on U.S., U.K., Japanese, and German equities were even lower at –47%, –44%, –53%, and –65%, respectively.

The top panel of Table 2 also summarizes real returns over four "golden ages" for equity investors. The 1990s, which we highlighted in Table 1 as a recent period of exceptional performance, was the most muted of the four, with the world index showing a real return of 113%. While the 1990s was an especially strong period for the U.S. market (279% real return), the world index was held back by Japan.[9] The world index rose by appreciably more during the 1980s (255% in real terms) and the two post-world war recovery periods (209% in the decade after World War I and 517% from 1949–59). During the latter period, a number of equity markets enjoyed quite staggering returns. For example, Table 2 shows that during these nascent years of the German and Japanese "economic miracles", their equity markets rose in real terms by 4094% (i.e., 40.4% p.a.) and 1565% (29.1% p.a.), respectively.

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[8] To measure the full impact of World War II on German and Japanese equity returns, it is necessary to extend the period through to 1948 to include the aftermath of the war. This is because, as noted above, stock prices in Germany were effectively fixed after January 1943, and the exchanges closed in 1944 with the Allied invasion, and did not reopen until July 1948, when prices could finally reflect the destruction from the war. Meanwhile, German inflation from 1943–48 was 55%. In Japan, the stock market closed in 1944, but over-the-counter trading resumed from 1946 onwards. In Japan, the sharp negative real returns recorded in 1945, 1946, and 1947 thus reflect the hyperinflation that raged from 1945 onward (inflation from 1945–48 was 5,588%), the resumption of trading at market-determined prices in 1946, and the break-up of the zaibatsu industrial cartels and the distribution of their shares to the workforce.

[9] Table 2 shows that Japan experienced a real return of –42% during the 1990s (equivalent to an annualized real return of –5.2% p.a. as shown in the third column of Table 1). At the start of the 1990s, the Japanese stock market was the largest in the world by market capitalization, with a 40.4% weighting in the world index, compared with 32.2% for the United States. Japan's poor performance, coupled with its high weighting in the world index, and even higher weighting (60%) in the world ex-U.S. naturally had a depressing effect on the returns on the world and world-ex U.S indexes (see Table 2 and column 2 of Table 1).

The second and third panels of Table 2 show the returns for, and dates of, the one-, two-, and five-year periods during which each country and the world indexes experienced their highest and lowest returns. The picture that emerges reinforces the discussion above: in nearly all cases, the best and worst periods are drawn from, and are subsets of, the episodes listed in the top panel. Note that the spreads between worst and best are wide. One-year real returns range from –35% to +70% (world), –38% to +57% (United States), –91% to +155% (Germany), and –86% to 121% (Japan). Five-year real returns extend from –50% to +174% (world), –45% to +233% (United States), –93% to +652% (Germany), and –98% to 576% (Japan).

Finally, the bottom panel of Table 2 reports the longest period over which each country (or world index) has experienced a cumulative negative real return. It shows that for the United States, the longest such period was the 16 years from 1905–20, when the cumulative return was –7%. This reconfirms Siegel's (2002) observation that U.S. investors have historically always enjoyed a positive real return as long as they have held shares for at least 20 years. However, Table 2 shows that investors in other countries have not been so fortunate, with Japan, France, and Germany suffering extended periods lasting over half a century during which cumulative equity returns remained negative in real terms. Dimson, Marsh, and Staunton (2004) report that three-quarters of the DMS countries experienced intervals of negative real stock market returns lasting for more than two decades.

The Long-Run Perspective

The statistics presented in Tables 1 and 2 and the discussion in the previous section serve to emphasize the volatility of stock markets, and the substantial variation in year-to-year and period-to-period returns. Clearly, because of this volatility, we need to examine intervals that are much longer than five years or a decade when estimating means or equity premiums. The fourth column of Table 1 (shown in boldface) illustrates the perspective that longer periods of history can bring by displaying real equity returns over the 106-year period 1900–2005. Clearly, these 106-year returns contrast favourably with the disappointing returns over 2000–2005 (second column), but they are much lower than the returns in the 1990s (third column).

The remaining columns of Table 1 present formal statistics on the distribution of annual real returns over 1900–2005, and again, they emphasize how volatile stock markets were over this period. The arithmetic means of the 106 one-year real returns are shown in the fifth column. These exceed the geometric means (fourth column) by approximately half the variance of the annual returns. The standard deviation column shows that the U.S., U.K., Swiss, and Danish equity markets all had volatilities of around 20%. While this represents an appreciable level of volatility, these countries are at the lower end of the risk spectrum, with only Australia and Canada having lower standard deviations. The highest volatility markets were Italy, Japan, and Germany, with volatilities close to, or above, 30%. These high levels of volatility imply that the arithmetic means are estimated with high standard errors (see column six), and we return to this issue below when we discuss the precision of equity premium estimates.

The skewness and excess kurtosis columns in Table 1 show that returns were positively skewed except in the United States, and in most countries, they were noticeably more fat-tailed than would be expected if they were normally distributed.[10] Finally, the serial correlation column shows that to a good approximation, returns are serially independent. The average serial correlation coefficient was 0.07, and only two out of 17 coefficients were significant at the 95% level—only slightly higher than the proportion that would be expected from chance.

The fourth column of Table 1 shows that the 106-year annualized real return on U.S. equities was 6.5%. The equivalent real return on non-U.S. equities—from the perspective of a U.S. investor, and as measured by the world index excluding the United States—was lower at 5.2%. This lends initial support to the concern about success bias from focusing solely on the United States. At the same time, the gap is not large, and it is also clear from Table 1 that the stock markets of several other countries performed even better than the United States. Table 1 shows real returns in local currency terms, however, rather than equity premiums, and we defer presenting comprehensive comparisons of the latter until Section 5 below.

However, to reinforce the importance of focusing on long-run data, we briefly preview the equity premium data for the U.S. market. The bars in **Figure 2** show the year-by-year historical U.S. equity premium calculated relative to the return on Treasury bills over 1900–2005.[11] The lowest premium was –45% in 1931, when equities earned –44% and Treasury bills 1%; the highest was 57% in 1933, when equities earned 57.6% and bills 0.3%. Over the entire 106-year interval, the mean annual excess return over treasury bills was 7.4%, while the standard deviation was 19.6%. On average, therefore, this confirms that U.S. investors received a positive, and large, reward for exposure to equity market risk.

Because the range of year-to-year excess returns is very broad, it would be misleading to label these as "risk premiums." As noted above, investors cannot have expected, let alone required, a negative risk premium from investing in equities. Many low and all negative premiums must therefore reflect unpleasant surprises. Nor could investors have required premiums as high as the 57% achieved in 1933. Such numbers are quite implausible as a required reward for risk, and the high realizations must therefore reflect pleasant surprises. To avoid confusion, it is helpful to refer to a return in excess of the risk free rate, measured over a period in the past, simply as an excess return or as the "historical" equity premium (rather than equity premium). When looking to the future, it is helpful to refer to the "expected" or "prospective" equity premium.

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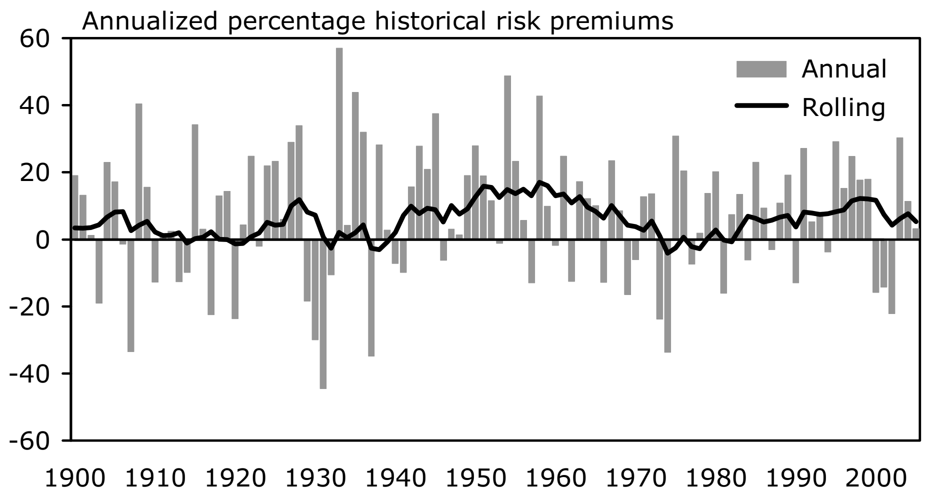
[10] The average coefficients of skewness and kurtosis for the 17 countries were 0.76 and 2.60. This is consistent with our expectation that the distribution of annual stock returns would be lognormal, rather than normal, and hence positively skewed. But when we examine the distribution of log returns (i.e., the natural logarithm of one plus the annual return), we find average skewness and kurtosis of –0.48 and 3.25, i.e., the skewness switches from positive to negative, and the distributions appear even more leptokurtic. This finding is heavily influenced by the extreme negative returns for Germany in 1948 and Japan in 1946. As noted in section 3 above, German returns from 1943–48 and Japanese returns from 1945–46 must be treated with caution, as although the total return over these periods is correct, the values for individual years cannot be regarded as market-determined. The values recorded for Germany in 1948 and Japan in 1946 thus almost certainly include accumulated losses from previous years. Excluding Germany and Japan, the coefficients of skewness and kurtosis based on log returns were –0.20 and 1.40, which are much closer to the values we would expect if annual returns were lognormally distributed.

[11] For convenience, we estimate the equity premium from the arithmetic difference between the logarithmic return on equities and the logarithmic return on the riskless asset. Equivalently, we define *1+EquityPremium* to be equal to *1+EquityReturn* divided by *1+RisklessReturn*. Defined this way, the equity premium is a ratio and therefore has no units of measurement. It is identical if computed from nominal or real returns, or if computed from dollar or euro returns.

