The Long-Term Risks of Global Stock Markets

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Executive Summary

One of the most enduring question in finance is the persistence of investment risk across time horizon. This issue of *time diversification* is crucial to long-term asset allocation decisions.

There is a widespread view that the longer the horizon, the more investors benefit from investing in equities. Young investors, for instance, are typically advised to allocate more to equities than those whose retirement is imminent, on the grounds that equities are less risky over long horizons. A common rule of thumb is that the percentage of stock allocation should equal 100 minus an investor's age.

This line of argument is supported by models considering the human capital component of wealth, or the flexibility in labor potential in the case of younger workers. Some researchers claim to have found empirical evidence that equities are less risky over long horizons because of mean reversion. Mean reversion implies that the variance of stock returns does not grow linearly with time, contrary to a random walk. As a result, several authors have claimed that greater equity allocations are justified on the grounds that shortfall risk lessens as the horizon is extended.

This conclusion seems hardly justified. Previous findings of mean reversion have considered on seventy years or so of U.S. data. For long-horizon returns, say ten years, this implies only seven truly independent observations, which seems insufficient to support robust conclusions about the risk of ten-year equity investments. The problem is that, with a fixed sample size, the number of effective observations diminishes as the investment horizon lengthens. Another problem is that markets with long histories may not represent investment risk for reasons of survivorship bias.

One solution is to expand the sample by adding cross-sectional data. We describe the distribution of long-term returns for a sample of thirty countries for which we have long series of equity prices. The empirical evidence expands on the work of Jorion and Goetzmann (1999) and substantially extends results described by Dimson, Marsh, and Staunton (2002), who analyze a century of stock market returns in fifteen countries.

The results are not reassuring. We find no evidence of long-term mean reversion in the expanded data sample. Downside risk declines very little as the horizon lengthens. In addition, U.S. equities appear systematically less risky than equities of other markets.

Mean reversion is analyzed first in terms of variance ratio tests. There is no evidence of mean reversion from variance ratio tests across this sample, taking into account statistical properties of these tests. Furthermore, markets that suffered interruption displayed mean aversion, or the opposite of mean reversion. Therefore, statistical properties such as high average returns and mean reversion may be an artifact of survival. Probabilities of losses on equities are reduced very slowly, if at all, with the horizon. In fact, shortfall measures such as value at risk (VAR) sharply increase with the horizon.

There is, however, some positive news. Diversification across assets pays. Over this century, a global stock market index would have displayed less downside risk than any single market. The conclusion is that across-country diversification is more effective than time diversification.

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Abstract

This research investigates the persistence of investment risk across time horizon, a crucial issue in asset allocation decisions. Previous empirical results have focused mainly on U.S. data and suffer from limited sample size in the analysis of long-horizon returns. Investigation of a long-term sample of thirty countries provides additional empirical evidence. The results are not reassuring. There is no evidence of long-term mean reversion in the expanded data sample. Downside risk is not reduced as the horizon lengthens. On the positive side, a globally diversified portfolio would have displayed much less downside risk than any single market.

One of the most enduring questions in finance is the persistence of investment risk across time horizon. This issue is crucial to long-term asset allocation decisions, yet there is scant history on long-term equity returns. While we have accumulated long series of monthly data in some global equity markets, we have at most a few useful observations on long-term equity returns.

The dilemma is that as the horizon lengthens, the number of independent observations is diminished. Seven decades of U.S. stock returns since 1926 seem hardly long enough to draw robust conclusions about the risk of ten-year equity investments.[1]

One solution is to expand the sample by adding cross-sectional data. We describe the distribution of long-term returns for a sample of thirty countries for which we have long series of equity prices. Each market is treated separately as representative of investment risk. This large sample provides a much richer description of investment risk than available focusing solely on U.S. data.

Our empirical results help to shed light on what has been called *time diversification*. Some practitioners take the view that the longer the horizon, the more investors benefit from investing in equities. Young investors, for instance, are typically advised to allocate more to equities than those whose retirement is imminent, on the grounds that equities are less risky over long horizons. A common rule of thumb is that the percentage of stock allocation should equal 100 minus an investor's age. Several academic authors have argued to the contrary that greater equity allocations are irrational with a constant investment opportunity set. Samuelson (1969) and Merton and Samuelson (1974) claim that, in a standard utility maximization framework, allocations of investors with constant relative risk aversion should be unaffected by the

[1]See Fama and French (1988) for U.S. data. Goetzmann (1993) also finds evidence of mean reversion in U.K. data.

investment horizon. This important difference of opinion has become known as the *time-diversification controversy.*

Perhaps some model extensions would support increasing equity allocations at longer horizons. One obvious, although artificial, candidate is reduced risk aversion for longer horizons. Another is the human capital component of wealth, which Samuelson (1994) explains could be considered as part of total wealth, in addition to what we may call liquid wealth. As a result, if equities are to be held as a constant fraction of total wealth, younger workers should hold a greater fraction of their liquid wealth in equities.[2]

Another line of reasoning has been advanced by Bodie, Merton, and Samuelson (1992), who explain that younger workers should bias their investment toward equities on the grounds that unlucky equity losses can be offset by working harder later; older workers do not have this option. This flexibility in labor supply leads to a greater risk tolerance. Finally, intertemporal hedging of changes in the investment opportunity set may provide another explanation.[3]

Beyond the theoretical arguments, there may be empirical reasons for equities to be less risky over long horizons. For instance, there could be mean reversion in long-term equity returns. Several authors have claimed that greater equity allocations are justified on the grounds that shortfall risk declines as the horizon is extended.[4] Poterba and Summers (1988) argue that variance ratios of long-horizon returns to short-horizon returns are lower than one would expect under the random

[2]Another issue is the correlation between human capital and equities. When earnings correlate positively with equity gains, however, workers should downplay equities. Contrary to the practitioners' standpoint, young workers should hold lower percentages of equities. This point is also made by Canner, Mankiw, and Weil (1997) in the context of the bond-stock asset allocation puzzle.

[3]Brennan (1998) shows that uncertainty about the mean return on the equity market can have a significant effect on portfolio decisions due to hedging considerations.

[4]See, for instance, Lloyd and Haney (1980), Lee (1990), and Siegel (1994).

walk assumption, which they interpret as evidence of mean reversion in international stock data. If so, long-horizon returns are relatively less risky, justifying an increased allocation to equities.

This argument is used by Siegel and Thaler (1997), who show that annual returns on a twenty-year period are much less volatile than would be implied by a random walk assumption (2.76% instead of 4.06%, extrapolating from one-year data).[5] Campbell and Viceira (1999) derive optimal equity allocation strategies when stocks are mean-reverting, and argue that their approach should be integrated into investment practice.

A major problem with all these studies is the limited data. Using data on U.S. equities since 1926, we have only seven truly independent observations. Tests based on such small sample sizes are bound to have low statistical power. In addition, statistical tests often rely on asymptotic properties and may lead to biased inferences in small samples.

This small sample size also makes it difficult to characterize the distribution of stock returns at long horizons. This is why some studies use simulations based on some distributional assumptions, such as lognormal returns.[6] The problem is that these distributions may not be appropriate to measure downside risk.

Finally, there may be a serious survivorship bias with respect to U.S. data. It is no coincidence that the longest time series available for equities is also that of the most successful capitalist system in the world. If we focus solely on the history of U.S. stocks, we may be looking at a distorted picture of equity risk. Perhaps the most

[5] More recently, Balvers, Wu, and Gilliland (2000) report evidence of co-integration for the recent histories of national stock markets. This implies mean reversion in deviations between stock market indices, however, as opposed to absolute levels.

[6] See Jones and Wilson (1995), for instance.

entertaining expression of this idea comes from Samuelson (1994, p. 17):

> *We have only* one *history of capitalism. Inferences based on a sample of one must never be accorded sure-thing interpretation. When a thirty-five-year-old lost 82% of his pension portfolio between 1929 and 1932, do you think it was fore-ordained in heaven that later it would come back and fructify to +400% by his retirement at sixty-five? How did 1913 Tsarist executives fare in their retirement years on the Left Bank of Paris?*

My paper extends the sample by adding to the history of U.S. equities the history of 29 other markets over the period 1921 to 1996. This sample includes virtually all stock markets that existed in the 1920s, with additional ones that started later. In order to evaluate survivorship biases, we include markets that suffered interruptions. The analysis still leaves out markets that suffered permanent interruptions during this century, such as all the Eastern bloc countries.

