

## **Lunar cycle effects in stock returns**

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## **Abstract**

We find strong lunar cycle effects in stock returns. Specifically, returns in the 15 days around new moon dates are about double the returns in the 15 days around full moon dates. This pattern of returns is pervasive; we find it for all major U.S. stock indexes over the last 100 years and for nearly all major stock indexes of 24 other countries over the last 30 years. In contrast, we find no reliable or economically important evidence of lunar cycle effects in return volatility and volume of trading. Taken as a whole, this evidence is consistent with popular beliefs that lunar cycles affect human behavior.

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# Lunar cycle effects in stock returns

## 1. Introduction

For thousands of years, there have been widespread beliefs that moon cycles affect human behavior. Specifically, people around the world believe that abnormal human behavior peaks around the full moon, increasing the propensity for psychotic disorders, violence, and other deviant behavior.<sup>1</sup> These beliefs can be traced all the way to ancient Greece and Rome, throughout the Middle Ages, and to the present, where they are commonly found in much professional folklore, most notably for the police and the emergency and medical services. More generally, the moon and its cycles have long been considered an important factor in many prominent human activities. Religious ceremonies were often timed to match precise phases of the lunar month, and calendar years were based on moon cycles, including the Islamic, Hebrew, and Chinese calendars. To this day, many popular holidays like Easter and Passover are still timed according to the lunar cycles.

Following this persistent pattern of beliefs, there is a considerable literature in psychology and medicine that investigates for a moon effect on human behavior. Some of these studies find significant relations, for example individual studies find that homicides, hospital admissions, and crisis incidents peak in the days around the full moon. However, reviews and meta-analyses of the literature have generally been negative. Rotton and Kelley (1985) examines and aggregates the evidence of 37 studies, and concludes that lunar phase influences are “much ado about nothing.” A recent updated review, Kelly, Rotton, and Culver (1996), also finds that lunar cycle effects in

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<sup>1</sup> Note that the very term “lunacy” is derived from “luna”, the Latin for moon.

existing studies are sporadic, unreliable, and generally of little practical interest.<sup>2</sup>

However, existing studies of lunar cycle effects on human behavior are mostly limited to investigations of pronounced abnormal behavior like suicides, aggressive acts, and mental instability. As a consequence, such studies usually rely on fairly limited samples of extreme outcomes and could be of low statistical power, especially if lunar-cycle effects on human behavior exist but are fairly mild.

We investigate for lunar cycle effects in stock returns for two reasons. First, contemporary surveys confirm that a large part of the population, about 50 percent, believes that strange behavior peaks around the full moon (e.g., Kelly, Rotton, and Culver 1996). If such behavior exists, it seems plausible that it influences investor behavior and the resulting stock prices and returns. Note that, in contrast to existing evidence of lunar effects on sporadic and extreme behavior, stock prices are powerful aggregators of regular and recurring human behavior. Using daily stock index data over decades and many countries allows one to test the lunar cycle hypothesis based on countless decisions of hundreds of millions of individuals.

Second, there is growing evidence that behavioral biases influence investor decisions and the resulting stock prices and returns (e.g., see Hirshleifer 2001 and Kahneman and Riepe 1998 for recent reviews). In particular, two recent studies suggest that a pervasive exogenous variable, amount of sunshine, affects human behavior and the resulting stock returns. Hirshleifer and Shumway (2001) finds that stock returns tend to be higher on sunny days, most likely because sunshine induces optimistic behavior.

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<sup>2</sup> However, there is evidence of reliable correlations between the lunar cycle and geophysical and biological behavior variables. For example, existing research has documented lunar cycle impacts on precipitation variations, atmospheric pressure changes, hurricanes, and daily global temperatures (e.g., see Balling and Cerveny 1995, and references thereof).

Kamstra, Kramer, and Levi (2001) documents that stock returns are related to the amount of daylight throughout the course of the year. Kamstra, Kramer, and Levi's interpretation is that lack of sunlight induces depression, which increases risk-aversion, affecting the valuation of stocks. A consideration of the evidence in Hirshleifer and Shumway (2001) and Kamstra, Kramer, and Levi (2001) suggests that it is likely that there are other pervasive exogenous factors that affect stock prices in systematic ways. Given the tradition and the persistence of beliefs about lunar cycle effect on human behavior, investigating the effect of moon cycles on stock returns seems like a natural step in this direction. For example, if the full moon induces depression and pessimism, one would expect that returns around full moon days are lower either because of heightened risk-aversion or because of more pessimistic projections of stocks' future cash flows.

We begin our investigation with a comprehensive look at possible lunar cycle effects in U.S. stock returns. We find that stock returns are substantially higher around new moon dates as compared to full moon dates. This pattern exists for all major U.S. stock indexes over the full history of available returns, including the Dow Jones Industrial Average (1896-1999), the S&P 500 (1928-2000), NYSE-AMEX (1962-2000), and Nasdaq (1973-2000). The economic magnitude of this difference is large, with daily returns around new moon dates nearly double those around full moon dates. As another calibration statistic, the annualized difference between new moon and full moon returns is on the magnitude of 5 to 8 percent, rivaling and probably exceeding the market risk premium. However, due to the large standard deviation of daily returns, most differences for individual stock indexes are not statistically significant. In additional tests, we find

that lunar cycle effects in return volatility and in volume of trading are either statistically unreliable or have small economic magnitudes.

The U.S. findings prompt us to expand our investigation internationally. We use Datastream data to derive results for 24 other countries over the last 30 years, covering essentially all major stock exchanges in the world. We find that the pattern of U.S. results is largely repeated in these other countries. If anything, the results are more pronounced for foreign countries. More specifically, the daily returns around new moon dates are more than double those around full moon dates, with annualized differences on the magnitude of 7 to 10 percent. In addition, combining U.S. and international data allows us to construct powerful statistical tests, which reject the null hypothesis of no difference in returns at high levels of statistical significance.