Figure 2: Annual and Rolling Ten-Year U.S. Premiums Relative to Bills, 1900–2005



The ten-year excess returns were sometimes negative, most recently in the 1970s and early 1980s. Figure 2 also reveals several cases of double-digit ten-year premiums. Clearly, a decade is too brief for good and bad luck to cancel out, or for drawing inferences about investor expectations. Indeed, even with over a century of data, market fluctuations have an impact. Taking the United Kingdom as an illustration, the arithmetic mean annual excess return from 1900–49 was only 3.1%, compared to 8.8% from 1950–2005. As over a single year, all we are reporting is the excess return that was realized over a period in the past.

To quantify the degree of precision in our estimates, we can compute standard errors. Assuming that each year's excess return is serially independent,[12] the standard error of the mean historical equity premium estimate is approximately $\sigma/\sqrt{T}$, where σ is the standard deviation of the annual excess returns, and T is the period length in years. Since we have seen that σ was close to 20% for the U.S. market, this implies that the standard error of the mean historical equity premium estimated over ten years is 6.3%, while the standard error using 106 years of data remains quite high at approximately 2%. Since we saw in Table 1 above that most countries had a standard deviation that exceeded that of the U.S. market, the standard error of the mean equity premium is typically larger in non-American markets.

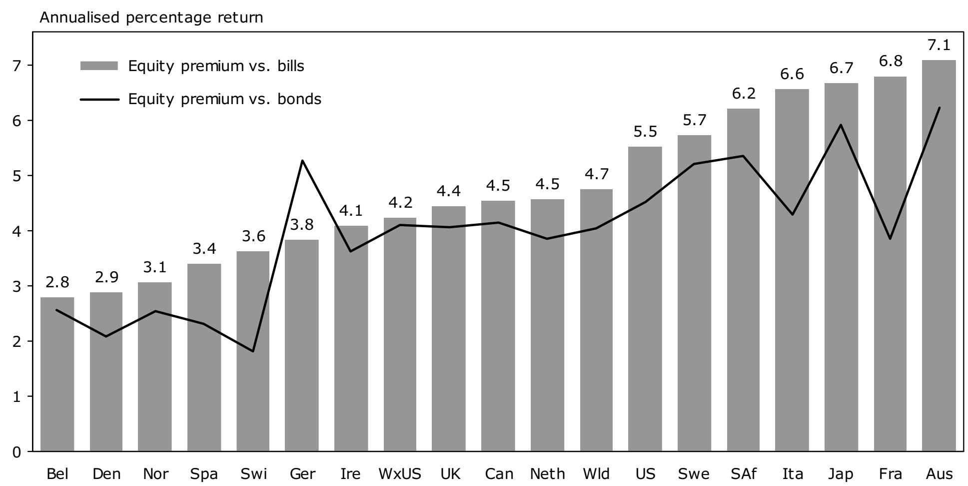
When estimating the historical equity premium, therefore, the case for using long-run data is clear. Stock returns are so volatile that it is hard to measure the mean historical premium with precision. Without long-run data, the task is impossible, and even with over a century of data, the standard error remains high—even if we assume that the underlying series is stationary.

[12] We saw in Table 1 above that this was a good approximation for real returns, and the same holds true for excess returns. For the United States, the serial correlation of excess returns over 1900–2005 was 0.00, while the average across all 17 countries was 0.05. For excess returns defined relative to bonds rather than bills, the average serial correlation was 0.04.

5. NEW GLOBAL EVIDENCE ON THE EQUITY PREMIUM

Figure 3 shows the annualized (geometric mean) historical equity premiums over the 106-year period from 1900–2005 for each of the 17 countries in the DMS database, as well as the world index and the world excluding the United States. Countries are ranked by the equity premium relative to bills (or the nearest equivalent short-term instrument), displayed as bars. The line-plot shows each country's equity premium relative to bonds (long-term government bonds). Since the world indexes are computed here from the perspective of a U.S. (dollar) investor, the world equity premiums relative to bills are calculated with reference to the U.S. risk-free (Treasury bill) rate. The world equity premiums relative to bonds are calculated relative to the world bond indexes.

Figure 3: Worldwide Annualized Equity Premiums 1900–2005*



* Germany omits 1922-23

Figure 3 shows that equities outperformed both bills and bonds in all 17 countries over this period, and that, in general, the equity premium was large. The chart lends support to the concern about generalizing from the U.S. experience by showing that the U.S. equity premium relative to bills was 5.5% compared with 4.2% for the rest of the world. But while noteworthy, this difference is not that large, and Figure 3 shows that several countries had larger premiums than the United States. For the world index (with its large U.S. weighting), the premium relative to bills was 4.7%. The U.K. equity premium was a little below the world average at 4.4%.

Relative to long bonds, the story for the 17 countries is similar, although on average, the premiums were around 0.8% lower, reflecting the average term premium, i.e., the annualized amount by which bond returns exceeded bill returns. The annualized U.S. equity premium relative to bonds was 4.5% compared with 4.1% for the world ex-U.S. Across all 17 countries, the equity premium relative to bonds averaged 4.0%, and for the world index it was also 4.0%.[13] Thus,

[13] Over the entire period, the annualized world equity risk premium relative to bills was 4.74%, compared with 5.51% for the United States. Part of this difference, however, reflects the strength of the dollar. The world risk premium is computed here from the world equity index expressed in dollars, in order to reflect the perspective of a U.S.-based global investor. Since the currencies of most other countries depreciated against the dollar over the twentieth century, this lowers our estimate of the world equity risk premium relative to the (weighted) average of the local-currency-based estimates for individual countries.

while U.S. and U.K. equities have performed well, both countries are toward the middle of the distribution of worldwide equity premiums, and even the United States is not hugely out of line compared to other markets.

The Equity Premium Around the World

Table 3 provides more detail on the historical equity premiums. The left half of the table shows premiums relative to bills, while the right half shows premiums relative to government bonds. In each half of the table we show the annualized, or geometric mean, equity premium over the entire 106 years (i.e., the data plotted in Figure 3); the arithmetic mean of the 106 one-year premiums; the standard error of the arithmetic mean; and the standard deviation of the 106 one-year premiums. The geometric mean is, of course, always less than the arithmetic mean, the difference being approximately one-half of the variance of the historical equity premium.

Table 3 shows that the *arithmetic* mean annual equity premium relative to bills for the United States was 7.4% compared with 5.9% for the world excluding the United States. This difference of 1.5% again lends support to the notion that it is dangerous to extrapolate from the U.S. experience because of *ex post* success bias. But again we should note that Table 3 shows that the United States was by no means the country with the largest arithmetic mean premium. Indeed, on a strict ranking of arithmetic mean premiums, it was eighth largest out of 17 countries.

Table 3: Annualized Equity Premiums for 17 Countries, 1900–2005

% p.a.	Historical Equity Premium Relative to Bills				Historical Equity Premium Relative to Bonds			
Country	Geometric Mean	Arithmetic Mean	Standard Error	Standard Deviation	Geometric Mean	Arithmetic Mean	Standard Error	Standard Deviation
Australia	7.08	8.49	1.65	17.00	6.22	7.81	1.83	18.80
Belgium	2.80	4.99	2.24	23.06	2.57	4.37	1.95	20.10
Canada	4.54	5.88	1.62	16.71	4.15	5.67	1.74	17.95
Denmark	2.87	4.51	1.93	19.85	2.07	3.27	1.57	16.18
France	6.79	9.27	2.35	24.19	3.86	6.03	2.16	22.29
Germany*	3.83	9.07	3.28	33.49	5.28	8.35	2.69	27.41
Ireland	4.09	5.98	1.97	20.33	3.62	5.18	1.78	18.37
Italy	6.55	10.46	3.12	32.09	4.30	7.68	2.89	29.73
Japan	6.67	9.84	2.70	27.82	5.91	9.98	3.21	33.06
Netherlands	4.55	6.61	2.17	22.36	3.86	5.95	2.10	21.63
Norway	3.07	5.70	2.52	25.90	2.55	5.26	2.66	27.43
South Africa	6.20	8.25	2.15	22.09	5.35	7.03	1.88	19.32
Spain	3.40	5.46	2.08	21.45	2.32	4.21	1.96	20.20
Sweden	5.73	7.98	2.15	22.09	5.21	7.51	2.17	22.34
Switzerland	3.63	5.29	1.82	18.79	1.80	3.28	1.70	17.52
U.K.	4.43	6.14	1.93	19.84	4.06	5.29	1.61	16.60
U.S.	5.51	7.41	1.91	19.64	4.52	6.49	1.96	20.16
Average	**4.81**	**7.14**	**2.21**	**22.75**	**3.98**	**6.08**	**2.11**	**21.71**
World-ex U.S.	**4.23**	**5.93**	**1.88**	**19.33**	**4.10**	**5.18**	**1.48**	**15.19**
World	**4.74**	**6.07**	**1.62**	**16.65**	**4.04**	**5.15**	**1.45**	**14.96**

* Germany omits 1922–23

Care is needed, however, in comparing and interpreting long-run arithmetic mean equity premiums. For example, Table 3 shows that, relative to bills, Italy had the highest arithmetic equity premium at 10.5%, followed by Japan at 9.8%, France at 9.3%, and Germany at 9.1%. Yet these four countries had below average equity returns (see Table 1). Table 3 shows that part of the explanation lies in the high historical volatilities in these four markets, 32%, 28%, 24% and 33%, respectively. As we saw above, much of this volatility arose during the first half of the twentieth century, during, or in the aftermath of, the World Wars. In all four cases, therefore, the long-run equity premium earned by investors (the geometric mean) was well below the arithmetic mean. But this is only part of the story, since Table 3 shows that these countries still had above-average geometric equity premiums, despite their below-average equity market returns. (Italy, Japan, and France had above average premiums relative to bills, while Italy, Japan, and Germany had above average premiums relative to bonds). The explanation, of course, lies in the very poor historical bill and/or bond returns in these four countries, and we return below to the issue of poor equity returns coinciding with poor bill and bond returns.

Table 3 shows that both the U.S. and U.K. equity premiums relative to bills had similar standard deviations of close to 20% per annum, and that only four other countries had standard deviations that were as low, or lower than this. As noted above, the relatively high standard deviations for the equity premiums for the 17 countries, ranging from 17–33%, indicate that, even with 106 years of data, the potential inaccuracy in historical equity premiums is still fairly high. Table 3 shows that the standard error of the equity premium relative to bills is 1.9% for the United States, and the range runs from 1.6% (Canada) to 3.3% (Germany).