This expanded dataset allows us to provide much-needed evidence on the issue of time diversification. This empirical evidence expands on the work of Jorion and Goetzmann (1999), and substantially extends results described by Dimson, Marsh, and Staunton (2002) who analyze a century of returns in fifteen countries.

In addition, I investigate another route to diversification, which is across assets. The evidence shows that across-asset diversification is more effective than time diversification.

This paper is organized as follows. Section I describes the methodology used to compute long-term returns and variance ratio tests. The data are presented in Section II. Section III is devoted to empirical results. Finally, Section IV contains some concluding comments.

I. Methodology

The methodology applies variance ratio tests to long-term returns.

A. Long-Term Returns

Define P_t as the value of the stock price index as of month t. We measure prices at monthly intervals, from which monthly returns can be computed as $R_{t-1,t} = (P_t - P_{t-1})/P_{t-1}$. More generally, returns can be measured over multiple months k as R, or in annualized form R^a:

$$R_{t-k,t} = (P_t/P_{t-k}) - 1, \qquad R^a_{t-k,t} = (P_t/P_{t-k})^{1/n} - 1 \tag{1}$$

where n is the number of years in the interval, i.e., $n = k/12$.

If price ratios are lognormally and independently and identically distributed $\ln(1 + R_{t-1,t}) \sim N(\mu, \sigma^2)$, we can write

$$\ln(1 + R_{t-k,t}) \sim N(k\mu, k\sigma^2) \tag{2}$$

$$\ln(1 + R^a_{t-k,t}) \sim N[(k/n)\mu, (k/n^2)\sigma^2] \tag{3}$$

Jones and Wilson (1995) report probabilities associated with U.S. stock returns at various horizons using this approximation.

One drawback of this approach is that it assumes a normal distribution (for log returns), which may not adequately represent financial series with fat tails. For some purposes, this may be an adequate approximation, but it may not be when measuring downside risk, as departures from the normal approximation may significantly affect loss probabilities. This is why it is preferable to use an empirical method such as the bootstrap, which does not rely on a distributional assumption. But first we need to ascertain whether returns are independently and identically distributed (i.i.d.).

B. Variance Ratio Tests

Whether the distribution of short-term returns can be compounded to generate long-term return distributions depends critically on the i.i.d. assumption. There is some evidence that casts doubt on this assumption. Fama and French (1988), for instance, conclude that long-horizon returns exhibit strong negative autocorrelation. Further evidence is provided in rejection of the random walk hypothesis in variance ratio tests.

Define $r_{t-k,t}$ as the log return (logarithm of price ratio) over the period. When multiperiod returns are non-overlapping, Cochrane (1988) shows that the variance ratio $\mathrm{VR}(k)$ can be approximated by

$$\mathrm{VR}(k) = \frac{V(r_{t-k,t})}{kV(r_{t-1,t})} \approx 1 + 2\sum_{j=1}^{k}(1 - \frac{j}{k})\hat{\rho}(j) \tag{4}$$

where $V(r)$ is the variance of returns, and $\hat{\rho}(j)$ is the sample autocorrelation of the one-period return at lag j. Under the null hypothesis of serially uncorrelated returns, $\hat{\rho}(j)$ should be close to zero at all lags.

Thus, if the data-generating process is a random walk, the variance of the k-period return should be equal to k times the variance of the one-period return. Under the null, the expected value of $\mathrm{VR}(k)$ should be unity for all k. If $\mathrm{VR}(k)$ is significantly lower than unity at long horizons, this indicates that prices tend to revert to a common trend, and prices would be said to be mean-reverting. If $\mathrm{VR}(k)$ is significantly higher than unity at long horizons, prices would be said to be mean-averting.

To test whether $\mathrm{VR}(k)$ is significantly different from unity, we need its distribution under the null. The limiting distribution of the centered variance ratio statistic $M_r(k) = \mathrm{VR}(k) - 1$ has been derived by Lo and MacKinlay (1988). Under the null hypothesis of i.i.d. normal returns, they show that

$$\sqrt{T}M_r(k) \sim N(0, 2k) \tag{5}$$

where T is the total number of observations.

When returns are overlapping, the ratio is

$$\sqrt{T}M_r'(k) \sim N(0, \frac{2(2k-1)(k-1)}{3k}) \tag{6}$$

which has a slightly lower standard error than in Equation (5) because it uses more information.

Lo and MacKinlay (1988) report that returns under one year are positively autocorrelated, which indicates mean aversion. They claim that this result cannot be explained by thin trading. Statistical inference based on the asymptotic distribution can be misleading, however, in small samples.[7] Poterba and Summers (1988), using simulations to compute standard errors for the variance ratios, also report evidence of mean aversion in returns under one year, as well as statistically significant mean reversion at longer horizons.[8]

More recently a number of researchers have suggested that these results may be spurious, and indicative more of statistical biases than true predictability. Even if returns are normally distributed, the variance ratio may not be normally distributed in finite samples. In addition, there is evidence that returns themselves are not normally distributed.

Richardson and Stock (1989) provide an alternative approach. They derive a limiting distribution that differs markedly from the conventional limiting distribution.[9]

[7] Lo and MacKinlay (1989) investigate the size and power of this test under i.i.d. Gaussian and heteroskedastic distributions.

[8] See also Campbell (1991).

[9] Richardson and Smith (1991) also note that statistics across horizons are not independent. Hence rejections across many horizons should not be construed as stronger evidence than rejection over one horizon only.

With this correction, they find no evidence of predictability for a value-weighted index of U.S. stocks.

Particularly interesting are the results of Kim, Nelson, and Startz (1991), who take a resampling approach using actual monthly returns and report the quantiles of the statistic under the null. They find no statistical evidence of predictability for U.S. stocks over the 1926-1986 period.

They report in addition that mean reversion is limited to pre-World War II data, which is interpreted as "evidence that the behaviour of stock returns changed at the end of World War II, perhaps because of the resolution of major uncertainties about the survival of the U.S. economy" (1991, p. 527). This is consistent with the theoretical results of Brown, Goetzmann, and Ross (1995), who show that survivorship leads to artificial mean reversion in the series. Our database that include markets with long-term interruptions is useful in that regard.

II. Data

Long-term studies of capital markets have used almost exclusively U.S. stock returns, for which we have good-quality data. U.S. studies are typically based on monthly stock market indices constructed by Standard & Poor's starting in 1926.[10]

It is no coincidence, however, that today's largest equity market has the longest continuous time history. In other words, the U.S. equity market itself is a survivor. It has avoided the calamities that plagued most other equity markets this century. Over long horizons, using the U.S. series to deduce the distribution of long-term returns may understate investment risk.

[10]Cowles (1939) compiled data going back to 1871, and Schwert (1990) reports even earlier data.

For the non-U.S. data, we use data on thirty stock markets collected by Jorion and Goetzmann (1999). The database comes from a variety of sources, including the International Abstract of Economic Statistics, the League of Nations, the United Nations, and the International Monetary Fund (IMF). We tried to minimize survivorship biases by following all markets when reported by these international agencies and going to other data sources to trace the behavior of markets with interruptions. The longest series cover the years 1921 through 1996. The database also includes global and non-U.S. stock market indices based on gross domestic product (GDP) weights.

To adjust for varying rates of inflation, returns are measured in real terms, deflating each series by the wholesale price index (WPI). Because many countries have experienced very high rates of inflation over this period, it would be meaningless to consider downside risk using nominal prices only. As a result, our results may not be directly comparable to results in the previous studies of the long-term risk of U.S. stocks that consider downside risk expressed in nominal terms only.

One drawback of this dataset is that it does not allow us to measure total stock returns, because dividend data are available only for a few countries. This may overstate the actual investment risk, as income payments provide a cushion against capital losses. When evaluating the investment risk of equities, however, the alternative is usually cash. Hence, the focus is on excess returns, or the equity premium.