The remainder of the paper is organized as follows. Section 2 presents evidence of lunar cycle effects in U.S. stock returns. Section 3 expands the analysis to other related economic variables in the U.S. Section 4 presents the returns results for other major stock indexes around the world. Section 5 provides additional analyses of international data. Section 6 concludes and offers suggestions for future research.

## **2. Evidence of lunar cycle effects in U.S. stock returns**

We begin our analysis with tests for lunar cycle effects in the most popular U.S. stock indexes. Data for the Dow Jones Industrial Average (DJIA) are from Dow Jones and Company, data for the Standard and Poor's 500 are from Global Financial Data ([www.globalfindata.com](http://www.globalfindata.com)), and the rest of the return data are from CRSP. We obtain new moon and full moon dates from the Web site [www.lunaroutreach.org](http://www.lunaroutreach.org). There are several

different lunar cycles but by far the most well known and widely used is the *synodic* lunar cycle, which has a periodicity of 29.53 days between two successive new moons. For the interested reader, we provide further detail on the terminology and the mechanics of the lunar cycle in Panel A of Appendix 1.

In a series of preliminary tests, we examined the pattern of mean daily returns throughout the lunar month, including visual inspections of return histograms. This examination reveals one interesting regularity. We observe that high returns tend to cluster around the new moon date, while low returns tend to cluster around the full moon date. Following this observation, we structure our returns tests to reflect the possible difference between new moon and full moon periods. Specifically, most of our tests are simple comparisons of mean daily returns for various return windows centered on the new moon and the full moon date.

For U.S. data, we limit our presentation to two return window specifications. The first specification, illustrated in Panel B of Appendix 1, compares mean daily returns occurring during one calendar week centered on the new moon date (new moon date +/- three calendar days) vs. the mean daily returns occurring during the calendar week centered on the full moon date (full moon date +/- three calendar days). Thus, since the lunar month has a length of about 29.5 days, the first specification uses only about half of all available daily returns. The second specification uses all available daily returns and compares mean daily returns during the 15 calendar days centered on the new moon date vs. the 15 calendar days centered on the full moon date.<sup>3</sup> Essentially, a comparison of

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<sup>3</sup> Since the lunar month has 29.53 days, the use of two 15-day calendar days implies that about every second lunar month the two 15-day return windows have an overlap of one day. The effect of this minimal overlap is likely immaterial. In any case, the tenor of the results remains the same for other comparable return windows, including the results for 7-day windows tabulated in the paper.

these two return window specifications allows one to assess whether possible lunar cycle effects are more concentrated around the two locus dates or are evenly spread throughout the lunar month.

The results for U.S. stock returns are summarized in Table 1. Panel A presents the results for the DJIA, which is the most popular U.S. stock index and for which we have the longest return series. Price level data on this index are available from 1896 until 1999. Based on price levels at closing, we compute the daily return for day  $t$  as  $(\text{Price level}_t - \text{Price level}_{t-1}) / \text{Price level}_{t-1}$ . Thus, returns for the DJIA reflect only capital appreciation and exclude dividends. For our purposes, this omission does not seem to be important because returns from dividends are fairly fixed, and there is no reason to believe that they should vary by phases of the moon. An examination of the results for the DJIA reveals that daily returns around new moon dates are substantially higher than returns around full moon dates. For the 7-day window specification, the mean daily return around new moons is 0.035 percent compared to 0.017 percent around full moons. This difference is large in relative terms, with new moon returns about double the full moon returns. The difference is also large in economic terms. Assuming 250 trading days per year and compounding of daily returns, the annualized difference in returns is 4.8 percent, which is on the magnitude of the stock market risk premium (e.g., Fama and French 2001). The tenor of the results is roughly the same for the 15-day window, although the return difference is marginally lower.

In addition to raw returns and differences, Table 1 presents the standard deviations of daily returns, number of daily return observations, and t-tests of the difference in mean returns between new moon and full moon windows. In spite of the

large difference in returns, the t-statistics for both return specifications are insignificant (0.96 and 1.16). The main reason for this lack of statistical significance is the large standard deviation of daily returns, about 1 percent, which swamps in magnitude the difference in returns. We also investigate whether the identified difference in returns between new moon and full moon windows is persistent. As a measure of persistence, we calculate the percentage of years in which mean new moon daily returns are higher than mean full moon returns. For the DJIA, this number is 56.3 percent, which is moderately above the 50 percent that would be expected by chance. This percentage also signifies that the difference in returns is unlikely to be due to outliers, and is a relatively persistent feature of the sample. For a more rigorous assessment of this number, we present binomial tests, which assume that under the null of no difference in returns new moon returns during a year are higher than full moon returns with a probability of 50 percent. These tests yield p-values of 0.10, which are significant at only fairly loose statistical levels.

Panels B, C, and D in Table 1 present the same set of tests for three other major U.S stock indexes for all available years. Specifically, we examine the Standard and Poor's 500 (1928-2000), the NYSE/AMEX index from CRSP (1962-2000), and the Nasdaq index from CRSP (1973-2000). For the S&P 500, we construct returns from closing daily price levels, so the S&P returns omit dividends, while NYSE/AMEX and Nasdaq returns include dividends. Of course, it is clear that many of the stocks and the years across the four return indexes in Table 1 are overlapping. Thus, the results across panels of Table 1 should not be viewed as independent of each other. However, it is also

probably clear that the inclusion of broader indexes that include dividends enriches the evidence on many dimensions.

An examination of the rest of Table 1 reveals that the results for these three additional indexes are similar to those for the DJIA. For all three indexes and for both return windows (a total of six return specifications), new moon returns are substantially higher than full moon returns. If anything, the return differences in Panels B, C, and D are somewhat larger than those for the DJIA in Panel A. The daily return differences range from a low of 0.017 percent for the 15-day specification for the S&P 500 to a high of 0.026 for the 7-day specification for Nasdaq. Using the convention of 250 trading days, this range of daily return differences translates to a range of annualized differences of 4.6 percent to 8 percent, which implies that for all specifications the difference is economically large. However, none of the t-statistics is significant at conventional levels, again because the return differences are comparatively small in relation to the standard deviation of daily returns.