A Smaller Risk Premium

By focusing on the world, rather than the United States, and by extending the time span to 1900–2005, the equity premium puzzle has become quantitatively smaller. We saw in Section 2 that, before our new database became available in 2000, the most widely cited number for the U.S. arithmetic mean equity premium relative to bills was the Ibbotson (2000) estimate for 1926–99 of 9.2%. Table 3 shows that by extending the time period backwards to include 1900–25 and forwards to embrace 2000–05, while switching to more comprehensive index series, the arithmetic mean equity premium shrinks to 7.4%. Table 3 also shows that the equivalent world equity premium over this same period was 6.1%.

But while the puzzle has become smaller than it once was, 6.1% remains a large number. Indeed, Mehra and Prescott's original article documented a premium of 6.2%, albeit for a different time period. As we noted in the introduction to this paper, the equity premium, and hence the equity premium puzzle, continued to grow larger in the years after their paper was written. By extending the estimation period, and expanding our horizons to embrace the world, we have simply succeeded in reducing the puzzle back down to the magnitude documented in Mehra-Prescott's original paper. If 6.2% was a puzzle, it follows that 6.1% is only a very slightly smaller puzzle.

In terms of the empirical evidence, if we are to further shrink our estimate of the expected premium, two further possibilities remain. The first is that our world index is still upward biased because of survivorship bias in terms of the countries included. The second possibility relates to "good luck" and/or a systematic repricing of equities and their riskiness to investors over the last century. As we have seen, however, although the U.S. equity market has performed well, it was not a massive outlier. The challenge for the good luck/repricing hypothesis is thus to explain not just why the United States had "100 years of good luck", but why the rest of the world was almost as fortunate. In the next subsection, we assess the possible impact of survivorship bias. Section 6 then addresses the issues of good luck and repricing.

Survivorship of Markets

Several researchers, most notably Brown, Goetzmann, and Ross (1995) and Jorion and Goetzmann (1999), have suggested that survivorship bias may have led to overestimates of the historical equity premium. Li and Xu (2002) argue on theoretical grounds that this is unlikely to explain the equity premium puzzle, since, for survival models to succeed, the *ex ante* probability of long-term market survival has to be extremely small, which they claim contradicts the history of the world's financial markets. In this section, we look at the empirical evidence on returns and survivorship, and reach the same conclusion as Li and Xu, namely that concerns over survivorship are overstated, especially with respect to true survivorship bias, namely, the impact of markets that failed to survive.

In practice, however, the term "survivorship bias" is often used to also embrace *ex post* success bias as well as true survivorship bias. By comparing U.S. history with that of 16 other countries, we have already addressed the issue of success bias. While a legitimate concern, we are still left with a high historical 17-country world equity premium. Mehra (2003) has also noted that, with respect to its impact on the equity premium, success bias is partly mitigated by the tendency of successful markets to enjoy higher bond and bill returns, as well as higher equity returns; similarly, unsuccessful markets have tended to have lower real returns for both government securities and equities. In other words, there has been a positive correlation between real equity and real bill (or bond) returns.[14] Among markets with high *ex post* equity premiums there are naturally countries with excellent equity performance (like Australia); but there are also countries whose below-average equity returns nevertheless exceeded their disastrous bond returns (like Germany or Japan). Consequently, the cross-sectional dispersion of equity premiums is narrower than the cross-sectional dispersion of equity returns.

Our equity premiums are, of course, measured relative to bills and bonds. In a number of countries, these yielded markedly negative real returns, often as a result of periods of very high or hyperinflation. Since these "risk-free" returns likely fell below investor expectations, the corresponding equity premiums for these countries are arguably overstated. Even this is not clear, however, as equity returns would presumably have been higher if economic conditions had not given rise to markedly negative real fixed-income returns. Depressed conditions were a particular feature of the first half of the twentieth century, a period in which hyperinflations were relatively prevalent.[15] Had economic conditions been better, it is possible that the equity premium could have been larger. Similarly, it could be argued that in the more successful economies, the *ex post* bill and bond returns may, over the long run, have exceeded investors' expectations.

[14] Over the entire 106-year period, the cross-sectional correlation between the 17 real equity and 17 real bill (bond) returns was 0.63 (0.66). Measured over 106 individual years, the time-series correlations between real equity and real bill returns ranged from 0.01 in The Netherlands to 0.44 in Japan, with a 17-country mean correlation of 0.22, while the time-series correlations between real equity and real bond returns ranged from 0.11 in The Netherlands to 0.55 in the United Kingdom, with a 17-country mean correlation of 0.37.

[15] In our sample of countries over 1900–1949, the cross-sectional correlation between real equity and real bill (bond) returns was 0.68 (0.80). The time-series correlations between annual real equity and real bill (bond) returns had a 17-country mean of 0.31 (0.42).

We concluded above, therefore, that provided a very long run approach is taken, inferences from the United States do not appear to have given rise to very large overestimates of the historical world equity premium. It is still possible, however, that our world index overstates worldwide historical equity returns by omitting countries that failed to survive. The most frequently cited cases are those of Russia and China, whose equity markets experienced a compound rate of return of –100%.[16] However, there are other stock markets, apart from Russia and China, which we have so far been unable to include in our sample due to data unavailability.[17]

At noted earlier, at the start-date of our database in 1900, stock exchanges already existed in at least 33 of today's nations. Our database includes 17 of these, and we would ideally like to assess their importance in terms of market capitalization relative to the countries for which we have no data. Unfortunately, the required data are not available. Such aggregate data were neither recorded nor even thought of in 1900.[18] Rajan and Zingales (2003), however, do report a set of market capitalization to GDP ratios for 1913. By combining these with Maddison (1995) GDP data, coupled with some informed guesses for countries not covered by Rajan and Zingales, we can calculate approximate equity market capitalizations at that date.

Based on these estimates, it is clear that the 17 DMS database countries dominated the early twentieth century world equity market. The largest omitted market is Russia, which we estimate in those days represented just under 5% of total world capitalization. Next is Austria-Hungary, which then incorporated Austria, Hungary, the Czech Republic, Slovakia, Slovenia, Croatia, Bosnia, and parts of modern-day Ukraine, Poland, and even Italy (Trieste), and which accounted for some 2% of world capitalization. Data described in Goetzmann, Ukhov, and Zhu (2006) suggest that the Chinese equity market accounted for 0.4% of world equity market capitalization in 1900. In addition, there was a group of Latin American markets, including Argentina, Brazil, Mexico, and Chile that in total made up around 1½% of overall capitalization; and a number of small markets that total less than 1%.[19] In addition to Russia and China, several other exchanges from 1900 did not survive World War II and ended in disaster, notably those in Czechoslovakia (now the Czech Republic and Slovakia), Hungary, and Poland (though these three countries were not independent states in 1900, being part of the Russian and the Austria-Hungary empires). We believe that the DMS database accounted for 90% of world equity capitalization at the start of the twentieth century, and that omitted countries represented just 10%.

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[16] It could be argued that the nationalization of corporations in Russia after the revolution of 1917 and in China after the communist victory in 1949 represented a redistribution of wealth, rather than a total loss. But this argument would not have been terribly persuasive to investors in Russian and Chinese equities at the time. It is possible, however, that some small proportion of equity value was salvaged in Russian and Chinese companies with large overseas assets, e.g., in Chinese stocks with major assets in Hong Kong and Formosa (now Taiwan).

[17] We are endeavouring to assemble total return index series over 1900-2005 for countries such as New Zealand, Finland, and Austria; and we believe that, in principle, series for Argentina, India, Hong Kong, and other markets might also be compiled.

[18] The few snippets of historical data that exist, e.g., Conant (1908) are expressed in terms of the nominal value of the shares outstanding rather than the total market value of the shares. Furthermore, figures are often given only for the total nominal value of all securities, rather than that of equities. For the U.S., U.K., and two other countries we have meticulously constructed market capitalization data from archival sources relating to individual stocks. But for many of the other markets, it is possible that even the disaggregated archive source data may not have survived from the end of the nineteenth century to the present time.

[19] The Latin American stock markets suffered several episodes of political and economic instability and hyperinflation; today, they account for some 1.15% of world market capitalization, which is roughly three-quarters of their weighting in 1913. The other markets, that in 1913 totalled less than 1% of world market capitalization, today account for some 2.3% of the world market; this group includes countries such as Egypt, Finland, Greece, Hong Kong (China), India, New Zealand, and Sri Lanka.

Survivorship Bias is Negligible

Our estimates of the equity premium are based on 17 surviving markets and, as noted earlier, ignore at least 16 non-surviving markets. To quantify the global impact of omitted markets, it is unnecessary to focus on individual markets as in Li and Xu (2002). We assume the annualized historical equity return for markets that survived for T years was $R_{survivors}$ and that for markets which are missing from the DMS database, it was $R_{omitted}$. Assume a proportion S of the worldwide equity market survived the entire period. Then the cumulative worldwide equity premium $ERP_{worldwide}$ is given by:

$$(1 + ERP_{worldwide})^T = [S\,(1 + R_{survivors})^T + (1\text{-}S)\,(1 + R_{omitted})^T] \,/\, [(1 + R_{riskfree})^T] \qquad \textbf{[1]}$$

where $R_{riskfree}$ is the riskfree interest rate for the reference country. An extreme assumption would be that all omitted markets became valueless, namely $R_{omitted} = -1$; and that this outcome occurred, for every omitted country in a single disastrous year, rather than building up gradually. The worldwide equity premium, incorporating omitted as well as surviving markets, would therefore be given by:

$$(1 + ERP_{worldwide}) = S^{1/T}\,(1 + R_{survivors}) \,/\, (1 + R_{riskfree}) = S^{1/T}\,(1 + ERP_{survivors}) \qquad \textbf{[2]}$$

where $ERP_{survivors}$ is the historical equity premium for markets that survived. In our case, we estimate the proportion of the world equity market capitalization that survived was at least S=0.9 and our time horizon is T=106 years. To account for the omission of markets that existed in 1900 but did not survive, we must therefore adjust the *ex post* equity premium of the 17-country world index using a factor of $S^{1/T} = 0.9^{1/106} = 0.999$. The survivorship bias in the estimated equity premium is therefore the following:

$$ERP_{survivors} - ERP_{worldwide} = (1 - S^{1/T})(1 + ERP_{survivors}) = (1 - 0.999)(1 + ERP_{survivors}) \approx 0.001 \qquad \textbf{[3]}$$

where the final approximation reflects the fact that $ERP_{survivors}$ is an order of magnitude below 1. We see that, at most, survivorship bias could give rise to an overstatement of the geometric mean risk premium on the world equity index by about one-tenth of a percentage point. If disappearance were a slower process, the index weighting of countries destined to disappear would have declined gradually and the impact of survivorship bias would have been even smaller. Similarly, if omitted markets did not all become valueless, the magnitude of survivorship bias would have been smaller still.