Decomposing the total return on stocks (R_S) into capital return (CR_S) and income return (IR_S), and the risk-free rate (R_F) into the inflation component and the real rate, we can write the equity premium as

$$\begin{aligned} R_S \text{ - } R_F &= [CR_S + IR_S\ ] \text{ - } [\text{Inflation} + \text{Real Rate}] \\ &= [CR_S - \text{Inflation}] + [IR_S - \text{Real Rate}] \end{aligned} \tag{7}$$

Thus, real capital appreciation returns (the term defined as $[CR_S$ – Inflation]) will provide a good measure of the performance of equities relative to risk-free assets as long as the difference between dividend returns and the real interest rate (the term defined as [IR_S – Real Rate]) is small and stable over time. The data also allow cross-country comparisons as long as this term is not too different across countries.

In addition, capital appreciation indices may be adequate for risk measurement purposes, as opposed to measuring total returns. Poterba and Summers (1988), for instance, report that variance ratio tests are not affected by the omission of dividends. We also provide evidence that the omission of dividends has no effect on variance ratios, using a limited sample of markets for which we have long-term histories of total and capital returns,

Income returns are available for a subset of fifteen countries, discussed in Dimson, Marsh, and Staunton (2002), henceforth DMS. As of this writing, however, these data are not publicly available. All we have are tables describing total returns over ten-year periods. We use these data combined with the Jorion-Goetzmann (1999) data to deduce monthly total returns on these fifteen countries.[11]

This simple step, however, creates survivorship biases, as the fifteen countries for which dividend data are available are more likely to have done well than the others. Indeed, the average total return for real capital appreciation indices is 0.73% per annum for the total sample of thirty countries. For fifteen countries with dividend history, the average appreciation is 1.57%. For the countries without dividend history, the average is only −0.11%. This is strong evidence of survivorship bias for countries

[11]This is achieved by adding a constant monthly income return to the capital series so that the total return matches that reported by DMS (2002). This procedure is similar to the general practice of adding the dividend yield to capital returns. Given that the greatest fraction of swings in total returns is due to price movements, this recovers the essential characteristics of the data. In the case of U.S. data, for which we have actual monthly capital and income returns, we verify that the statistics are similar for the actual series and the series obtained with this procedure.

with dividend histories. Therefore, while it is useful to look at countries with complete dividend data, we should be mindful that this subsample has an inherent upward bias in returns of about 1.7%.

Table I presents the group of thirty countries for which long-term data are available, and the relevant periods. Seven of the series experienced interruptions, which are bridged by spreading the total growth between the starting and ending values evenly over each month.[12] Even this group is not free of survivorship, as it excludes markets that suffered permanent interruptions during this century. There is certainly no mean reversion for that group.

Another feature of the data is that the majority of the series are monthly averages of daily data, as indicated. Working (1960) has shown that averaging a series over a great number of data points introduces spurious first-order autocorrelation of about 0.25 and reduces the volatility to 82% of the true value. Indeed, the table shows that indices that have been time-averaged systematically display higher first-order autocorrelation.[13] As expected from a moving-average process, the table shows that second-order terms are mostly insignificant.

The variance reduction, or Working effect, however, disappears at longer horizons. It can be shown, for example, that with quarterly differences in these monthly data, the volatility is reduced to only 94% of the true value, and the first-order autocorrelation is only 0.06. The effect becomes negligible with annual or longer intervals, which are my main focus.

[12]Note that the same series is used before and after the breaks, to preserve the long-term properties of the series are preserved. While data interpolation may induce some spurious short-term autocorrelation, the effect on the statistics of interest is negligible as the break periods are short compared to the total sample period.

[13]Note that this may be also due to thin trading, a totally different explanation.

III. Empirical Results

A. Variance Ratios

The first issue is whether equity returns indeed display mean reversion. Table II presents variance ratios at horizons of one month, and two, three, four, five, and ten years (measured relative to one-year returns). Returns are measured as the logarithm of price ratios. Because of the Working effect in most series, the one-month ratios are biased downward and should not be considered.

These results can be compared to those in Poterba and Summers (1988), who report variance ratio tests for a group of 18 countries over the period 1957 to 1986 (mostly). As with the U.S. data, nearly all of the Poterba-Summers countries show variance ratios lower than one. They find only three countries with variance ratios that increase with maturity. Even though the sample period is not long enough to find statistical significance, they interpret their results as supporting their findings of "substantial transitory price components," that is, mean reversion.

Table II presents a different picture. In this larger sample, thirteen out of thirty countries display mean *aversion* at the five-year horizon. For the remaining countries, it is not clear that the low variance ratios are meaningful. The variance ratios over these longer periods are all higher than those in Poterba and Summers (1988), except for one country.

Figures at the end of Table II display 5% one-sided critical values from the asymptotic standard error described in Equation (6) for two sample sizes.[14] None of the

[14] These numbers assume annual intervals, e.g. for $T = 912$ and a two-year ratio, $k = 912/12 - 2 = 74$. This is conservative and slightly overestimates standard errors because observations are sampled at monthly and not at annual intervals, as assumed in Lo-MacKinlay (1988). On the other hand, the simulations of Kim, Nelson, and Startz (1991) show that these asymptotic standard errors are too low in finite samples using the actual return distribution.

observed variance ratios falls below the critical values, except for the two- and three-year ratios for Germany. We should expect, however, to find some significant numbers in this table at the 5% level, simply due to chance.

We also report the results of simulations using U.S. stocks as the baseline process and assuming normally distributed monthly returns. Median variance ratios are shown for various horizons with 1,000 replications (average values are similar to median values). Sample variance ratios are biased away from unity, even when returns are truly independent over time. At the ten-year horizon, for instance, the median value is 0.810 instead of 1.000. Thus we should expect a decline in the variance ratio, even when successive returns are totally independent. These variance ratios appear to be subject to serious small sample biases.

Some empirically estimated variance ratios, however, are lower than the median numbers from the simulation. Are they statistically significant? To answer this question, let us focus on the 5% lower quantile, which is reported as 0.398 for the ten-year horizon and 912 data points. At this level, none of the series has a significant statistic. Hence, there is no evidence of mean reversion.

An important result in Table II is that series with interruptions have variance ratios greater than unity (except again for Germany). The reason is that markets with interruptions experienced a large drop in value before or around the interruption. A large permanent drop is inconsistent with mean reversion. If one were to discard series with interruptions, there would be stronger evidence of mean reversion. This result confirms the conjecture of Brown, Goetzmann, and Ross (1995) that survival artificially induces mean reversion in equity returns.

One issue is whether the omission of dividends materially affects mean reversion in the sample. To examine this issue, we consider a sample of five countries for which we have annual data for total as well as capital returns. For comparison purposes, we also report results for U.S. data using the S&P 500 index, which differs from the IMF series.

Results are presented in Table III. There seems to be no systematic difference between variance ratios of total and capital returns. Variance ratios display similar patterns for both measures. There is no significant evidence of mean reversion.

B. Long-Horizon Risk and Return

Estimates of risk and return over various horizons are presented in Table IV. Returns are defined using price ratios and are annualized using the usual convention for five- and ten-year horizons, as in Equation (1).

The 1-month columns report the arithmetic average and standard deviation of monthly returns, non-annualized. As explained before, these standard errors are too low due to the averaging of the series, which is why we concentrate on longer-term returns.

The one-year series correspond to overlapping one-year returns, for which we report the mean and volatility. Using overlapping observations increases the precision of the estimates (but precludes us from using conventional standard errors). Statistics for the five-year and ten-year series use the distribution of overlapping annualized returns.

As the time span lengthens, the number of effective observations diminishes. The distribution of these annualized long-horizon returns converges to one number, the *geometric* compound return over the whole period. This return, reported under the total return column, entails only one observation.

We also observe that average returns tend to decline when going from the one-year to the five-year to the ten-year to the total period return. This should be expected, for the same reason that the geometric growth is below the arithmetic growth. To put it differently, the expectation of the logarithmic change, $\mu - \sigma^2/2$, must be below the expectation of the one-period mean μ. In small samples, the relationship may not hold exactly, but it should be reflected in a general pattern of changing average returns across horizons.

The drawback of the total geometric return is that it depends only on the starting and ending values of the series. The geometric return represents only one long-term history. For Japan, for example, the 76-year sample includes World War II, which explains the negative real return of -0.81%. Different ten-year samples give a slightly more favorable picture, with an average real return of 0.65%.