The results on the persistence of the difference between new moon and full moon returns are stronger in Panels B, C, and D, as compared to those for the DJIA in Panel A. The percentage of years in which mean new moon daily returns are higher than full moon returns ranges from a low of 60.3 percent to a high of 64.3 percent. Binomial tests similar to those for the DJIA yield p-values ranging from a low of 0.02 to a high of 0.13, with 4 of the 6 specifications significant at the five percent level or better. Note that the only binomial p-values that are not significant are for Nasdaq, which has the shortest time-series, and the most significant results are for the S&P 500, which has the longest time series.

For an alternative summary of our U.S. return results, Figure 1 presents a graph of new moon vs. full moon annualized mean daily returns for the 15-day specification. In interpreting the graph, it is useful to keep in mind that the returns for the DJIA and the S&P 500 exclude dividends, while dividends comprise the bulk of total stock returns up until the last 30 or 40 years (e.g., Fama and French 2001). Thus, it is not surprising that the returns for the DJIA and the S&P 500 (which start a lot earlier) are lower than those for NYSE/AMEX and Nasdaq. The message of Figure 1 is straightforward. New moon returns are substantially higher than full moon returns. In fact, new moon returns are nearly double the full moon returns for all four major U.S. stock indexes over the last 100 years.

### **3. Additional U.S. evidence**

Prompted by the intriguing pattern in stock returns, in this section we broaden the investigation of lunar cycle effects to other related variables in the U.S. economy. First, we extend the analysis to other variables related to stock trading, specifically the standard deviation of stock returns and volume of trading. Recall that the magnitudes of the standard deviations in Table 1 suggest that there is little difference between new moon and full moon volatilities of returns. The formal tests for possible differences are presented in Table 2, Panel A for the 7-day window specification and Panel B for the 15-day window specification. An examination of Table 2 reveals that the standard deviation of returns is always higher for new moon periods. In addition, all differences in standard deviation are highly statistically significant except one. However, the economic magnitude of these differences is small, with an average of about 5 percent and a

maximum of less than 10 percent of the standard deviation of the pooled new and full moon samples. Thus, it seems that these differences have only modest practical value.

The results for trading volume are reported in Table 3, Panel A for the 7-day window specification, and Panel B for the 15-day window specification. We use all available data for volume on NYSE (1888-2000), the S&P 500 (1942-2000), and NASDAQ (1978-2000), where volume of trading is defined as number of shares traded. In preliminary tests, we find that the behavior of daily volume of trading and first differences in volume are highly non-normal, so simple tests of means based on these statistics are inappropriate. We address this difficulty by defining a new lunar month-based test statistic called *Standardized Differences in Trading Volume* as  $(\text{Mean New Moon Volume} - \text{Mean Full Moon Volume}) / (\text{Mean New Moon Volume} + \text{Mean Full Moon Volume}) / 2$ . The variable Mean New Moon Volume represents the mean volume of trading over all trading days within a 7 (15) calendar day window around a new moon date during a particular lunar month, and Mean Full Moon Volume is defined analogously. This transformation yields a *Standardized Difference* variable, which is fairly normal, and has one observation for each lunar month in the sample. Tests on the mean of this variable identify possible differences in trading volume. An examination of the results in Table 3 reveals no reliable lunar cycle effects in volume of trading. All test statistics are insignificant at conventional statistical levels. Even more importantly, all mean standardized differences are less than one percent, which indicates that volume of trading differs by less than one percent between new and full moon trading windows.

We continue by expanding our analysis beyond stock trading, to testing for lunar cycle effects in bond returns and changes in interest rates. Our motivation is that

evidence from other related and plausible economic variables helps put the stock returns results in sharper perspective and can give some clues about the possible causes of this phenomenon. The reason is that (unexpected) stock returns are essentially determined by two variables, changes in investors' expectations of future cash flows and changes in the discount rate, while bond returns are (mostly) determined by changes in the discount rate. Thus, finding a pattern of high bond returns and interest rate decreases during new moon periods, and the converse during full moon periods, suggests that factors related to interest rate revisions are instrumental to the lunar cycle effect in stock returns. Alternatively, finding no lunar cycle effects in bond returns and interest rates suggests that the lunar cycle effect in stock returns is related to a systematic pattern of revisions of investors' forecasts of future cash flows.

Table 4 presents a comparison of lunar cycle effects in U.S. stock returns, bond returns, and interest rate changes from 1915 to 1999. As the stock return benchmark and for a link with earlier results, we use the DJIA (returns exclude dividends). Choosing the bond return and the interest rate change variables presents more challenges in terms of choosing appropriate and available data. For computing bond returns, we choose the Dow Jones Bond Average (DJBA) because it is prominent, reasonably representative and diversified, and has by far the longest bond index daily price history. Currently, the DJBA is an equally-weighted index of 20 NYSE-traded long-term bonds, which are continually replaced as they mature.<sup>4</sup> The represented bonds are from 10 prominent industrial companies and 10 utilities, with current examples including AT&T, Bell South,

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<sup>4</sup> The DJBA was started in 1915. It originally consisted of 40 bonds, including 10 industrials, 10 utilities, 10 high-grade railroads, and 10 low-grade railroads. The index was reorganized in July 1976, dropping all railroad bonds because there were not enough viable railroads left. Today, the DJBA consists of 10 industrials and 10 utilities. These two groups are also reported as separate indexes.

Occidental Petroleum, ARCO, Borden, and IBM. The bonds are generally long-term debentures, although there are other types of bonds as well (e.g., mortgage-backed securities). The average maturity of the DJBA fluctuates but is generally between 10 and 20 years.<sup>5</sup> We use price level data from the DJBA to compute bond returns, which exclude interest.