While there is room for debate about the precise impact of the bias arising because some, but not all, equity markets experienced a total loss of value, the net impact on the worldwide geometric mean equity premium is no more than 0.1%. The impact on the arithmetic mean is similar.[20] At worst, an adjustment for market survivorship appears to reduce the arithmetic mean world equity premium relative to bills from around 6.1% (see Table 3 above) to approximately 6.0%. Thus the equity premium puzzle has once again become smaller, but only slightly so.

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[20] It is duplicative to derive this formally. The intuition involves disappearance of 10% of the value of the market over a century, which represents a loss of value averaging 0.1% per year.

6. DECOMPOSING THE HISTORICAL EQUITY PREMIUM

The conventional view of the historical equity premium is that, at the start of each period, investors make an unbiased, albeit inaccurate, appraisal of the end-of-period value of the stock market. Consequently, the *ex post* premium, averaged over a sufficiently long interval, is expected to be a relatively accurate estimate of investors' expectations. A key question is whether the historical premium may nevertheless be materially biased as a proxy for expectations because the past was in some sense unrepresentative. For instance, investors may have benefited from a century of exceptional earnings, or stock prices may have enjoyed a major, but non-sustainable, expansion in their valuation ratios. Our argument, which has some roots in Mehra and Prescott (1988), is that the historical equity premium may have beaten expectations not because of survivorship, but because of unanticipated success within the equity market. This analysis therefore draws on, and complements, Fama and French (2002), Ibbotson and Chen (2003), and Arnott and Bernstein (2003).

Unanticipated Success

To examine whether history may have witnessed exceptional earnings and/or expanding valuation ratios, consider how the stock market's past performance could, over multiple decades, be below or above expectations. The twentieth century opened with much promise, and only a pessimist would have believed that the next 50 years would involve widespread civil and international wars, the 1929 Crash, the great depression, episodes of hyperinflation, the spread of communism, conflict in Korea, and the Cold War. During 1900–1949 the annualized real return on the world equity index was 3.5%, while for the world excluding the U.S. it was just 1.5%. By 1950, only the most rampant optimist would have dreamt that over the following half-century, the annualized real return on world equities would be 9.0%. Yet the second half of the twentieth century was a period when many events turned out better than expected. There was no third world war, the Cuban missile crisis was defused, the Berlin Wall fell, the Cold War ended, productivity and efficiency accelerated, technology progressed, and governance became stockholder driven. As noted by Fama and French (2002), among others, the 9.0% annualized real return on world equities from 1950 to 1999 probably exceeded expectations.

In many countries valuation ratios expanded, reflecting—at least in part—reduced investment risk. Over the course of the twentieth century, the price/dividend ratio rose in all the DMS countries. Davis et al (2000) and Siegel (2002) report that for the U.S. over the period since the 1920s, the aggregate stock market price/earnings and price/book ratios also rose, and Dimson, Nagel and Quigley (2003) make similar observations for the U.K. In 1900 investors typically held a limited number of domestic securities from a few industries (Newlands (1997)). As the century evolved, new industries appeared, economic and political risk declined, closed- and open-ended funds appeared, liquidity and risk management improved, institutions invested globally, and finally, wealthier investors probably became more risk tolerant. Yet even if their risk tolerance were unchanged, as equity risk became more diversifiable, the required risk premium is likely to have fallen. These trends must have driven stock prices higher, and it would be perverse to interpret higher valuation ratios as evidence of an *increased* risk premium. Furthermore, insofar as stock prices rose because of disappearing barriers to diversification, this phenomenon is non-repeatable and should not be extrapolated into the future.

To unravel whether twentieth-century equity premiums were on balance influenced by exceptional earnings and expanding valuation ratios, we decompose long-term premiums into several elements. We use the fact that the historical equity premium is equal to the sum of the growth rate of real dividends, expansion in the price/dividend ratio, the mean dividend yield, and the change in the real exchange rate, *less* the risk-free real interest rate. As shown in Appendix 1, provided the summations and subtractions are geometric, this relationship is an identity.[21]

Decomposition of the Equity Premium

Table 4 reports these five components of the equity premium for each country. The first two columns show the growth rate of real dividends and the expansion in the price/dividend ratio. There is a widespread belief, largely based on the long-term record of the U.S. (Siegel (2002)), that nominal dividends can be expected to grow at a rate that exceeds inflation. In fact, only three countries have recorded real dividend growth since 1900 of more than 1% per year, and the average growth rate is –0.1%, i.e., the typical country has not benefited from dividends (or, in all likelihood, earnings) growing faster than inflation. Equally, there is the belief that superior stock market performance may be attributed to the expansion of valuation ratios. While there is some truth in this, it should not be overstated. Over the last 106 years, the price/dividend ratio of the average country grew by just 0.6% per year. Given the improved opportunities for stock market diversification, 0.6% seems a modest contribution to the historical equity premium.

Each country's real (local currency) capital gain is attributable to the joint impact of real dividend growth and expansion in the price/dividend ratio. Although the real capital gain is not reported explicitly in Table 4, note that only two countries achieved a real, local-currency capital gain of at least 2% per year: the U.S. (2.1%) and Sweden (3.6%). We should be cautious about extrapolating from these relatively large rates of capital appreciation to other markets around the world.

The middle column of Table 4 is the geometric mean dividend yield over the 106-year sample period. Averaged across all 17 countries, the mean dividend yield has been 4.5%, though it has been as large as 6.0% (in South Africa) and as low as 3.5% (in Switzerland). Interestingly, the countries whose mean dividend yield is closest to the cross-sectional average are Canada (4.5%) and the U.S. (4.4%). Drawing on Grullon and Michaely (2002) and Mauboussin (2006) to adjust for the impact of repurchases,[22] which are more important in the U.S. than elsewhere, that country's (adjusted) historical dividend yield rises to approximately 4.7%, which is just above the (unadjusted) 17-country average of 4.5%.

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[21] Let G_{dt} be the growth rate of real dividends; G_{PDt} be the rate at which the price/dividend ratio has expanded; $Y_t = D_t / P_t$ be the dividend yield, the ratio of aggregate dividends paid during period t divided by the aggregate stock price at the end of period t; X_t be the change in the real exchange rate; and R_{ft} be the risk-free real interest rate. The geometric mean from period 1 through period t, denoted by boldface italic, is calculated like this for all variables: $(1 + \boldsymbol{Y}_t) = [(1 + Y_1)(1 + Y_2)\ldots(1 + Y_t)]^{1/t}$. Appendix 1 shows that the equity risk premium is given by: $(1 + \boldsymbol{ERP}_t) = (1 + \boldsymbol{G}_{dt})(1 + \boldsymbol{G}_{PDt})(1 + \boldsymbol{Y}_t)(1 + \boldsymbol{X}_t) / (1 + \boldsymbol{R}_{ft})$ where boldface italic indicates a t-period geometric mean.

[22] Since the 1980s, U.S. yields have been low relative to the past partly because, under prior tax rules, companies could return capital to shareholders more effectively on an after-tax basis by means of stock repurchases. From 1972–2000, Grullon and Michaely (2002) estimate that annual repurchases averaged 38.0% of cash dividends (57.5% from 1984–2000), while over 1977–2005, Mauboussin (2006) estimates the average to be 64.8%. Adding repurchases to the yield, the "adjusted dividend yield" for the U.S. rises from its raw historical average of 4.4% to 4.7%, whether we use the data from Grullon and Michaely (2002) or Mauboussin (2006). The impact of a similar adjustment to other countries' dividend yield is smaller and often zero (see Rau and Vermaelen (2002)).

Table 4: Decomposition of the Historical Equity Premium for 17 Countries, 1900–2005

% p.a. Country	Real dividend growth rate	*plus** Expansion in the P/D ratio	*plus* Geometric mean dividend yield	*plus* Change in real exchange rate	*minus* U.S. real interest rate	*equals* Equity premium for U.S. investors
Australia	1.30	0.46	5.83	-0.24	0.96	6.42
Belgium	-1.57	0.08	3.95	0.62	0.96	2.05
Canada	0.72	0.98	4.46	-0.04	0.96	5.18
Denmark	-0.87	1.43	4.68	0.47	0.96	4.74
France	-0.74	0.42	3.93	-0.14	0.96	2.47
Germany	-1.54	0.97	3.69	0.23	0.96	2.35
Ireland	-0.25	0.38	4.66	0.25	0.96	4.05
Italy	-1.46	-0.08	4.05	0.10	0.96	1.58
Japan	-2.39	1.59	5.39	0.32	0.96	3.85
Netherlands	-0.16	0.41	5.00	0.27	0.96	4.54
Norway	-0.25	0.50	4.02	0.25	0.96	3.54
South Africa	0.91	0.31	5.95	-0.80	0.96	5.38
Spain	-0.62	0.24	4.13	0.00	0.96	2.75
Sweden	2.88	0.67	4.09	-0.05	0.96	6.72
Switzerland	0.32	0.60	3.52	0.72	0.96	4.22
U.K.	0.61	0.18	4.68	-0.03	0.96	4.46
U.S.	1.32	0.75	4.36	0.00	0.96	5.51
Average	**-0.10**	**0.58**	**4.49**	**0.11**	**0.96**	**4.11**
Std deviation	**1.32**	**0.45**	**0.71**	**0.35**	**0.00**	**1.51**
World (USD)	0.77	0.68	4.23	0.00	0.96	4.74

* Note: Premiums are relative to bill returns. All summations and subtractions are geometric

To examine the equity premium from the perspective of a global investor located in a specific home country, such as the U.S., we convert from real, local-currency returns to real, common-currency returns. Taylor (2002) demonstrates that, over the very long term, exchange rate changes reflect purchasing power changes. It is unsurprising, then, to see that the annualized change in our 17 countries' real exchange rate averages only 0.1% per year, and that every country's real exchange rate change was within the range ±1%. Note that, for the average country, the capital gain in real U.S. dollars (the sum of the second, third and fifth columns) was just 0.6% per year (not reported in Table 4). Measured in real U.S. dollars, only two countries achieved a capital gain that exceeded 2% per year. Nine countries achieved a real U.S. dollar capital gain that was between zero and +2%; and six achieved between zero and –2%.