Table IV shows that U.S. equities have experienced the highest compound return among these thirty markets when considering the longest time period available, at 4.31% with annual compounding. Sweden follows, with a slightly lower return. These results are comparable to those of DMS, who report that, over the period 1900–2000, the U.S. had the third-highest real total return, just behind Sweden and Australia.[15]

Across all markets, the median total growth is much lower, only 1.52%. The median is 1.59% for countries with dividend histories, however, versus -0.25% for other countries. This translates into a survivorship bias of 1.8% based on median values. Thus even groups of countries with long histories of data and dividends cannot be considered representative.

A similar picture emerges in the case of shorter intervals, although there are more instances of other markets outperforming U.S. equities, because the dispersion of re-

[15]The difference in rankings could be attributed to differences in the sample period. The DMS period covers an additional thirty years of data.

turns increases for shorter horizons. With ten-year horizons, U.S. equities are slightly outperformed by Sweden. At five-year horizons, the performance of U.S. stocks is below that of Chile, Mexico, and Israel. With one-year horizons, the arithmetic average for U.S. equities is 6.21%. Seven of twenty-nine markets perform better than the U.S. For the whole sample, the median one-year return is 4.45%.

Table IV also shows a wide dispersion in annual volatilities across countries, ranging from about 20% to 70% per annum. The median one-year volatility is 23%. In particular, the so-called emerging markets of Asia and Latin America display the highest volatility.[16] U.S. equities are among those with the lowest volatility, even though they enjoyed the highest growth among all of these markets.

As the horizon increases, the volatility of the annualized return decreases. This should not be taken to imply that risk decreases with the horizon, however. It is simply an artifact of the annualization of the returns. For instance, if returns were in log-form, we could infer the ten-year volatility from that of one-year returns of U.S. stocks, as $(1/\sqrt{10})20.89 = 6.61$. Instead, the volatility of ten-year overlapping returns is 5.99 percent, just slightly lower than the predicted number of 6.61 percent.

The simulations in Table II, however, demonstrate that we should expect a slight decrease in annualized volatility due to small sample bias. Using the median variance ratio of 0.810, the ten-year volatility should be $6.61\% \times \sqrt{0.810} = 5.94\%$, which is in line with the observed volatility of 5.99%.

These data can shed additional light on the long-running debate of whether stocks are less risky in the long run. One view is that, as the investment horizon lengthens, stocks become less risky because of across-time diversification.[17] Some practition-

[16] As Table I shows, many of these markets have operated for longer than tends to be presumed by the definition of emerging.

[17] See, for instance, Bernstein (1976) and Siegel (1992).

ers mistakenly take this view from the fact that the annualized volatility of returns declines as the horizon lengthens. This interpretation, of course, is incorrect. What matters is the total dollar loss from a fixed initial investment, or the whole distribution of long-horizon returns (non-annualized).

Table V presents data on such distributions. It includes average returns and volatilities over 1-, five-, and ten-year periods.[18] Without annualization, long-horizon returns display increasing volatility in every single case. The distribution of long-horizon returns is highly skewed, however, so it may be better to focus on the distribution statistics, discussed below.

C. Long-Horizon Downside Risk

Table VI displays the probability of loss and 95% value at risk (VAR) numbers across horizons. VAR is a measure of downside risk, defined as the worst loss that will not be exceeded at a high confidence level.[19]

These results can be related to shortfall probabilities calculated by Leibowitz and Langetieg (1989), who perform simulations of bond and stock returns based on hypothetical distributions. They report that the risk of stocks relative to bonds persists over the long term. With a five-year horizon, the shortfall probability is 36% and over a ten-year horizon, 31%. The Leibowitz and Langetieg results, however, depend heavily on the specification of the stochastic process. In particular, they assume that annual stock returns have a lognormal distribution with a 4.00% equity premium. This is not too far from the 4.45% median real return reported in Table IV at the one-year horizon.

[18]These numbers are not simple transformations of the numbers in Table IV, because the annualization function is non-linear.

[19]See Jorion (2000) for an analysis of VAR risk measures.

Instead of assuming a probability distribution, Butler and Domian (1991) bootstrap monthly U.S. data to reconstruct long market histories. With this procedure, the shortfall probability of stocks relative to bonds is about 18% over five years and 11% over ten years. Their lower probabilities can be attributed to the underlying U.S. data, which displayed an annual equity premium of about 7% over the period 1926-1988. The bootstrap procedure, however, destroys any time series dependence in the data.

Our results instead use actual data. The distinction is that we thus avoid biases due to survivorship; we use the actual distribution of returns; and we increase the sample size by adding non-U.S. data.

Figure 1 plots the historical distribution of five-year returns obtained by pooling monthly overlapping returns for all countries. The histogram represents about 25,000 observations. There is substantial redundancy in these observations, because within each market, we have monthly data overlap. Accounting for overlaps yields about 418 non-overlapping data points. There is also some correlation across markets. Even so, the empirical distribution is relatively smooth.

The distribution exhibits substantial skewness. While monthly returns are approximately normally distributed, the same cannot be said of long-horizon returns. The variance of discrete returns is therefore of limited use in describing the distribution.

Figure 1 also plots the lognormal model fitted to this data. The fit appears to be good, although the lognormal distribution seems to underestimate extreme loss probabilities. Unfortunately, goodness of fit cannot be easily tested, as conventional statistics (such as the Kolmogorov-Smirnov test) assume independent observations.

The results for this sample of thirty countries show there is substantial downside risk. Over a five-year horizon, there is a 0.4% probability of losing at least 90% of the investment. There is an 8.0% probability of losing more than 50% of one's funds.

How does this new information compare to results of previous analyses? Figure 2 compares the empirical distribution for all markets to the distribution of U.S. equities only. Because of the limited effective size of the U.S. sample (only 14 independent observations), the U.S. distribution is much more irregular. Still, it is instructive to note that the downside risk of U.S. equities is much lower than the downside risk of the total sample. Consider, for example, the probability of losing more than 50% of the investment. The probability is less than 3% for U.S. data, but a much higher 8% for the total sample.

Table VI shows probability of losses of 36.6%, 34.3%, and 33.7% for U.S. stocks at horizons of one, five, and ten years. These numbers are broadly in line with the simulations of Leibowitz and Langetieg (1989). The probability of a loss is reduced with the horizon, but very slowly.

More interestingly, the table shows that shortfall probabilities for U.S. stocks are among the lowest of this group. Across global stock markets, probabilities of losses are even greater. The median probabilities of loss for this group are 48.2%, 46.8%, and 48.2% at horizons of one, five, and ten years. These are quite high numbers, and indicate that shortfall risk hardly declines with the horizon. The median 95% VAR worsens badly, going from −31.0% to −60.3%, and then −65.9%.

At the end of Table VI, we report measures of downside risk for the global and non-U.S. indices. It is interesting that the shortfall probabilities for the global index are 37.8%, 35.4%, and 35.2%, over one, five, and ten years. That these numbers are much lower than the median probabilities for the group of thirty countries attests to the power of across-country diversification.

Table VII investigates the effect of omitting dividends for long-term risk measurement purposes. The first panel reports statistics for total returns, the second panel statistics for capital returns for the fifteen-country sample for which we have dividends. Adding about 4% in income return improves the long-term risk characteristics of stock markets. For the U.S., for instance, the probability of ten-year loss drops from 33.7% to 15.5% when income return is considered. The VAR also improves, from −51.2% to −22.3%. Even so, this latter figure is not much better than a one-year VAR of −24.5%.

Otherwise, the general conclusions are not affected by dividends. First, downside risk numbers for U.S. equities are substantially below those for the group as a whole. The median ten-year shortfall probability is 19.9%, with a VAR of −34.8%, both much worse than for the U.S. data numbers.

Second, the global index has much better downside risk characteristics than individual countries. The ten-year loss probability is only 12.0%, much below the median of 19.9% for the sample. The one-year, five-year, and ten-year VAR for the global index are all lower than the ten-year VARs for the median and even the U.S. market. For instance, the one-year VAR for the global index is −16.7%, which is better than the ten-year VAR of −22.3% for U.S. stocks. Global diversification appears quite effective in reducing risk.

Table VII does shows that long-term loss probabilities are sensitive to assumptions about expected returns. The actual long-term investment risks of equities, however, should be worse than those reported for total returns, for a number of reasons.

First, the investment alternative should be bills or bonds rather than a consumer price index. To measure shortfall risk relative to bills or bonds, we should subtract the real return on bills or bonds from the total real return on equities. Over the sample period, DMS (2002) report an average U.S. inflation rate of 2.8%, versus an average return of 4.2% and 5.3% on U.S. bills and bonds, respectively. The bond premium of $5.3 - 2.8 = 2.5\%$ would eliminate most of the dividend income return on stocks, bringing the results closer to the results in Table VII.