For our interest rate change variable, we use changes in the U.S. 3-month commercial paper rate. A short-term commercial paper rate is a reasonable proxy for the risk-free rate (e.g., Fama and French 2001), and the risk-free rate is a component of the discount rates of both stocks and bonds. Unfortunately, daily data for the commercial paper rate are available only after 1970, with weekly increments before that. This data limitation prompts us to present two sets of results. Panel A of Table 4 presents the first set of results for the period 1915-1970, where the results are organized around the weekly observations of interest rates. The problem with this period is that many of the weekly interest rate observations represent weeks that fall between new moon and full moon windows. To solve this problem, we use 15-day new moon and full moon windows, and retain only observations that belong to weeks that fall entirely within these windows. At the end, this procedure leads to a loss of about 40 percent of all observations but allows a clean classification of the remaining observations and meaningful comparisons across variables. Panel B of Table 4 presents the second set of results for the period 1971-1999, where the availability of daily interest rates allows us to include all available observations.

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<sup>5</sup> Most of the specific information about the DJBA is from the Dow Jones and Company Website and from telephone consultations with a Dow Jones and Company representative.

An examination of the DJIA results in Panels A and B reveals that, as expected from earlier tests, new moon stock returns are substantially higher than full moon returns for both subperiods. If one only considers the results in Panel B, it also seems that the lunar cycle effect appears in bond returns as well. The difference between new moon and full moon daily bond returns is fairly small in absolute magnitude, 0.006 percent daily or about 1.5 percent annualized, which is about a quarter of the difference in stock returns. However, since the standard deviation of bond returns is also about a quarter of the standard deviation of stock returns, the relative difference is about the same. What is even more intriguing in Panel B is that new moon interest rate changes are negative while full moon changes are positive. This pattern and the magnitude of the changes suggest that the lunar cycle effects in stock and bond returns might be due to lunar cycle effects in interest rates.<sup>6</sup> However, this appealing story is contradicted by the evidence in Panel A. The difference in bond returns is essentially zero for the period 1915-1970, and if anything, the pattern of interest rate changes is the opposite of that in Panel B. In addition, none of the changes in Panels A and B is statistically significant.

Thus, the evidence from bond returns and interest rate changes is weak and inconclusive. Future research could potentially expand this investigation to larger samples of bond returns and interest rate changes, consider other assets classes (e.g., commodities, options, and futures), and provide more conclusive answers. At this point, perhaps the only reliable conclusion from Table 4 is that the lunar cycle effect in stock

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<sup>6</sup>Note that the magnitude of the interest rate changes is roughly on the magnitude of what would be needed to explain the realized difference in stock returns. For example, assume a prototypical stock that is valued with a Gordon growth formula,  $P=D/(r-g)$ , where  $D=\$1$ ,  $r=12\%$ , and  $g=5\%$ . A decrease in the discount rate of 0.264 basis points (same as the daily difference in Panel B) produces a positive return of 0.038%, roughly the same as the 0.027% daily difference in stock returns in Panel B.

returns is unlikely to be entirely due to discount rate changes and is possibly more due to systematic fluctuations in investors' relative optimism about future cash flows.

#### **4. Evidence of lunar-cycle effects in stock returns around the world**

We continue our investigation with testing for lunar-cycle effects in stock returns around the world. Our expectation is that the lunar-cycle effects identified in U.S. stock data are pervasive. In addition, broadening the evidence with international stock returns allows us to derive large samples and increase statistical power. Our source of international stock data is Datastream, which provides daily returns for almost all major stock indexes in the world. After inspecting the set of available countries and stock data histories, we impose a minimum requirement of a 15-year history of stock prices for a country to be included in our sample. This requirement is fairly mild; it eliminates mostly marginal countries with relatively undeveloped stock markets and short return histories. Our ending international sample contains stock data for 24 countries, which comprises the bulk of international stock trading. We use all available stock data for these countries, with Datastream coverage starting most often in 1973. The available return series is generally longer for more developed economies, and shorter for newly industrialized countries. Just like for the DJIA in the U.S., index returns are computed from index price levels, and therefore omit dividends.

We start our investigation with an analysis of the stock returns for the G-7 group of nations. These seven countries, the U.S., Japan, the United Kingdom, France, Germany, Italy, and Canada, are the most important in terms of their role in the world economy and in international stock trading. The evidence for each individual country is

summarized in Panel A of Table 5. For ease of exposition and clarity of presentation, the results in Panel A follow the same format as the results for U.S. indexes in Table 1. In the interest of brevity, we only present results for the specification that uses a 15-day window of returns around new moon vs. full moon dates. The results for 7-day windows are similar to the 15-day window specification. To provide both continuity with earlier results and comparability with the other G-7 countries, Panel A includes the returns for the S&P 500 for the 1973-2000 period only.

An inspection of Panel A reveals that all seven stock indexes display the same lunar-cycle pattern found in U.S. returns. Mean daily returns around new moon dates are always higher than returns around full moon dates, and the difference is usually considerable. However, due to the relatively short time-series of observations, the t-statistics for most individual countries are insignificant, with only the Frankfurt and the Toronto results approaching significance at conventional levels (t-statistics of 1.75 and 1.88). This return pattern also seems fairly persistent, with the percentage of years in which new moon returns exceed full moon returns ranging from a low of 50 percent to a high of 71.4 percent. The binomial p-values on these percentages are mixed, with four insignificant, two significant at the 10 percent level, and one significant at nearly the 1 percent level.

For a graphical view and a somewhat different perspective on these results, Figure 2 plots new moon vs. full moon annualized mean daily returns for the G-7 countries. The most striking feature of Figure 2 is the sheer magnitude of the difference between new moon and full moon returns. The average new moon annualized return across the G-7 countries is 13.18 percent, more than double the full moon average of 4.82 percent. The

difference of 8.36 percent is large by any traditional yardstick in stock returns, and is likely higher than the market risk premium for these countries.