The annualized real, local-currency returns were reported for all countries in Table 1; across all 17 countries, the average 106-year return is 5.0%. The real, USD-denominated returns (the sum of the second to the fifth columns in Table 4) average 5.1%. Deducting the U.S. risk-free interest rate of 0.96% in real terms, the equity premium for a U.S. investor buying stocks in each of the 17 markets is as listed on the right of Table 4: on average the premium is 4.1%.

The *ex post* equity premiums on the right of Table 4 vary cross-sectionally for two reasons: the expected reward for risk, and the impact of chance. In 1900 the expected premium for higher risk markets may have merited a high reward that was subsequently realised; if Australia, Canada, South Africa and Sweden were such economies, they achieved relatively large *ex post* premiums of over 5%. The expected premium for safer markets may have been low; if these markets are typified by Belgium, France, Germany, Italy and Spain, their *ex post* premiums were below 3%. However, this rationalization is not a credible explanation for historical performance. It is more likely that, in 1900, investors underestimated the probability of wars in Europe, not to mention the ultimate value of resource-rich economies like the U.S. and Canada. National returns thus probably had more to do with noise than with the expected premium in 1900, and averaging mitigates the impact of noise. In projecting the equity premium into the future, we therefore focus on the equally weighted worldwide average of 4.1% and on the market-capitalization weighted world index. The world index is shown in the bottom-right corner of Table 4; from the point of view of a U.S. based investor, the world equity premium was 4.7%.[23]

From the Past to the Future

Over the long run, real returns accrued largely from dividend payments, but Dimson, Marsh and Staunton (2000, 2002), Arnott and Ryan (2001), and Ritter (2005) highlight the time-series and cross-sectional variation of global equity premiums. Given the large standard errors of historical estimates, and the likelihood that risks and equity premiums are nonstationary, one cannot determine a precise, forward-looking expected premium. However, by considering separately each component of the historical equity premium, we can develop a framework for making inferences. We start by discussing the real dividend growth rate, followed by expansion in the price/dividend ratio, and then the average dividend yield. We also consider changes in the real exchange rate.

The second column of Table 4 indicates that, over the last 106 years, real dividends in the average country fell by 0.1% per year; in the world index, they rose by +0.8%; and in the U.S., they rose by +1.3%. Siegel (2005) and Siegel and Schwartz (2006), among others, observe that these long-term dividend growth rates were not achieved by a cohort of common stocks. The growth is that of a portfolio whose composition evolved gradually; today it contains almost no stocks from 1900, and largely comprises companies that gained a listing subsequently.[24] In large part, the long-term increase in index dividends reflects companies that not only gained a listing after 1900, but ceased to exist quite some years ago.[25] So what real dividend growth can we anticipate for the future? The worldwide growth rate was 0.8% per year; relative pessimists might project real dividend growth that is zero or less (Arnott and Bernstein (2002)), while relative optimists might forecast indefinite real growth in excess of 1% (Ibbotson and Chen (2003)).

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[23] We also computed the premium from the viewpoint of investors in the other 16 countries (for example, with a Japanese investor's premium based on every market's local-currency return converted into yen); the 17-country average equity premium varied between 2.3% for Denmark and 9.2% for Italy, with an average across all 17 reference currencies of 4.8%. Similarly, we computed the world premium from the viewpoint of investors in the other 16 countries (again converting every market's return into yen, and so on); the world equity premium varied between 2.9% for Denmark and 9.9% for Italy, with an average across all 17 reference currencies of 5.4%. This wide range of values is attributable mostly to differences in the annualized real risk-free rate between countries, rather than to exchange rate differences.

[24] To illustrate how much the listed equity market has evolved, Dimson, Marsh and Staunton (2002) report that almost two-thirds of the value of the U.S. market and half the value of the U.K. market was represented by railroad stocks at the end of 1899.

[25] There can also be a spurious jump in measured dividends when indexes are chain-linked. As a dividend series switches from narrower to broader composition, or from pre-tax to net-of-tax dividend payments, this can give rise to a step in income that impacts dividend growth estimates and (in the opposite direction) changes in the price/dividend ratio. We experimented with making adjustments for this for the U.S. and U.K. but the impact on estimated long-term dividend growth from splicing index series was small, and we abandoned this idea.

The third column of Table 4 reports that, over the last 106 years, the price/dividend ratio in the average country expanded by +0.6% per year; in the world and U.S. indexes it expanded by +0.7% and +0.8% respectively. As discussed earlier, this expansion reflected, at least in part, the enhanced opportunity to reduce portfolio risk as institutions increased the scope for diversification both domestically and internationally. If investors' risk tolerances are today similar to the past, we have already argued that the required risk premium is likely to have fallen and valuation ratios to have risen. There is no reason to expect the required risk premium to fall further over the long haul, so persistent multiple expansion seems unlikely. Without further expansion in the price/dividend ratio, this source of historical performance cannot contribute to forward-looking equity premiums.

The fourth column of Table 4 shows that, over the last 106 years, the geometric mean dividend yield in the U.S. was 4.4%, compared with 4.5% for the average country and 4.2% for the world index. Contemporary dividend yields (i.e., yields at end-2005, at the conclusion of the 106-year period) are lower than the historical average, even when buybacks are incorporated (see footnote 22 above). Whether adjusted for stock repurchases or not, projected levels for the long-term, geometric mean dividend yield are unlikely to be as large as the worldwide historical average of 4.2%. To the extent that the current (end-2005) level of dividends is indicative, the mean yield is likely to be lower in the future by at least ½–1%.

Over the long term, nominal exchange rates tend to follow fluctuations in relative purchasing power. The consensus forecast for changes over the long term in the real (inflation adjusted) exchange rate is zero. While the fifth column of Table 4 indicates that, historically, Americans gained (and others lost) from the rising real value of the U.S. dollar, this pattern cannot be extrapolated. We may assume that, over the long term, the real exchange rate change is expected to average zero.

The historical equity premium comprises the sum of the factors discussed in the preceding paragraphs, minus the real interest rate (see the penultimate column of Table 4). The final column of Table 4 reports the historical equity premiums for our 17 countries; they have an average of a 4.1% premium, with a cross-sectional standard deviation of 1.5%. While forward-looking estimates cannot be precise, a long-term projection of the annualized equity premium might, at the very least, involve making an adjustment to the historical record for components of performance that cannot be regarded as persistent. First, the expected change in the real exchange rate may be assumed to be zero, which implies an upward bias of 0.1% in the cross-sectional average of the country equity premiums. Second, the historical expansion in the price/dividend ratio cannot be extrapolated and might be assumed to be zero, which implies an upward bias of 0.6% in the cross-sectional average. These two adjustments, alone, attenuate the average country equity premium from 4.1% to 3.4%. When the same adjustments are made to the world index, the world equity premium shrinks from 4.7% to 4.0%. We noted above that if current dividend levels are a guide to the future, then the prospective mean dividend yield on the world index is likely to be lower than the historical average by at least ½–1%. This suggests a current equity premium of approximately 3–3½%.

Goyal and Welch (2006) conclude that for forecasting the equity risk premium one cannot do better than to project the historical average equity premium into the future, and Mehra (2003) contends that "over the long term, the equity premium is likely to be similar to what it has been in the past." However, as Campbell and Thompson (2005) point out, this cannot be the full story. History suggests that some part of the historical premium represents equity investors' good luck, and Fama and French (2002) say in relation to the period 1951–2000 that their "main message is that the unconditional expected equity premium…is probably far below the realized premium."

Jorion and Goetzmann (1999) justified estimating equity premiums from capital-appreciation indexes, stating "to the extent that cross-sectional variations in [dividend return minus real interest rate] are small, this allows comparisons of equity premiums across countries." They compared six markets with and without dividends, with similar conclusions, albeit over a sample period differing from the 1900-2005 interval used here. However, there is a cross-country standard deviation in dividend yields of 0.7% (see Table 4). If one computes the sum for each country of dividend yield plus dividend growth, the cross-sectional standard deviation is 1.6%. Our estimates of the equity premium avoid the inaccuracies that arise from the Jorion-Goetzmann approximation.

The debate on the size of the equity premium is sometimes conducted in terms of the arithmetic mean. For a stationary series the arithmetic mean is straightforward to interpret, but as Lettau and Nieuwerburgh (2006) highlight, the underlying parameters are unstable. This makes arithmetic means harder to interpret, which is why we undertake our decompositions using annualized returns.[26] For those who focus on the arithmetic mean equity premium, for the world index the latter is 1.3% larger than the geometric mean (see Table 3), and our forward-looking estimate of the arithmetic mean premium for the world index would be approximately 4½–5%.

Twentieth-century financial history was a game of two halves. In the first half, markets were harsh on equity investors; but in the second half they were benevolent.[27] As we show in Dimson, Marsh and Staunton (2002), early in the century dividend yields were mostly high relative to interest rates, whereas more recently yields have generally been lower. Looking at the 1900-2005 period as a whole, the world equity market experienced dividend growth and price/dividend multiple expansion that contributed 0.8% and 0.7% per year respectively to long-run real returns and hence to the *ex post* equity premium. The remainder was contributed by the annualized dividend yield of 4.2% (for the world index) and a real exchange rate adjustment. This suggests that the equity premium *expected* by investors was lower than the realized premium. The fact that *ex post* equity premiums were enhanced by this rate of dividend growth and multiple expansion is the "triumph" experienced by twentieth-century stock market investors.