Second, this fifteen-country sample with dividend history suffers from survivorship bias on the order of 1.8% per annum. Consequently, downside risks are much worse than those based on total returns.

Finally, it could be argued that the performance numbers represented by equity indices are not achievable, due to transaction costs and management fees. The first index funds were opened in the U.S. in 1971. Since then, while the industry has become huge and has achieved economies of scale, Frino and Gallagher (2001) report that S&P 500 index funds underperform their benchmark by an average of 40-50 basis points per annum. This shortfall must be greater in foreign markets, where indexing is less widespread. Overall, these transaction costs further reduce the average total return from investing in equities.

Finally, Table VIII reports the downside risk of the thirty markets, focusing on the worst loss over the interval considered. The last four columns indicate the (ending) month in which the loss is realized. For the U.S. market, for instance, the worst monthly, one-year, five-year, and ten-year losses were −24.0%, −55.9%, −56.4%, and −60.7%, occurring on November 1929, June 1932, September 1934, and August 1982. The worst time for losses up to a five-year horizon was the period of the Great Depression. Up to a ten-year horizon, however, U.S. stocks did worst during the inflationary period of 1973-1982.

It is disconcerting to see that even with a five-year or ten-year horizon, "patient" U.S. equity investors could have lost 56 to 61% of their initial investment. The new information coming from foreign markets is even more unsettling. The median loss across all thirty markets would have been much worse, at about 76%. Comparing losses across countries, it appears again that U.S. equities did much better than other markets. U.S. five-year losses, for instance, were lower than in any other market, except Denmark and Sweden.

The dates reported in the tables are also useful to check whether shocks were of a global nature. When we compare the months of the worst loss, we see a wide dispersion in dates. Some occurred during the Depression, some during World War II, some during the inflationary 1980s, and some during October 1987. Because of the dispersion in these loss dates, the global index experienced smaller losses than all other markets, a worst loss of 54% over a ten-year horizon. This loss is much lower than the median loss of 76% for all markets. It is also lower than the worst loss of 61% for U.S. equities.

The only comforting result emerging from this table is that, while time diversification does not diminish risk, across-country diversification does appear to be quite effective in reducing downside risk.

IV. Conclusions

This research produces a number of new insights. The long-term risks of equities are traditionally analyzed using standard data sources for U.S. equities. To the extent that historical data are relevant for projecting future returns, there is no reason to look at U.S. data only. By focusing on a larger and a longer sample of countries, we are able to develop a richer description of the long-term risks of equity markets.

Our results are not reassuring. We show that the downside risk of investment in foreign markets has been even greater than the downside risk of investment in U.S.

equities. This result may be explained by the survival of the U.S. equity series—the U.S. data are not representative of investment risk.

One issue unresolved to date is whether long-term returns are mean-reverting. If so, the annualized long-term investment risk of equities may be lower than at short horizons. This issue has obvious important implications for long-range investment policies.

Variance ratio tests indicate no evidence of mean reversion. Due to the small sample sizes, variance ratios are biased downward. There is no statistically significant mean reversion. Furthermore, markets that suffered interruption display mean aversion. Thus, evidence of mean reversion must be evaluated considering the survival of the market. These results are contrary to the general conclusions of Poterba and Summers (1988), who examine a smaller group of countries over a shorter period.

If history is to be taken as a guide for investment risks, these results show that time diversification is less beneficial than generally believed. Probabilities of losses on equities decline very slowly, if at all, with the investment horizon.

There is some positive news. Diversification across assets pays. Over the past century, a global stock market index would have displayed less downside risk than any single market. The conclusion is that across-country diversification is more effective than across- time diversification.

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Table I

Sample of Global Equity Markets

Countries for which long-term data are available, showing the total sample period, as well as long-term interruption periods. Data averaging indicates whether the series is a monthly average as opposed to end-of-period value.

Country	Period	Total Months	Interruption Periods	Data Averaging	Monthly Autocorrelation Lag (1)	Monthly Autocorrelation Lag (2)
U.S.	1/21-12/96	912		Yes	0.279	-0.003
Canada	1/21-12/96	912		Yes	0.160	-0.015
U.K.	1/21-12/96	912		Yes	0.198	-0.015
Austria+	1/25-12/96	864	4/38-11/46	Yes	0.153	0.131
Belgium	1/21-12/96	912		No	0.000	-0.000
Denmark	1/26-12/96	852		Yes	0.163	0.153
Finland	1/31-12/96	792		Yes	0.349	0.070
France	1/21-12/96	912		No	0.052	-0.060
Germany+	1/21-12/96	912	8/44-12/49	Yes	0.158	0.062
Ireland	1/34-12/96	756		Yes	0.219	0.064
Italy+	12/28-12/96	817	7/39-11/44	Yes	0.217	-0.027
Netherlands	1/21-12/96	912		Yes	0.339	0.043
Norway	1/28-12/96	828		No	0.112	0.023
Portugal+	12/30-12/96	793	5/74-2/77	Yes	0.186	0.046
Spain+	1/21-12/96	912	7/36-3/40, 10/44-9/46	Yes	0.196	0.024
Sweden	1/21-12/96	912		No	0.169	-0.028
Switzerland	1/26-12/96	852		Yes	0.191	-0.066
Australia	1/31-12/96	792		Yes	0.314	0.034
New Zealand	1/31-12/96	792		Yes	0.333	0.115
India	12/39-12/96	688		Yes	0.301	0.055
Japan+	1/21-12/96	912	9/45- 7/46	Yes	0.331	0.114
Pakistan	7/60-12/96	438		Yes	0.302	0.052
Philippines	7/54-12/96	510		Yes	0.085	0.044
South Africa	1/47-12/96	600		Yes	0.324	0.053
Brazil	2/61-12/96	432		Yes	0.040	0.006
Chile+	1/27-12/96	840	4/72-7/73	Yes	0.210	0.056
Colombia	12/36-12/96	722		Yes	0.239	0.051
Mexico	12/34-12/96	746		Yes	0.269	0.019
Venezuela	12/37-12/96	711		Yes	0.144	0.069
Israel	1/57-12/96	480		No	0.103	0.048
Index:						
Global	1/21-12/96	912			0.321	0.039
Non-U.S.	1/21-12/96	912			0.315	0.074

+ Denotes a market that suffered a long-term interruption.

Table II

Variance Ratios for Global Equity Markets

Variance ratios of real capital returns relative to the variance of annual returns, with monthly sampling. Returns are defined as the log of price ratios. Results at the end are 5% one-sided asymptotic critical value under the null of a random walk with annual sampling for two sample sizes, and simulated distribution of variance ratios assuming normal returns and monthly sampling.