The evidence so far indicates a persistent pattern of lunar-cycle effects in U.S. and international stock returns. However, the combination of high standard deviation of daily returns and relatively short time series results in insufficient statistical significance at the individual stock index level. In Panel B of Table 5 we use the cross-section of international stock data to offer more powerful tests of the lunar cycle effect. Specifically, in the first part of Panel B we pool all data for the G-7 countries together and compute the same statistics. Essentially, this test treats all stock returns as independent observations. The pooled data results confirm that new moon returns (mean of 0.055 percent) are considerably higher than new moon returns (mean of 0.023 percent). However, this time the difference in returns of 0.032 percent is highly statistically significant, with a t-statistic of 3.43.

The evidence from the pooled data is simple and intuitive but is open to criticism because contemporaneous international stock returns are likely to be positively correlated. It is well known that cross-sectional correlation in returns can lead to understated estimates of standard error and inflated t-statistics (e.g., Bernard 1987). However, this concern is unlikely to be overly important in our setting for two reasons. First, Bernard (1987) shows that problems due to cross-sectional dependence in returns are less pronounced for shorter time-series, and are fairly mild for the case of daily returns. Second, Hirshleifer and Shumway (2001), who use a very similar sample and time period, find that an explicit correction for cross-sectional dependence has almost no effect on their results.

In any case, we offer one additional combined specification that completely avoids concerns about cross-sectional dependence in returns. Specifically, we provide results for a portfolio, where each daily return is an equally weighted average of the corresponding daily returns for the G-7 stock indexes. Not surprisingly, the mean daily returns are very similar to those for the pooled results, with a nearly identical difference in returns of 0.033 percent. The t-statistic for the difference is 2.18, which is significant at the 0.03 level. However, the persistence results for both the pooled and the equal-weighted specification are not significant at conventional levels.

We continue our investigation of international stock returns with a comprehensive coverage of the smaller stock exchanges around the world. Panel A of Table 6 lists the individual results for 18 additional countries, which include most remaining sizable stock exchanges in the world. The available return series for these countries vary in length, with the longest series starting in 1971 and the shortest series starting in 1982. An examination of Panel A reveals that the lunar-cycle effect found for the G-7 countries is pervasive around the world.<sup>7</sup> In fact, the most striking evidence of Panel A is that returns around new moon dates are higher than the returns for full moon dates for all examined exchanges except for the Oslo stock exchange, where this difference is essentially zero. Combined with the preceding results for the G-7 countries, this evidence implies that the new moon/full moon difference is positive in 24 out of 25 examined countries. A simple binomial test rejects at a very high level of statistical significance the probability of observing such a one-sided pattern of return differences across countries by pure chance.

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<sup>7</sup> Another concurrent working paper, Yuan, Zheng, and Zhu (2001), also finds that new moon returns are higher than full moon returns. Yuan, Zheng, and Zhu concentrate on stock return effects in a sample of 50 stock exchanges over the last 20 to 30 years. We consider a smaller set of exchanges, but our return series

As one might expect from the preceding results in Tables 1 and 5, most of the return differences between new moon and full moon windows are insignificant at the individual exchange level. The persistence results are also similar to earlier results. New moon returns exceed full moon returns for most years for 16 out of 18 exchanges, one shows an even split of years, and one shows the converse result.

Similar to Figures 1 and 2, in Figure 3 we illustrate the economic magnitude of the return differences by presenting a graph of annualized new moon and full moon returns for all smaller exchanges. Figure 3 reveals a considerable dispersion of the relative magnitude of new moon and full moon returns across countries. However, new moon returns are higher than full moon returns for nearly all countries, and the difference is usually large. The average of annualized new moon returns across countries is 16.16 percent, which is more than double the average for full moon returns of 6.87 percent. The difference in averages of 9.29 percent is striking in magnitude, and is higher than that for the G-7 countries.

To combine the explanatory power of all data, Panel B of Table 6 presents a pooled data specification and an equally-weighted portfolio specification. Note that the specifications in Panel B of Table 6 combine the data for all 25 available countries, rather than just for those with smaller stock exchanges. The mean daily new moon return for the pooled data is 0.059 percent, more than double the full moon return of 0.025 percent. The difference of 0.034 percent is highly statistically significant, with a t-statistic of 5.35. Annualizing the new moon and full moon daily returns yields an annualized difference of 9.44 percent, which is economically large by any reasonable standard. In addition, new

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go back up to 100 years plus we consider stock return volatility, volume of trading, bond returns, and interest rate changes.

moon returns exceed full moon returns on a fairly persistent basis, in 19 out of 28 years, which yields a binomial p-value of 0.03. The tenor of these results is confirmed in the equally-weighted specification. The difference in daily returns is 0.034, with a t-statistic of 2.60. Again, new moon returns exceed full moon returns in 19 out of 28 years, with a binomial p-value of 0.03.

Finally, we complement the pooled test results with a summary graph that includes all available data and vividly illustrates the main themes in our findings. The motivation is that, taken in and of itself, each of the preceding test results and graphs of stock returns provides a somewhat one-sided perspective on the nature of the lunar cycle phenomenon. For example, the tests of mean effects provide little information about the rest of the distribution, and one needs the evidence on return persistence and standard deviation to flesh out a more complete picture. To provide an alternative and intuitive summary, we use all available observations to plot the entire distributions of new moon and full moon returns in Figure 4. We rely on country-year observations because the mean effects in daily returns (about 0.034 percent) are small compared to the standard deviation of daily returns (1 percent and above). More specifically, for each country and year we calculate new moon and full moon means of daily returns, and then annualize these returns using the assumption of 250 trading days and compounding of daily returns. At the end, we have a new moon and a full moon set of 667 country-year annualized return observations. We group these observations in 10 percent intervals to provide a density plot of the new moon and the full moon return distributions in Figure 4.