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[26] For example, consider a hypothetical index that provides a zero equity premium over a two-period interval. Assume that, within this interval, it suffers from transient volatility; for instance, the single-period returns might be +900% and –90%. Unless there is reason to suppose that volatility will persist at its historical level, the expected equity premium will be lower than the high arithmetic mean of +405% per period. In contrast with formerly turbulent countries like Germany, Italy and Japan, the U.S. and world indexes did not experience volatility on this scale—at least, not during the twentieth century.

[27] Averaged across all 17 countries, the real, local-currency annualised equity returns were 2.7% in the first half of the twentieth century, versus 7.1% over the following 55 years. Note, however, that adverse stock market conditions also tended to impact the real returns from bonds and bills (see section 5).

7. CONCLUSION

We have presented new evidence on the historical equity premium for 17 countries over 106 years. Our estimates, including those for the U.S. and U.K., are lower than frequently quoted historical averages. The differences arise from bias in previous index construction for the U.K. and, for both countries, our use of a longer time frame that incorporates the earlier part of the twentieth century as well as the opening years of the new millennium. Prior views have been heavily influenced by the U.S. experience, yet we find that the U.S. equity premium is somewhat higher than the average for the other 16 countries.

The historical equity premium, presented here as an annualized estimate (i.e., as a geometric mean), is equal to investors' *ex ante* expectations plus the impact of luck. In particular, expanding multiples have underpinned past returns. In part, this reflects a general decline in the risk faced by investors as the scope for diversification has increased, and stocks have become more highly valued. In addition, past returns have also been enhanced during the second half of the twentieth century by business conditions that improved on many dimensions.

We cannot know today's consensus expectation for the equity premium. However, after adjusting for non-repeatable factors that favoured equities in the past, we infer that investors expect an equity premium (relative to bills) of around 3–3½% on a geometric mean basis and, by implication, an arithmetic mean premium for the world index of approximately 4½–5%. These estimates are lower than the historical premiums quoted in most textbooks or cited in surveys of finance academics. From a long-term historical and global perspective, the equity premium is smaller than was once thought. The equity premium survives as a puzzle, however, and we have no doubt that it will continue to intrigue finance scholars for the foreseeable future.

APPENDIX 1: DECOMPOSITION OF THE EQUITY PREMIUM

This appendix explains how we decompose the historical equity premium into five elements. These are, firstly, the average dividend yield over the sample period; next, the impact of real dividend growth, expansion of the price/dividend ratio, and the change in the real exchange rate; and finally, the risk-free interest rate that is used to compute the equity premium. Without loss of generality, the decomposition is in real (inflation adjusted) terms.

Capital Appreciation and Income

We assume the dividend payment on the equity index portfolio is received at the end of period t and is equal to D_t, that the price at the end of period t-1 is P_{t-1}, and that inflation over period t runs at the rate I_t.

Real dividends are $d_t = D_t / (1 + \boldsymbol{I}_t)^t$, where the denominator measures the inflation rate from period 1 to period t, namely $(1 + \boldsymbol{I}_t)^t = (1 + I_1)(1 + I_2)\ldots(1 + I_t)$. The price/dividend ratio is $PD_t = P_t / D_t$. The real capital gain over period t is given by:

$$\begin{aligned} 1+\text{Real gain}_t &= (P_t / P_{t-1}) / (1 + I_t) \\ &\equiv [(D_t / D_{t-1}) / (1 + I_t)]\ (PD_t / PD_{t-1}) \\ &= (d_t / d_{t-1})(PD_t / PD_{t-1}) \\ &= (1 + G_{dt})(1 + G_{PDt}) \qquad \textbf{[A1]} \end{aligned}$$

where the growth rate of real dividends is $G_{dt} = d_t / d_{t-1} - 1$, and the rate at which the price/dividend ratio has expanded is $G_{PDt} = PD_t / PD_{t-1} - 1$.

As a proportion of the initial investment, real dividend income during period t is:

$$\begin{aligned} \text{Real income}_t &= (D_t / P_{t-1}) / (1 + I_t) \\ &\equiv (D_t / P_t)(P_t / P_{t-1}) / (1 + I_t) \\ &= Y_t (P_t / P_{t-1}) / (1 + I_t) \qquad \textbf{[A2]} \end{aligned}$$

where $Y_t = D_t / P_t$ is the dividend yield, defined as the ratio of aggregate dividends paid over period t divided by the aggregate stock price at the end of period t. Note that the terms to the right of Y_t measure (one plus) the real capital gain over period t, as defined above.

Total Returns

The real return is equal to the arithmetic sum of [1] real capital gain and [2] real income, namely:

$$\begin{aligned} 1+\text{Real return}_t &\equiv [D_t / P_{t-1} + (P_t / P_{t-1})] / (1 + I_t) \\ &= (1 + G_{dt})(1 + G_{PDt})(1 + Y_t) \end{aligned}$$

So far we have decomposed returns denominated in a single currency. If the assets are purchased in unhedged foreign currency, we assume that each period's return is converted from foreign currency into home currency. The real return is then:

$$1+\text{Real return}_t = (1 + G_{dt})(1 + G_{PDt})(1 + Y_t)(1 + X_t) \quad \textbf{[A3]}$$

where X_t is the increase in the inflation-adjusted value of the home currency relative to the foreign currency, namely the change in the real exchange rate.[28]

The Equity Premium

Finally, we define the equity premium as the geometric difference between the real return defined in [3] and the risk-free real interest rate, R_{ft}. Hence the historical equity premium is:

$$1 + ERP_t = (1+\text{Real return}_t) / (1 + R_{ft})$$

$$= (1 + G_{dt})(1 + G_{PDt})(1 + Y_t)(1 + X_t) / (1 + R_{ft}) \quad \textbf{[A4]}$$

The historical equity premium is therefore equal to the sum of the real dividend growth rate, expansion in the price/dividend ratio, the dividend yield, and the change in the real exchange rate; less the risk-free real interest rate. All additions and subtractions are geometric.

Consequently, the geometric mean equity premium from period 1 through period t may be decomposed as follows:

$$1 + \boldsymbol{ERP}_t = (1 + \boldsymbol{G}_{\boldsymbol{d}t})(1 + \boldsymbol{G}_{\boldsymbol{PD}t})(1 + \boldsymbol{Y}_t)(1 + \boldsymbol{X}_t) / (1 + \boldsymbol{R}_{\boldsymbol{f}t}) \quad \textbf{[A5]}$$

where each term on the right hand side of [5] is the geometric mean of t single-period components. That is, $(1 + \boldsymbol{Y}_t)^t = (1 + Y_1)(1 + Y_2)\ldots(1 + Y_t)$, and so on.

To sum up, the annualized historical equity premium may be decomposed geometrically into five elements. These are as follows: firstly, the mean growth rate in real dividends; secondly, the mean rate of expansion in the price/dividend multiple; thirdly, the mean dividend yield; fourthly, the mean change in the real exchange rate; and finally, the mean risk-free real interest rate.

Finally, note that the reference country for the real exchange rate and the real interest rate must correspond. For example, the exchange rate may be relative to the U.S. dollar; and if so, the real interest rate should be the rate on the U.S. risk-free asset.

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[28] Obviously, when the investment is in domestic securities, the change in the real exchange rate is $X_t = 0$.

APPENDIX 2: DATA SOURCES FOR THE DMS DATABASE

Section 3 outlined the general methodology and guiding principles underlying the construction of the DMS database (see also Dimson, Marsh, and Staunton (2002, 2006a, and 2006b)). This appendix describes the data sources used for each country.

Australian equities are described in Officer's chapter in Ball, Brown, Finn, and Officer (1989). Ball and Bowers (1986) provide a complementary, though brief, historical analysis. We are grateful to Bob Officer for making his database available to us. Officer compiled equity returns from a variety of indexes. The early period made use of data from Lamberton's (1958) classic study. This is linked over the period 1958–74 to an accumulation index of fifty shares from the Australian Graduate School of Management (AGSM) and over 1975–79 to the AGSM value-weighted accumulation index. Subsequently, we use the Australia All-Ordinary index. Bond returns are based on the yields on New South Wales government securities from the start of the century until 1914. For the period 1915–49 the yields were on Commonwealth Government Securities of at least five years maturity. During 1950–86 the basis is ten-year Commonwealth Government Bonds. From 1986 we use the JP Morgan Australian government bond index with maturity of over seven years. For 1900–28 the short-term rate of interest is taken as the three-month time deposit rate. From 1929 onward we use the Treasury bill rate. Inflation is based on the retail price index (1900–48) and consumer price index (1949 onward). The switch in 1966 from Australian pounds to Australian dollars has been incorporated in the Exchange Rate index history.

Belgium is being researched by Annaert, Buelens, de Ceuster, Cuyvers, Devos, Gemis, Houtman-deSmedt, and Paredaens (1998). We are grateful for access to their interim results for 1900–28, which are subject to correction. From 1929 we use the National Bank of Belgium's 80-share index. The market was closed from August 1944 to May 1945, and we take the closing level for 1944 as the year-end value. For 1965–79 we use the Banque Bruxelles Lambert 30 share index and from 1980 the Brussels Stock Exchange All Share Index. Up to 1956, bond returns are based on estimated prices for 4% government bonds. During the 1944–45 closure, we take the last available value from 1944 as the year-end level. Over 1957–67 the index is for bonds with a five to twenty year maturity, for 1968–85 for bonds with maturity over five years. Subsequent years use the JP Morgan Belgian government bond index with maturity of over five years. Short-term interest rates are represented over the period 1900–26 by the central bank discount rate, followed during 1927–56 by the commercial bill rate. From 1957 onward, we use the return on Treasury bills. Inflation is estimated for 1900–13 using the consumer price index, and for 1914 we take the French inflation rate. Over 1915–20 and 1941–46 we interpolate the Belgian consumer price index from Mitchell (1998). From 1921 inflation is measured using the Institut National de Statistique's consumer price index.