		12-Mo	Variance Ratio						
Country	Months	Variance	1-Mo	1-Year	2-Year	3-Year	4-Year	5-Year	10-Year
U.S.	912	0.04171	0.600	1.000	1.027	0.994	0.997	0.990	0.828
Canada	912	0.03863	0.727	1.000	1.017	0.989	0.918	0.812	0.475
U.K.	912	0.03917	0.630	1.000	1.042	1.008	0.960	0.964	0.817
Austria+	864	0.06561	0.495	1.000	1.296	1.450	1.489	1.528	1.198
Belgium	912	0.03927	0.884	1.000	1.048	1.008	0.944	0.925	0.723
Denmark	852	0.03534	0.454	1.000	0.831	0.721	0.687	0.649	0.652
Finland	792	0.07050	0.408	1.000	1.326	1.442	1.489	1.463	1.382
France	912	0.05830	0.763	1.000	1.161	1.305	1.416	1.409	1.074
Germany+	912	0.15581	0.882	1.000	0.746*	0.684*	0.670	0.666	0.591
Ireland	756	0.04551	0.504	1.000	1.090	1.083	1.061	0.996	0.921
Italy+	817	0.09933	0.625	1.000	0.914	0.925	0.975	0.956	1.048
Netherlands	912	0.03778	0.582	1.000	1.130	1.146	1.088	1.076	1.006
Norway	828	0.03932	0.817	1.000	0.933	0.887	0.856	0.866	0.821
Portugal+	793	0.13064	0.500	1.000	1.316	1.423	1.354	1.205	0.859
Spain+	912	0.04814	0.516	1.000	1.315	1.587	1.771	1.812	1.638
Sweden	912	0.04146	0.676	1.000	1.019	0.988	0.994	0.937	0.740
Switzerland	852	0.03423	0.641	1.000	1.172	1.161	1.106	1.045	0.813
Australia	792	0.03567	0.571	1.000	0.971	0.898	0.864	0.878	0.699
New Zealand	792	0.03540	0.457	1.000	0.993	0.931	0.996	0.936	0.596
India	688	0.04602	0.558	1.000	1.077	1.121	1.131	1.145	1.178
Japan+	912	0.12581	0.442	1.000	1.309	1.492	1.647	1.829	2.252
Pakistan	438	0.04170	0.549	1.000	0.989	0.949	0.929	0.831	0.940
Philippines	510	0.15048	0.580	1.000	1.208	1.209	1.215	1.185	1.280
South Africa	600	0.04911	0.548	1.000	1.004	0.931	0.872	0.915	0.925
Brazil	432	0.28844	0.922	1.000	0.846	0.843	0.816	0.748	0.340
Chile+	840	0.10941	0.869	1.000	1.065	1.183	1.219	1.290	1.245
Colombia	722	0.07412	0.523	1.000	1.118	1.212	1.213	1.199	0.828
Mexico	746	0.11761	0.540	1.000	1.091	1.142	1.113	1.010	0.799
Venezuela	711	0.11299	0.514	1.000	0.957	0.703	0.566	0.528	0.386
Israel	480	0.08815	0.620	1.000	1.067	0.934	0.734	0.683	0.296
Index:									
Global	912	0.02445	0.514	1.000	1.156	1.211	1.267	1.309	1.238
Non-U.S.	912	0.02222	0.458	1.000	1.184	1.265	1.335	1.389	1.464
Asymptotic Test Statistic:									
5% 1-Sided Level	912				0.808	0.712	0.636	0.571	0.314
5% 1-Sided Level	432				0.717	0.572	0.454	0.351	NM
Simulation Test Statistic:									
Median Value	912				0.987	0.960	0.930	0.916	0.810
5% 1-Sided Value	912				0.828	0.731	0.661	0.598	0.398

+ Denotes a market that suffered a long-term interruption.

Table III

Effect of Dividend Exclusion on Variance Ratios

Variance ratios of various series with dividends (total returns) and without dividends (capital returns). The first panel reports results for five countries for which we have long-term data with dividends, using real returns by deflating nominal returns by the wholesale price index (WPI). The second panel compares variance ratios for the U.S. S&P 500 index. Real returns are deflated by the WPI and consumer price index (CPI); excess returns are measured in excess of the short-term Treasury Bill rate.

Real Returns, deflated by WPI

			Variance Ratio					
Country	Period	Return	1-year	2-year	3-year	4-year	5-year	10-year
U.S.	1921-1996	Total	1.000	1.016	0.916	0.909	0.902	0.852
		Capital	1.000	1.020	0.919	0.911	0.902	0.858
U.K.	1921-1996	Total	1.000	0.918	0.798	0.706	0.720	0.612
		Capital	1.000	0.915	0.797	0.701	0.710	0.589
Denmark	1923-1996	Total	1.000	0.813	0.723	0.761	0.704	0.646
		Capital	1.000	0.829	0.748	0.798	0.740	0.700
Sweden	1921-1996	Total	1.000	0.982	0.860	0.826	0.786	0.655
		Capital	1.000	1.028	0.980	0.984	0.930	0.739
Switzerland	1926-1996	Total	1.000	1.047	0.922	0.867	0.844	0.696
		Capital	1.000	1.132	1.069	1.027	0.974	0.720

U.S. Returns, S&P 500

			Variance Ratio				
Series	Return	1-year	2-year	3-year	4-year	5-year	10-year
Real, WPI-Deflated	Total	1.000	0.980	0.939	0.960	0.960	0.783
	Capital	1.000	0.983	0.942	0.961	0.960	0.787
Real, CPI-Deflated	Total	1.000	0.952	0.885	0.879	0.845	0.603
	Capital	1.000	0.953	0.884	0.874	0.836	0.586
Excess Return	Total	1.000	0.982	0.930	0.921	0.871	0.629
	Capital	1.000	0.979	0.921	0.903	0.844	0.572

Table IV

Long-Horizon Return and Volatility, Annualized Real Capital Indices

Average returns and volatilities for real capital appreciation returns on global equity markets across various horizons. Returns beyond one year are annualized. Statistics for one-year to ten-year data involve overlapping observations. Average ten-year return, for instance, is the arithmetic average of all ten-year returns. Average return over the total period is the geometric growth.

Country	Average Return					Volatility			
	1-Mo	1-Year	5-Year	10-Year	Total	1-Mo	1-Year	5-Year	10-Year
		----- (annualized) -----					-- (annualized) --		
U.S.	0.46	6.21	3.79	2.78	4.31	4.57	20.89	9.39	5.99
Canada	0.37	4.77	2.74	2.04	3.05	4.79	20.49	8.13	4.32
U.K.	0.30	4.04	1.90	1.28	2.35	4.53	19.09	8.57	5.71
Austria	0.27	5.08	2.69	2.48	1.62	5.28	27.74	13.82	9.09
Belgium	0.12	1.77	-0.34	-0.71	-0.32	5.47	21.12	8.44	5.29
Denmark	0.22	3.38	1.37	1.01	1.86	3.66	20.09	6.96	4.91
Finland	0.29	5.60	2.34	1.43	2.07	4.93	28.94	14.11	9.74
France	0.26	3.68	1.34	0.42	0.93	6.13	25.18	12.72	7.93
Germany	0.55	8.65	3.13	2.36	1.90	7.33	44.36	14.14	9.88
Ireland	0.22	3.63	1.40	1.45	1.46	4.34	21.96	9.88	6.58
Italy	0.27	5.23	0.96	0.63	0.06	7.37	38.55	13.60	10.32
Netherlands	0.22	3.49	1.78	1.25	1.59	4.28	20.08	9.18	6.29
Norway	0.37	4.50	2.31	1.55	2.90	5.16	21.05	8.33	5.84
Portugal	0.24	6.71	0.42	-0.38	-0.58	8.34	47.96	17.37	10.72
Spain	-0.05	0.20	-1.94	-2.92	-1.78	4.51	23.27	13.00	8.60
Sweden	0.45	6.04	3.85	3.12	4.11	4.79	21.56	9.28	5.80
Switzerland	0.36	4.78	2.65	2.23	3.23	4.26	19.21	8.54	5.38
Australia	0.22	3.17	0.96	0.38	1.58	4.03	18.78	7.87	5.00
New Zealand	0.06	1.41	-0.62	-1.02	-0.25	3.62	19.55	8.12	4.55
India	-0.08	0.36	-0.74	-1.36	-2.28	4.65	22.95	10.28	7.47
Japan	0.16	4.39	1.22	0.65	-0.81	6.69	30.29	17.96	14.86
Pakistan	-0.05	0.84	-0.18	-0.87	-1.77	4.39	21.40	8.12	6.22
Philippines	0.11	6.30	-2.65	-4.33	-3.64	10.73	70.47	19.94	13.65
South Africa	-0.03	0.66	-1.03	-0.61	-1.76	4.59	22.07	9.41	6.75
Brazil	1.08	15.14	2.40	0.05	-0.17	14.97	64.22	22.09	9.78
Chile	0.63	9.15	4.24	2.72	3.00	8.77	39.65	19.14	12.48
Colombia	-0.17	0.09	-3.37	-5.82	-4.11	6.29	35.83	13.70	8.01
Mexico	0.45	9.11	4.54	2.71	2.28	7.05	47.31	17.10	10.83
Venezuela	0.07	3.43	-2.23	-2.79	-2.03	7.16	44.82	10.22	6.20
Israel	0.48	7.60	3.84	1.74	3.03	6.62	31.07	11.70	5.19
Average	0.26	4.65	1.23	0.38	0.73	5.98	30.33	12.04	7.78
Median	0.25	4.45	1.39	0.83	1.52	5.05	23.11	10.25	6.67
Index									
Global	0.38	5.11	3.73	3.02	4.04	3.19	16.10	8.33	5.65
Non-U.S.	0.32	4.38	3.36	2.93	3.39	2.87	15.57	8.08	5.85

Table V

Long-Horizon Return and Volatility, Non-annualized Real Capital Indices

Average returns and volatilities for real capital appreciation returns on global equity markets across various horizons, without annualizing.