As one might expect from the well-known properties of stock returns, both the new moon and the full moon distributions in Figure 4 are fairly bell-shaped, right

skewed, and have central tendencies around the 10 percent mark. The new moon and full moon distributions are also quite similar in shape, with about the same dispersion, rates of increase and decrease, and magnitude at the peak. However, the truly remarkable evidence in Figure 4 is the fact that the new moon distribution looks as if someone made a copy of the full moon distribution and shifted it to the right about 5 to 10 percent. Note that this shift looks regular and clean throughout the entire left and right tails of the distribution, except for the extreme right hand tail observations.

In other words, Figure 4 is a concise graphical summary of our main findings. Throughout the world over the last 30 years, new moon returns are greater than full moon returns on the magnitude of 5 to 10 percent in annualized returns. This difference is pervasive and is not due to outliers or any other isolated effects. Other characteristics of returns (e.g., standard deviation, skewness, and kurtosis) are roughly the same between these two samples.

## **5. Additional international evidence**

In this section we present additional analyses that expand our understanding of lunar cycle effects in international stock markets. First, we present evidence on cross-country variation in the new moon/full moon stock return differential. Second, similar to the U.S. analyses earlier, we expand the investigation of lunar cycle effects to return volatility. We do not present tests of volume of trading effects because Datastream data on volume are often missing, incomplete, available only for later years, or only available for stock indexes different from those we use to calculate returns.<sup>8</sup>

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<sup>8</sup> In addition, we find several cases where Datastream volume data are apparently rounded to the point of uninformativeness, particularly for smaller exchanges and early years. For example, volume of shares

Recall that new moon returns are less than double the full moon returns in the U.S., while this differential is generally larger for other countries. The preceding tables and figures also reveal that other countries, and especially non G-7 countries, also tend to have higher volatility of returns. In addition, in working closely with the international data, we observe that at the country level the new moon/full moon return differential tends to be positively related to volatility of returns. To investigate this observation more explicitly, in Figure 5 we present a scatter plot of country-specific new moon/full moon return differential as a function of country-specific standard deviation of returns. For each country, the new moon/full moon return differential is defined as the mean of daily new moon returns minus the mean of daily full moon returns in a 15-day window specification (same as in Tables 5 and 6). Standard deviation is calculated over all daily observations.

The scatter plot in Figure 5 reveals a clear positive relation between return differential and return volatility. This impression is confirmed by calculating simple correlations between the two variables. The Pearson correlation between cross-country return differences and return volatility is 0.51 with a p-value of 0.009, and the Spearman correlation is 0.48 with a p-value of 0.015. Thus, we find a strong positive relation between lunar cycle return differentials and volatility of returns across countries. This cross-country result suggests that it might be interesting to investigate whether the cross-sectional relation between return differential and return volatility holds within countries as well. Evidence along these lines could help in understanding the causes of the lunar cycle effect in returns. For example, it is possible that the new moon/full moon return

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traded is expressed in millions of shares, and the recorded data series shows only 2's and 3's. Essentially, rounding like this introduces a large amount of noise in recorded volumes of trading.

differential is caused by systematic fluctuations in investors' relative optimism, which are amplified in environments of high uncertainty. This conjecture seems plausible because existing research suggests that behavioral biases are often exacerbated in the presence of high uncertainty (e.g., see review in Hirshleifer 2001). However, an investigation along these lines is beyond the scope of this study, and we leave this topic for future research.

Table 7 presents the results for new moon/full moon differences in the standard deviation of international daily returns. An examination of the results for individual countries reveals no consistent pattern of differences. The difference between new moon and full moon volatility is significantly positive for 8 countries (at the 5 percent level), significantly negative for 2 countries, and insignificant for 15 countries. In addition, all differences are economically small, on the magnitude of a few percent of the combined new moon/full moon standard deviation. The impression from individual countries is confirmed in the combined data tests in Panel B. The first specification, which simply pools all available country-day observations together, yields essentially equal standard deviations. The equally weighted portfolio specification yields a very small positive difference, which is insignificant. Thus, we find no reliable evidence of new moon/full moon differences in return volatility in international data.

## **6. Conclusion and suggestions for future research**

This paper documents a lunar cycle effect in stock returns around the world. Returns around new moon dates are about double the returns around full moon dates. This pattern of returns is pervasive. We find it for all major U.S. stock indexes over the last 100 years and for nearly all of 24 other countries analyzed over the last 30 years.

The economic magnitude of the new moon/full moon difference is large, with annualized differences on the magnitude of 5 to 10 percent, rivaling and probably exceeding the market risk premium. However, we find no reliable evidence of lunar cycle effects in return volatility or volume of trading.

Similar to the Monday effect, the nature of the lunar cycle effect in returns makes it unlikely that it will translate into exploitable trading strategies. However, the lunar cycle effect is intriguing because it provides strong new evidence about a link between stock prices and human behavior that is difficult to fully explain in terms of traditional economic thought. Some of our preliminary findings also suggest possible future areas for exploration. For example, we find some evidence of lunar cycle effects in bond prices and interest rate changes. However, this evidence is mixed and rather limited, suggesting that it might be useful to expand the investigation to larger samples and a wider array of asset prices (e.g., commodities, futures, and options). Since realized stock returns reflect unexpected changes in expectations, another possibility is to investigate whether changes in analysts' forecasts are more optimistic during new moon than in full moon periods. Such additional evidence would sharpen our understanding of the magnitude and the causes of the lunar cycle effect and offer links and implications to the wider world of finance and economics.