Canadian stocks, bonds, bills, and inflation since 1924 are presented in Panjer and Tan (2002), with supplementary data kindly compiled for us by Lorne Switzer. For 1900–14 the annual index returns are based on Switzer's equally weighted (2000) Montreal index, adjusted for dividends. The equity series for 1915–46 is taken from Urquhart and Buckley (1965). Houston (1900–14) provides dividends for 1900 and hence the Canadian yield premium relative to the 1900 S&P, and Panjer and Tan (2002) estimate the Canadian yield relative to the 1924 S&P. To compute yearly total returns over 1900–23, we interpolate the Canadian yield premium relative to the S&P. For the period 1947–56 returns are for the TSE corporates, and from 1957 the TSE 300 total return index. The bond index for 1900–23 is based on a 4% bond from Global Financial Data (GFD). For 1924–36 we use the Government of Canada long bond index from Panjer and Tan (2002). Starting in 1936 the index is the Cansim index of bonds with maturity of over ten years, switching in 2002 to the JP Morgan Canadian government bond index with maturity of over ten years. For 1900–33 the short-term rate is represented by U.S. Treasury bills or equivalent. From 1934 onward the short-term rate is based on Canadian Treasury bills. Inflation is measured using the Canadian wholesale price index for 1900–10. For 1911–23 we switch to the Canadian consumer price index, and thereafter consumer price inflation is taken from Cansim.

Danish stock market data has involved working with Claus Parum to extend his research back to 1900. We have also referred to the papers by Steen Nielsen and Ole Risager (1999, 2000) and Allan Timmermann (1992). Over the period 1900–14 we use Parum's (2002) equally weighted index of equity returns, which covers some forty to fifty constituents each year. Thereafter, all the studies cited above are based on equity price indexes from Statistics Denmark, though we incorporate Parum's adjustments for capital changes that are not incorporated into the published index numbers. For 1915–2001 we use the data compiled in Parum (1999a,b and 2002) switching from 2002 to the Copenhagen KAX Index. Danish bond returns are estimated from yields on government bonds until 1924. For 1925–2001 our data is from Parum (1999a,b and 2002) who uses the return on mortgage bonds, a large and liquid asset class throughout the period, in contrast to more thinly traded government bonds, as described in

Christiansen and Lystbaek (1994). From 2002 we use the JP Morgan Danish government bond index with maturity of over seven years. Short-term interest rates are represented by the central bank discount rate until 1975, and thereafter by the return on Treasury bills.

France is documented by Laforest (1958) then Laforest and Sallee (1977), for the first half of the twentieth century, followed by Gallais-Hamonno and Arbulu (1995) for the period commencing in 1950. The common basis for equity returns in all the primary studies is the index series compiled by the Institut National de la Statistique et des Etudes Economiques (INSEE). The INSEE equity index is a weighted average of price relatives with about three hundred constituents. Over the period from 1914-18 we interpolate, assuming constant real returns. We use the SBF-250 from 1991 onward. The bond series for France, also compiled by INSEE, is based on consol yields. Over the period from 1914-18 we interpolate, assuming constant nominal returns. We switch in 1950 to the Gallais-Hamonno and Arbulu (1995) series, which is the INSEE General Bonds Index, with coupons reinvested monthly as received. From 1993 we use the JP Morgan French government bond index with maturity of over ten years. The short-term interest rate for France is based on the central bank discount rate until 1930. The rate is measured by the return on Treasury bills starting in 1931. To measure consumer price inflation, we use the consumption price index that is compiled by the Institut National de la Statistique et des Etudes Economiques, taken from Laforest (1958), Gallais-Hamonno and Arbulu (1995) and directly since 1981.

German data was provided by George Bittlingmayer (1998) and Richard Stehle (1997); also see Stehle, Wulff, and Richter (1999),and also Gregor Gielen (1994) and Ulrich Ronge (2002). We use Ronge's reconstruction of the DAX 30 share index to provide nominal equity returns for 1900-53. For August 1914–October 1918 Ronge uses the Gielen over-the-counter index. For 1954–94 we use the Stehle (1997) comprehensive index, switching in 1995 to the CDAX as given in Stehle/Hartmond-Reihe. For 1900–23, German bond returns are based on the price of 3% perpetuals, which essentially lost all value during the 1922–23 hyperinflation. For 1924–35 the bond index is based on mortgage bonds, and for 1936–51 it is based on 4.5% conversion (to 1943), 4.5% western zone (1946–47) and 5% tax-free (from 1948) bonds. We use the REX performance index starting in 1968, switching in 1986 to the JP Morgan German government bond index with maturity of over seven years. The short-term rate of interest is represented by the discount rate on private bills through 1945. We assume rates of 2% during 1946–50, 3% for 1951–53, and use Treasury bills beginning in 1954. Inflation in Germany is from Gielen (1994), using consumer price level data from the Imperial Statistical Office (see Bittlingmayer (1998)). Inflation rates during 1922 and 1923 were inferred from exchange rates against the dollar. From 1993 we use the CPI from the Federal Statistical Office.

Ireland was first studied by Shane Whelan (1999), who used Irish Central Statistical Office (CSO) data from 1934, and British data before that. Thomas (1986) provides some additional early data, but only in graphical form. We therefore created a new, market capitalization-weighted index of Irish equity prices for 1900–33 from original archive stock price and dividend sources (and this index has now been adopted by Whelan (2002)). For 1934–83 we use the Irish CSO Price Index of Ordinary Stocks and Shares. Until 1987, we incorporate our estimates of U.K. dividend yields. From 1988 we use the Irish Stock Exchange Equity (ISEQ) total return index. The bond series for Ireland uses U.K. returns for 1900–78. For 1979–98, we use Whelan's (1999) return on a twenty-year representative Irish gilt, as estimated by Raida Stockbrokers, turning thereafter to the Datastream ten-year Irish government bond index. Short-term Irish interest rates again use U.K. Treasury bills for 1900-1969. From 1970 we use Irish Treasury bills. Up to the date of political independence from Britain, inflation is measured using Bowley's (1937) cost of living index for 1900–13 and the working-class cost of living index for 1914–22. For 1923–52 we use Meghen's (1970) Irish cost of living index, and from 1953, the Irish consumer price index.

Italian data was provided by Fabio Panetta and Roberto Violi (1999). The equity data for 1900–07 are from the Official List and supplementary sources, and this is extended through 1911 with data from Aleotti (1990). From 1912–77 the share price and dividend series are based on the Bank of Italy index, which covers at least three-quarters of the total market capitalization of the Italian equity market. Thereafter, the Bank of Italy's index is calculated from the bank's monthly share price database, which covers all listed shares. From 1999 onward, we use the Milan BCI performance index. The government bond returns over 1900–44 are from Bianchi (1979). For the period 1945–83, the index of total bond returns is based on a treasury bond index with a coverage of over half, and often over three-quarters, of the value of all treasury bonds in issue. Thereafter, the data are sourced from Panetta and Violi's (1999) study. From 1988, we use the JP Morgan Italian government bond index with maturity of over three years. The short-term bank deposit rate to 1940 is from Biscaini Cotula and Ciocca (1982). Panetta and Violi estimate the values for the period 1941–46, and for 1947–61 the figures are from the Bank of Italy's Bollettino Economico. After that, the source is the Bank of Italy's Bollettino Statistico.

Japanese data of good quality are available from the Hamao (1991) database, and from the study by Schwartz and Ziemba (1991). We are grateful to Kenji Wada for facilitating provision of pre–World War I equity data. For 1900–14 we use the Laspeyres price index for the Tokyo Stock Exchange (TSE), as published in Fujino and Akiyama (1977). Thereafter, share prices are represented by the Japan National Bank index for 1915–32; the Oriental Economist Index from 1933 until September 1948 (although trading was suspended in August 1945, and no index values were published again until May 1946 when black market trading resumed in Tokyo); the Fisher index from September 1948 until the market officially reopened in May 1949; and the Nikkei-225 from May 1949 to 1951. During 1952–70 we use the Japan Securities Research Institute total return index. From 1971 we use total returns from Hamao and Ibbotson (1989). Returns continue from 1995 with the TSE TOPIX index. The Japanese government bond index data is taken from Global Financial Data. Until 1957, the returns are estimated from yield data. No yield information is available for the end of 1947, and the yield for 1946 is used instead. The data for 1948–57 represent the yields on newly issued bonds. From 1957 through 1968, the bonds are those issued by Nippon Telephone and Telegraph. From 1971 we use the government bond index from Hamao and Ibbotson (1989), followed from 1995 by the JP Morgan Japanese government bond index with maturity of over ten years. The short-term riskless rate is available from 1900. It is based on call money rates to 1959, and on Treasury bills thereafter. Inflation is measured by the wholesale price index for 1900, the retail price index for 1901–46 and the consumer price index from 1947 onward.

The Netherlands is based on work by Eichholtz, Koedijk, and Otten (2000). The equity returns over 1900–18 are based on the Central Bureau of Statistics (CBS) general index of share prices, and historical yield data. For the period 1919–51 returns are based on the 50-stock, CBS weighted arithmetic index. The exchange was closed from August 1944 to April 1946, so the end-year index levels are represented by the intra-year values that are closest to the turn of the year. During 1952–80, returns are based on the CBS All Share index, with dividends estimated by the Dutch central bank. For 1981 onward we use the CBS total return index, which went live in 1989 with retrospective estimation of the impact of income reinvestment, changing to the Amsterdam AMS All Share index from 2004. During 1900–14, Dutch bond returns are represented by 2.5% and 3% consols. During 1915–73, the Eichholtz-Koedijk-Otten bond index is based on a series of 3.5% bonds. From 1974, the index is the JP Morgan Netherlands government bond index with maturity of over seven years. For the riskless rate, during 1900–40 we use the discount rate on three-month private bills. The rate is assumed unchanged when data were unavailable during August 1914 to December 1918, and from mid-May 1940 to the end of that year. From 1941 to date we use the rate on Dutch Treasury bills. Inflation is measured using the consumer price index. No data were available between August 1944 and June 1945, and the index was interpolated for end-1944.