Country	Average Return			Volatility		
	1-Year	5-Year	10-Year	1-Year	5-Year	10-Year
U.S.	6.21	30.55	51.78	20.89	59.74	81.79
Canada	4.77	21.84	32.00	20.49	49.78	51.29
U.K.	4.04	17.33	30.20	19.09	44.63	69.19
Austria	5.08	34.42	79.54	27.74	82.44	169.99
Belgium	1.77	5.43	5.44	21.12	44.80	55.09
Denmark	3.38	12.32	23.53	20.09	41.81	67.88
Finland	5.60	33.54	63.46	28.94	86.34	136.90
France	3.68	23.93	36.18	25.18	74.96	108.04
Germany	8.65	38.72	93.39	44.36	93.77	233.58
Ireland	3.63	18.24	38.51	21.96	64.54	86.36
Italy	5.23	24.12	66.19	38.55	77.64	170.19
Netherlands	3.49	18.17	33.68	20.08	52.01	80.33
Norway	4.50	19.57	36.16	21.05	48.86	87.84
Portugal	6.71	37.94	68.37	47.96	155.23	258.32
Spain	0.20	7.97	3.69	23.27	80.55	92.07
Sweden	6.04	30.91	58.65	21.56	61.93	109.29
Switzerland	4.78	21.77	40.47	19.21	48.48	71.53
Australia	3.17	11.22	15.53	18.78	42.43	54.92
New Zealand	1.41	3.65	-0.77	19.55	44.67	47.60
India	0.36	7.38	15.22	22.95	61.77	108.87
Japan	4.39	34.75	83.38	30.29	88.71	137.73
Pakistan	0.84	5.54	8.78	21.40	40.50	67.90
Philippines	6.30	38.59	60.11	70.47	212.07	289.15
South Africa	0.66	3.85	15.62	22.07	51.20	82.58
Brazil	15.14	77.47	46.52	64.22	228.13	128.36
Chile	9.15	79.10	163.91	39.65	250.93	402.28
Colombia	0.09	5.01	-11.54	35.83	100.68	147.92
Mexico	9.11	66.92	161.20	47.31	187.48	501.33
Venezuela	3.43	-1.25	-12.36	44.82	48.69	43.47
Israel	7.60	37.49	33.41	31.07	86.14	71.13
Average	4.65	25.55	44.64	30.33	87.03	133.71
Median	4.45	21.81	36.10	23.11	63.24	89.90
Index						
Global	5.11	28.07	53.34	16.10	52.87	80.33
Non-U.S.	4.38	25.22	53.55	15.57	49.03	84.88

Table VI

Long-Horizon Downside Risk, Real Capital Indices

Downside risk for real capital appreciation indices of stock markets. Risk is measured using probability of loss over the horizon and the 95% Value at Risk, without annualizing.

	Probability of Loss			95% Value at Risk		
Country	1-Year	5-Year	10-Year	1-Year	5-Year	10-Year
U.S.	36.6	34.3	33.7	-27.8	-45.5	-51.2
Canada	42.2	33.0	31.1	-28.1	-44.9	-43.6
U.K.	40.3	32.5	45.2	-24.5	-54.8	-50.8
Austria	51.4	44.3	42.1	-28.5	-76.1	-75.7
Belgium	49.4	49.2	57.6	-27.1	-55.2	-62.4
Denmark	43.2	43.9	47.7	-25.0	-37.6	-42.1
Finland	48.1	44.3	36.8	-33.3	-77.6	-85.2
France	48.6	46.9	51.3	-34.7	-68.3	-74.6
Germany	47.0	38.8	41.9	-30.8	-75.0	-80.3
Ireland	47.7	46.8	48.6	-29.1	-47.7	-56.0
Italy	48.2	50.6	50.1	-36.5	-71.1	-81.0
Netherlands	47.8	41.7	46.2	-26.6	-48.8	-59.2
Norway	46.1	36.6	43.6	-25.3	-38.9	-53.4
Portugal	53.0	52.5	58.2	-49.0	-75.7	-86.1
Spain	56.4	60.1	67.9	-33.4	-76.5	-83.4
Sweden	38.9	35.7	33.5	-25.9	-38.2	-42.3
Switzerland	41.3	31.8	37.8	-26.2	-49.6	-47.3
Australia	42.2	43.2	47.6	-27.3	-50.5	-55.4
New Zealand	50.9	56.0	61.9	-27.0	-54.4	-58.7
Japan	47.0	38.1	26.3	-37.8	-95.1	-98.5
India	55.8	55.3	63.0	-31.2	-63.7	-72.5
Pakistan	52.8	49.7	50.0	-30.8	-60.1	-63.6
Philippines	60.0	61.3	68.7	-42.2	-80.3	-92.2
South Africa	53.1	54.6	57.5	-33.4	-60.5	-68.1
Brazil	47.9	50.0	47.4	-57.6	-76.9	-82.8
Chile	48.7	57.1	57.2	-39.6	-56.6	-72.6
Colombia	61.4	71.0	89.4	-35.4	-68.0	-75.2
Mexico	56.4	49.0	51.6	-36.4	-62.8	-56.9
Venezuela	51.4	51.2	64.0	-39.0	-74.9	-81.9
Israel	44.0	45.5	38.1	-36.2	-45.2	-48.2
Average	48.6	46.8	49.9	-32.9	-61.0	-66.7
Median	48.2	46.8	48.2	-31.0	-60.3	-65.9
Index						
Global	37.8	35.4	35.2	-20.8	-40.4	-41.1
Non-U.S.	42.7	31.9	36.4	-17.1	-42.6	-53.9

Table VII

Long-Horizon Downside Risk, Real Capital and Total Return Indices

Downside risk for a subset of equity markets for which both real capital and total returns are available, using probability of loss over the horizon and the 95% Value at Risk. The first column is the income return in percent per annum.

Country	Income Return	Probability of Loss 1-Year	5-Year	10-Year	95% Value at Risk 1-Year	5-Year	10-Year
Total Returns							
U.S.	3.8	30.8	20.7	15.5	-24.5	-33.7	-22.3
Canada	4.2	34.7	18.4	11.9	-24.7	-32.9	-11.1
U.K.	5.3	30.1	22.1	20.2	-20.4	-42.5	-16.7
Belgium	4.4	42.3	32.9	30.8	-24.9	-47.8	-45.1
Denmark	3.5	36.1	24.6	19.9	-22.2	-25.0	-19.8
France	3.4	43.8	34.3	36.2	-32.2	-65.4	-69.9
Germany	3.2	40.3	28.6	26.0	-27.2	-73.1	-77.5
Ireland	4.7	40.1	29.7	16.7	-25.6	-31.9	-29.0
Italy	2.4	45.1	45.8	43.2	-35.1	-65.0	-74.1
Netherlands	5.1	35.9	26.9	15.2	-23.3	-38.6	-39.0
Spain	4.8	43.4	39.8	42.4	-29.9	-70.9	-75.1
Sweden	3.6	31.4	23.2	7.4	-22.5	-23.2	-8.1
Switzerland	2.8	35.6	23.4	19.7	-24.3	-39.9	-24.9
Australia	5.3	31.0	19.1	14.9	-24.0	-38.8	-34.8
Japan	4.7	38.6	26.9	21.5	-36.4	-90.5	-96.1
Average	4.1	37.3	27.8	22.8	-26.5	-47.9	-42.9
Median	4.2	36.1	26.9	19.9	-24.7	-39.9	-34.8
Global	3.8	30.2	18.2	12.0	-16.7	-19.8	-11.2
Capital Returns							
U.S.		36.6	34.3	33.7	-27.8	-45.5	-51.2
Canada		42.2	33.0	31.1	-28.1	-44.9	-43.6
U.K.		40.3	32.5	45.2	-24.5	-54.8	-50.8
Belgium		49.4	49.2	57.6	-27.1	-55.2	-62.4
Denmark		43.2	43.9	47.7	-25.0	-37.6	-42.1
France		48.6	46.9	51.3	-34.7	-68.3	-74.6
Germany		47.0	38.8	41.9	-30.8	-75.0	-80.3
Ireland		47.7	46.8	48.6	-29.1	-47.7	-56.0
Italy		48.2	50.6	50.1	-36.5	-71.1	-81.0
Netherlands		47.8	41.7	46.2	-26.6	-48.8	-59.2
Spain		56.4	60.1	67.9	-33.4	-76.5	-83.4
Sweden		38.9	35.7	33.5	-25.9	-38.2	-42.3
Switzerland		41.3	31.8	37.8	-26.2	-49.6	-47.3
Australia		42.2	43.2	47.6	-27.3	-50.5	-55.4
Japan		47.0	38.1	26.1	-37.8	-95.1	-98.5
Average		45.1	41.8	44.4	-29.4	-57.3	-61.9
Median		47.0	41.7	46.2	-27.8	-50.5	-56.0
Global		36.7	36.6	33.3	-19.9	-37.2	-43.3

Table VIII
Downside Risk of Global Equity Markets

Worst loss of real returns over various periods, as well as the month in which the loss occurs. Multiple-year returns are annualized as indicated. The sample period varies across country and is reported in Table I.