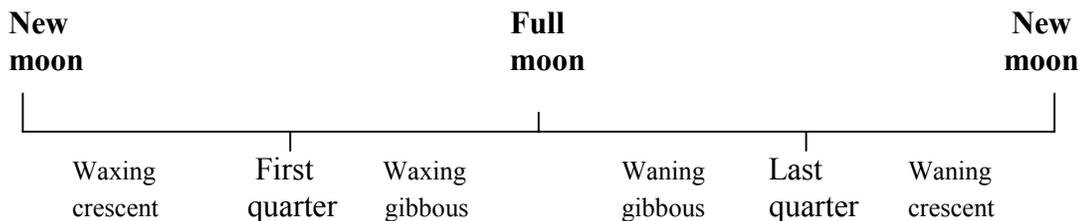
Finally, the evidence from stock returns differs from the conclusions of the lunar cycle literature in psychology and medicine. The consensus in this literature is that there is no reliable relation between lunar cycles and human behavior. However, most of these studies investigate deviant and fairly extreme behavior and rely on limited samples, often on the magnitude of a few dozen to a few hundred observations. This approach

potentially results in low statistical power, especially if lunar cycle effects on human behavior exist but are fairly mild. In contrast, the evidence in this study relies on stock price indexes, which aggregate routine investment decisions of hundreds of millions of people over periods ranging from dozens of years to over one hundred years. The difference in findings suggests that it might be fruitful to explore new approaches to identifying a link between lunar cycles and human behavior. For example, the evidence in this study suggests that people are more optimistic during new moon periods than in full moon periods. This evidence could be used to design controlled experiments that investigate for predictable changes in relative optimism as a function of the lunar cycle.

## Appendix 1

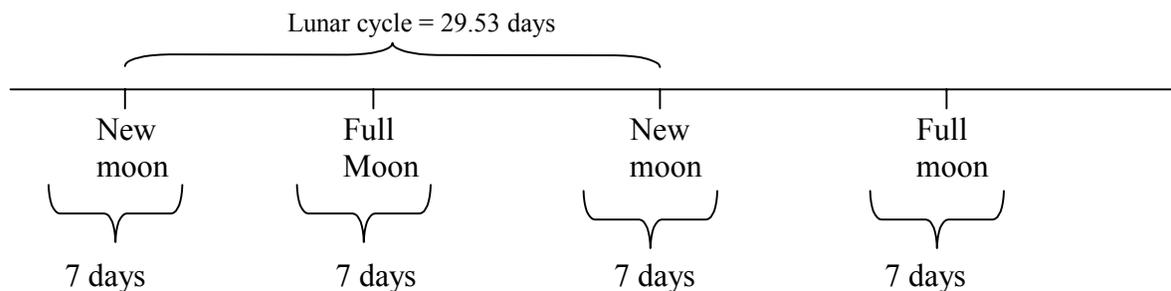
### Panel A: Brief Review of the Terminology and the Mechanics of the Lunar Cycle

The lunar cycle is determined by the relative positions of the earth, the moon, and the sun. *New moon* signifies the situation when the moon is directly between the earth and the sun. Since one only sees the part of the moon which reflects light from the sun, one sees very little or nothing of the moon around *new moon*. As the relative positions of the sun, the moon, and the earth, change, one begins to see more and more of the moon. The moon starts growing from right to left until it reaches *full moon*. During *full moon*, the moon is on the opposite side of the earth with respect to the sun, and one sees a full round side of the moon. The growing of the moon from *new moon* to *full moon* is called *waxing*, where the mid point when the moon is half full is called *first quarter*. During the days after the new moon but before the first quarter, the moon is called *waxing crescent*, and between first quarter and full moon, it is called *waxing gibbous*. After the full moon, the moon starts to decrease, again from right to left. During the contraction, the moon goes through *waning gibbous*, *last quarter*, and *waning crescent*, until it reaches new moon, and the cycle starts again. The lunar cycle has a periodicity of 29.53 days, with the full moon date halfway in between two successive new moons.



### Panel B: Illustration of the 7-day return window

Return window is defined as new moon or full moon date +/- 3 calendar days



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**Table 1**  
**Mean Daily Stock Returns around New and Full Moon Dates for Four Major U.S. Stock Indexes**

**Panel A: Dow Jones Industrial Average (1896-1999)**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>7-Day Window</b>						
Mean Daily Return	0.035%	0.017%	0.018	0.96	56.3%	0.100
Standard Deviation	1.099%	1.028%		(0.338)		
Number of Obs.	6,725	6,634				
<b>15-Day Window</b>						
Mean Daily Return	0.032%	0.017%	0.015	1.16	56.3%	0.100
Standard Deviation	1.102%	1.045%		(0.247)		
Number of Obs.	14,422	14,283				

**Panel B: Standard & Poor's 500 (1928-2000)**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>7-Day Window</b>						
Mean Daily Return	0.046%	0.024%	0.022	0.96	61.6%	0.023
Standard Deviation	1.155%	1.091%		(0.337)		
Number of Obs.	4,627	4,556				
<b>15-Day Window</b>						
Mean Daily Return	0.036%	0.019%	0.017	1.07	60.3%	0.040
Standard Deviation	1.148%	1.108%		(0.286)		
Number of Obs.	9,909	9,812				

**Table 1 (Continued)**

**Panel C: NYSE/AMEX Composite Index (1962-2000)**

	<i>Difference results</i>				<i>Persistence results</i>	
	New Moon Period	Full Moon Period	Difference	t-statistic (p-value)	Years Difference > 0	Binomial p-value
<b>7-Day Window</b>						
Mean Daily Return	0.066%	0.045%	0.021	0.84	63.2%	0.052
Standard Deviation	0.889%	0.812%		(0.402)		
Number of Obs.	2,307	2,282				
<b>15-Day Window</b>						
Mean Daily Return	0.060%	0.036%	0.024	1.44	63.2%	0.052
Standard Deviation	0.854%	0.822%		(0.150)		
Number of Obs.	4,943	4,898				