Norway was introduced into the study through Thore Johnsen, Knut Kjær and Bernt Ødegaard who provided data and sources. Equity returns for 1900–17 are derived from an equally weighted index based on all stocks listed in Statistisk Arbok and supplemented with those shares listed in Kierulf's Handbook for which there was information on year-end prices and dividends. The index contained between 33–36 shares until the end of 1914, but this fell to 21 by the start of 1918. For the period 1918–72 we use an all-share index including industrial, banking and whaling/shipping shares calculated by Statistics Norway. From 1973 we use a comprehensive index compiled by Thore Johnsen, switching in 1981 to the Oslo Stock Exchange indexes. We first use the Industrial index, switching in 1983 to the General Index and then, from 1996, to the All Share index. During 1900–92 Norwegian bond returns are based on Global Financial Data's government bond yields. From 1993, the index is the Datastream government bond index with maturity of ten years. For the riskless rate, during 1900–71 we use the central bank discount rate, followed by money market rates until 1983. From 1984 to date we use the rate on Norwegian Treasury bills. Inflation is measured using the consumer price index published by Statistics Norway.

South African stocks, bonds, bills, and inflation since 1925 are presented in Firer and McLeod (1999) who, in turn, draw on earlier work going back to 1910 by Schumann and Scheurkogel (1948). These studies provide indexes for industrial and commercial companies in South Africa. However, mining and financial companies are of particular importance, especially early last century. We therefore create a market capitalization weighted index of mining and financial shares for 1900–59, based on London price quotations. We blend our mining and financial indexes with the Firer and McLeod industrial index, by starting with a weighting of 5% in the industrial index at the start of 1910, with weights increasing to 25% by the start of 1950. From 1960–78 we use the Rand Daily Mail Industrial Index and, from 1979, the Johannesburg Stock Exchange–Actuaries Equity Index. Up to 1924, bond returns are based on the yields for 4% government bonds. Subsequently we use the bond returns from Firer and McLeod, based first on market yields together with a notional twenty-year bond prior to 1980, followed by the JSE-Actuaries Fixed Interest Index (to 1985), the JSE-Actuaries All Bond Index (to 2000) and the BESA Government total return index from 2001 onward. Before 1925, short-term interest rates are represented by U.K. Treasury bills.

Subsequently, we use the bill returns from Firer and McLeod, based on three-month fixed deposits (1925–59), bankers' acceptances (1960–66), and thereafter negotiable certificates of deposits. Inflation is estimated prior to 1925 using the consumer price index and thereafter using the official price index from Central Statistical Services. The switch in 1961 from pounds to rand has been incorporated in the Exchange Rate index index history.

Spanish stock returns are presented in Gonzalez and Suarez (1994) for the period commencing in 1941. Valbuena (2000) provides a longer-term perspective. Valbuena's equity index for Spain over 1900–18 is from Bolsa de Madrid. For 1919–36 we use a total returns index from Valbuena (2000) that rectifies some problems in the Sandez and Benavides (2000) index. Trading was suspended during the Civil War from July 1936 to April 1939, and the Madrid exchange remained closed through February 1940. Over the closure we assume a zero change in nominal stock prices and zero dividends. During 1941–85 we use the Gonzalez and Suarez (1994) data, subsequently linking this to the Bolsa de Madrid total return index. The bond series for 1900–26 is based on the price of Spanish 4% traded in London through 1913 and in Madrid thereafter. For 1926–57 and 1979-87 it is based on Global Financial Data's (GFD) estimates for government bonds, with prices kept unaltered during the Civil War. A private bond index is used for 1958–78. From 1988 we use the JP Morgan Spanish government bond index series with maturity of over three years. The short-term interest rate over 1900–73 is the central bank discount rate. From 1974 we use the return on Treasury bills. Inflation during 1900–14 is measured using the wholesale price index from Mitchell (1998). For 1915–35 we use the consumer price index from Mitchell (1998); see also Vandellos (1936). During 1936–40 we revert to the wholesale price index from Mitchell. For 1941–85 we use the Spanish consumer price index from Gonzalez and Suarez (1994) and thereafter from the Instituto Nacional de Estadistica.

Sweden is studied in a series of papers by Per Frennberg and Bjorn Hansson's (1992a, 1992b, 2000) whose database on stocks, bonds, bills, and inflation covers the period 1919–99. The Swedish stock market data we use starts at the end of 1900, and we assume that stock prices did not move over 1900; thereafter we use the index values of the Swedish Riksbank. Over the period 1900–18, Swedish equity dividends are estimated from contemporaneous bond yields adjusted upwards by 1.33% (the mean yield premium over 1919–36). From the start of 1919, the Swedish equity series is based on the share price index published in the journal Affarsvarlden, plus the dividend income estimated by Frennberg and Hansson (1992b). The government bond series uses data for 1900–18 from The Economist. For 1919–49 the returns are for perpetuals, and after that the series measures the return on a portfolio of bonds with an average maturity of ten years. We use the JP Morgan Swedish government bond index with maturity of over five years from 2000. The short-term riskless rate of interest from 1900 is represented by the official discount rate of the Swedish Riksbank. Frennberg and Hansson (1992b) switch in 1980 to the return on short-term money market instruments, and from 1982 to Treasury bills. Inflation is represented by the Myrdal-Bouvin consumer price index before 1914, the cost of living index between 1914-54 and the Swedish consumer price index for 1955 onward.

Switzerland is investigated using the series spliced together by Daniel Wydler (1989, 2001) coupled with extra data kindly provided by Urs Walchli and Corina Steiner. We have created a new, equally-weighted index of Swiss equity prices for 1900-10. This used the series of annual prices and dividend yields collected from Neue Zurcher Zeitung, with an average of 66 year-end stock prices over the period. Over 1911–25 we use the index of 21 industrial shares from Statistiches Jahrbuch. The Swiss exchanges were closed during September 1914 to December 1915, so for end-1914 and end-1915 we use the index at the date closest to the year-end. For 1926–59 Ratzer (1983) estimates total returns. For 1960–83 Huber (1985) computes the returns from index levels and dividends on the SBC index. Over 1984–98 we use the Pictet return index, and then the Swiss All Share index. For Switzerland only, and solely for the period 1900–15, we estimate bond returns from the short rate. We use the latter as a proxy for the yield on seven-year bonds, and infer the annual returns for this series. For 1915–25 we use annual data from the Statistischen Bureau. The interval 1926–59 employs Ratzer's (1983) estimates based on redemption yields for new Swiss bond issues. The 1960–80 period is represented by Huber's (1985) bond index based on actual trading prices. From 1981 we use the Datastream ten-year Swiss government bond index. During 1900–55 short-term rates are represented by the central bank discount rate, and for 1956–79, by the return on three-month time deposits. From 1980 onward, we use the return on Treasury bills. Nominal returns are adjusted for inflation using movements in the Swiss consumer prices index.

The United Kingdom is analysed using index series described in Dimson and Marsh (2001) for the interval from 1955 to date, and in Dimson, Marsh, and Staunton (2002, 2006a) for the period 1900–1954. Because of biases and inaccuracies in prior index series, the last half-century is based on the fully representative record of equity prices maintained by London Business School and described in Dimson and Marsh (1983). The period up to the end of 1954 is based on an index of the returns from the 100 companies that, before each New Year, have the largest equity market capitalization. Share capital was checked against the annual Stock Exchange Official Yearbook up to 1955, to account for capital changes and corporate events. Before 1955, all cash flows are assumed to occur at the end of each year, including dividends, special dividends, returns of capital, and cash from acquisitions. Where companies are acquired for shares or merge, we base returns on the end-year share price of the acquirer or merged entity, taking account of the exchange ratio. Dividends were obtained from the Stock Exchange Ten-Year Record published by Mathiesons. The U.K. bond index was compiled from original British government bond data. For the 1900–54 period the returns are based on 2½% Consols, and for 1955–2000 the bond index measures the return on a portfolio comprising high-coupon government bonds with a mean maturity of twenty years. Throughout the century, Treasury bills are used to measure the short-term riskless rate of interest. Inflation is calculated using the retail price index and, before 1962, the index of retail prices.

The United States was first researched in the Ibbotson and Sinquefield (1976) article and subsequent Ibbotson Associates updates. The broadest index of U.S. stock market returns is in Wilson and Jones (2002), and we use the latter for this study. Earlier sources are described in Goetzmann, Ibbotson, and Peng (2001). Our series, however, commences with the Wilson-Jones index data over 1900–25. For 1926–61 we use the University of Chicago's Center for Research in Security Prices (CRSP) capitalization-weighted index of all New York Stock Exchange stocks. For 1962–70 we use the CRSP capitalization-weighted index of NYSE, American, and Nasdaq stocks. From 1971 onward we employ the Dow Jones Wilshire 5000 index. All indexes include reinvested dividends. The government bond series for 1900–18 is based on 4% government bonds. Over 1919–25 we use the Federal Reserve ten-to-fifteen year bond index. After that bond returns are based on Ibbotson Associates' long bond index. The bill index uses commercial bills during 1900–18. From 1919 onward, the series is based on U.S. Treasury bills. Inflation is based on the consumer price index.

The World is represented by an equity series that comprises a 17-country, common-currency (here taken as U.S. dollars) index. For each period, we take a market's local-currency return and convert it to U.S. dollars. We therefore have the return that would have been received by a U.S. citizen who bought foreign currency at the start of the period, invested it in the foreign market throughout the period, liquidated his or her position, and converted the proceeds back at the end of the period into U.S. dollars. We assume that at the beginning of each period our investor bought a portfolio of 16 such positions in each of the foreign markets in this study, plus domestic equities, weighting each country by its size. We use GDP weights with start-decade rebalancing before 1968 due to a lack of reliable data on capitalizations prior to that date. Thereafter, we use country capitalizations taken from Morgan Stanley Capital International (MSCI). The above procedure results in an index expressed in U.S. dollars. To convert this to real terms, we then adjust by the U.S. inflation rate. This gives rise to a global index return denominated in real terms, from the point of view of our notional U.S. investor. Our 17-country world bond market index is constructed in the same way. This is again weighted by country size, to avoid giving, say, Belgium the same weight as the United States. Equity capitalization weights are inappropriate here, so the bond index is GDP-weighted throughout. The short-term risk free rate is taken as the return on U.S. Treasury bills. The inflation rate is as for the United States.

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