Country	Worst Loss 1-Mo	1-Year (annualized)	5-Year (annualized)	10-Year (annualized)	5-Year (actual)	10-Year (actual)	Ending Month 1-Mo	1-Year	5-Year	10-Year
U.S.	-24.0	-55.9	-15.3	-8.9	-56.4	-60.7	11/29	6/32	9/34	8/82
Canada	-22.9	-45.6	-17.1	-7.8	-60.9	-55.6	10/87	6/82	3/42	6/82
U.K.	-22.8	-65.6	-24.0	-11.0	-74.7	-68.7	11/87	11/74	12/74	12/74
Austria	-21.8	-73.5	-36.4	-16.4	-89.6	-83.2	6/49	8/48	7/51	7/51
Belgium	-22.6	-45.5	-21.6	-11.3	-70.3	-70.0	11/87	11/47	12/47	5/51
Denmark	-16.9	-48.8	-12.7	-7.0	-49.2	-51.8	11/73	8/74	7/51	6/49
Finland	-20.1	-51.0	-33.1	-20.2	-86.6	-89.5	3/48	10/45	8/48	10/48
France	-25.4	-53.4	-30.3	-17.2	-83.5	-84.8	3/82	10/45	6/49	1/53
Germany	-92.4	-89.7	-39.7	-19.9	-92.0	-89.1	7/48	6/49	7/48	7/48
Ireland	-29.1	-59.0	-18.4	-12.1	-63.7	-72.5	11/87	1/75	1/75	2/83
Italy	-32.9	-73.0	-33.9	-18.7	-87.3	-87.3	7/81	4/46	4/46	6/77
Netherlands	-20.3	-44.2	-17.3	-11.8	-61.4	-71.5	4/32	4/32	3/49	2/53
Norway	-34.6	-53.8	-25.4	-9.2	-76.8	-61.8	11/87	1/75	6/78	8/82
Portugal	-26.0	-67.9	-53.4	-25.5	-97.8	-94.7	10/87	9/88	11/78	12/83
Spain	-28.6	-52.4	-31.0	-21.4	-84.3	-91.0	10/87	9/77	4/80	2/83
Sweden	-27.5	-56.7	-13.4	-7.9	-51.2	-56.1	3/32	6/32	2/33	4/40
Switzerland	-22.0	-45.8	-19.1	-7.9	-65.4	-56.3	11/87	10/74	12/66	8/82
Australia	-32.9	-49.8	-20.5	-9.5	-68.2	-63.1	11/87	8/74	12/74	7/78
New Zealand	-30.4	-52.1	-19.0	-11.5	-65.1	-70.6	11/87	12/87	12/91	1/80
Japan	-47.1	-92.7	-56.3	-37.1	-98.4	-99.0	7/47	8/46	11/47	4/50
India	-24.3	-50.5	-23.2	-14.9	-73.2	-80.2	11/87	4/93	6/50	10/49
Pakistan	-12.7	-42.6	-19.6	-10.4	-66.4	-66.8	7/96	3/95	2/75	8/74
Philippines	-27.2	-65.8	-32.1	-23.9	-85.6	-93.5	5/86	9/74	1/85	9/83
South Africa	-28.4	-46.4	-19.1	-12.3	-65.3	-73.2	2/93	10/74	5/53	6/79
Brazil	-67.9	-82.0	-36.1	-22.5	-89.4	-92.2	3/90	5/87	10/90	6/81
Chile	-68.3	-67.4	-25.4	-15.2	-76.9	-80.8	10/73	9/74	6/85	4/50
Colombia	-20.5	-48.3	-26.6	-16.2	-78.7	-82.9	3/71	6/47	2/76	2/81
Mexico	-46.5	-73.2	-31.5	-14.1	-84.9	-78.2	11/87	5/82	4/84	4/83
Venezuela	-37.2	-84.3	-30.9	-22.6	-84.3	-92.3	2/89	7/89	9/82	7/89
Israel	-34.2	-67.4	-14.6	-9.6	-54.6	-63.6	10/83	12/83	6/68	1/75
Average	-32.3	-60.1	-26.6	-15.1	-74.7	-76.0				
Median	-27.4	-54.9	-24.7	-13.2	-75.8	-75.8				
Index										
Global	-20.1	-43.2	-13.4	-7.5	-51.4	-54.0	11/29	10/74	6/49	6/49
Non-U.S.	-22.7	-39.7	-16.4	-8.4	-59.2	-58.3	7/48	10/74	6/49	6/49

Figure 1. Distribution of Five-Year Returns: All Markets
Empirical distribution of five-year returns across all markets, including overlapping observations, as well as lognormal distribution that provides the best fit.

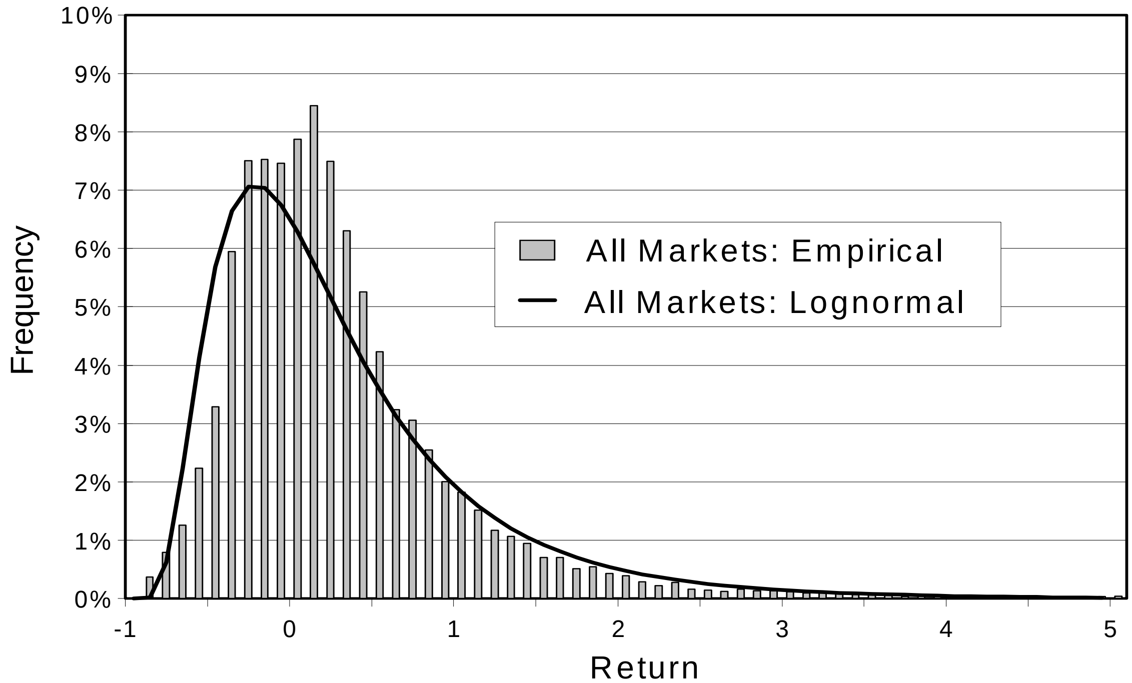

Figure 2. Distribution of Five-Year Returns: All Markets and U.S.
Empirical distribution of five-year returns across all markets, compared to the distribution for the U.S. equity market.