**Panel D: NASDAQ Composite Index (1973-2000)**

	<i>Difference results</i>				<i>Persistence results</i>	
	New Moon Period	Full Moon Period	Difference	t-statistic (p-value)	Years Difference > 0	Binomial p-value
<b>7-Day Window</b>						
Mean Daily Return	0.081%	0.055%	0.026	0.69	60.7%	0.128
Standard Deviation	1.131%	1.050%		(0.488)		
Number of Obs.	1,686	1,670				
<b>15-Day Window</b>						
Mean Daily Return	0.065%	0.043%	0.022	0.83	64.3%	0.065
Standard Deviation	1.094%	1.094%		(0.405)		
Number of Obs.	3,606	3,582				

The 7-Day Window represents all trading days within +/- three calendar days of the new (full) moon date. The 15-Day Window represents all trading days within +/- seven calendar days of the new (full) moon date. Years Difference > 0 is the percentage of years in the sample when the mean daily return during new moon periods exceeds mean daily return during full moon periods. The Binomial p-value is the p-value from a binomial test of the null hypothesis that (Years Difference > 0) = 50%. Partial years of data are excluded from the binomial test. Return data are from Dow Jones and Company, Global Financial Data, and CRSP. Lunar cycle dates are from [www.lunaroutreach.org](http://www.lunaroutreach.org).

**Table 2**  
**Standard Deviations of Stock Returns around New Moon and Full Moon**  
**Dates for Four Major U.S. Stock Indexes**

**Panel A: Standard deviations of returns for the 7-day return window specification**

	<b>New Moon</b>	<b>Full Moon</b>		
	<b>Period</b>	<b>Period</b>	<b>Difference</b>	<b>p-value</b>
Dow Jones Industrial Average (1896-1999)	1.10%	1.03%	0.07	<0.001
Standard & Poor's 500 (1928-2000)	1.16%	1.09%	0.07	<0.001
NYSE/AMEX Composite Index (1962-2000)	0.89%	0.81%	0.08	<0.001
NASDAQ Composite Index (1973-2000)	1.13%	1.05%	0.08	0.002

**Panel B: Standard deviation of returns for the 15-day return window specification**

	<b>New Moon</b>	<b>Full Moon</b>		
	<b>Period</b>	<b>Period</b>	<b>Difference</b>	<b>p-value</b>
Dow Jones Industrial Average (1896-1999)	1.10%	1.05%	0.06	<0.001
Standard & Poor's 500 (1928-2000)	1.15%	1.11%	0.04	<0.001
NYSE/AMEX Composite Index (1962-2000)	0.85%	0.82%	0.03	0.009
NASDAQ Composite Index (1973-2000)	1.09%	1.09%	0.00	0.994

The 7-Day Window represents all trading days within +/- three calendar days of the new (full) moon date. The 15-Day Window represents all trading days within +/- seven calendar days of the new (full) moon date. The p-values are from folded F-value tests of difference in standard deviation (see the SAS manuals for more details). The number of observations for each index is the same as those in Table 1. Return data are from the Dow Jones and Company, Global Financial Data, and CRSP. Lunar cycle dates are from [www.lunargoutreach.org](http://www.lunargoutreach.org).

**Table 3**  
**Means of Standardized Differences in Trading Volume between New and Full Moon Trading Windows**

**Panel A: 7-day trading window specification**

	Number of Lunar Months	Mean of Standardized Differences	t- statistic	p-value
New York Stock Exchange (1888-2000)	1,392	-0.0007	-0.095	0.924
Standard & Poor's 500 (1942-2000)	729	0.0047	0.684	0.494
NASDAQ (1978-2000)	283	0.0055	0.675	0.501

**Panel B: 15-day trading window specification**

	Number of Lunar Months	Mean of Standardized Differences	t- statistic	p-value
New York Stock Exchange (1888-2000)	1,392	-0.0087	-1.67	0.096
Standard & Poor's 500 (1942-2000)	729	0.0036	0.78	0.437
NASDAQ (1978-2000)	283	0.0018	0.36	0.719

Standardized Difference in Trading Volume is defined as the following statistic computed for each lunar month in the sample:  $(\text{Mean New Moon Volume} - \text{Mean Full Moon Volume}) / (\text{Mean New Moon Volume} + \text{Mean Full Moon Volume}) / 2$ . Here Mean New Moon Volume represents the mean volume of trading over all trading days within a 7-calendar day window (or a 15-calendar day window) around a new moon date during a particular lunar month. Mean Full Moon Volume is defined analogously. NYSE volume data is from [www.nyse.com](http://www.nyse.com), S&P 500 volume data is from Global Financial Data, and NASDAQ volume data is from [www.nasdaq.com](http://www.nasdaq.com). Lunar cycle dates are from [www.lunaroutreach.org](http://www.lunaroutreach.org).

**Table 4**  
**Comparison of Lunar Cycle Effects in Stock Returns, Bond Returns, and**  
**Changes in Interest Rates in the U.S.**

**Panel A: Includes only observations from calendar weeks falling entirely within a 15-day new moon or full moon window (1915-1970)**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>Dow Jones Industrial Average</b>						
Mean Daily Return	0.029%	0.008%	0.021	0.88	60.0%	0.069
Standard Deviation	1.179%	1.100%		(0.377)		
Number of Obs.	4,808	4,758				
<b>Dow Jones Bond Average</b>						
Mean Daily Return	-0.001%	-0.001%	0.000	-0.13	60.0%	0.069
Standard Deviation	0.195%	0.176%		(0.897)		
Number of Obs.	4,807	4,758				
<b>Interest rate on U.S. 3-Month Commercial Paper</b>						
Mean Weekly Change (basis points)	0.293	0.224	0.069	0.13	54.6%	0.250
Standard Deviation	9.42	12.22		(0.895)		
Number of Obs.	888	892				

**Table 4 (continued)**

**Panel B: Includes all observations from daily data (1971-1999)**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>Dow Jones Industrial Average</b>						
Mean Daily Return	0.050%	0.023%	0.027	1.18	66.7%	0.042
Standard Deviation	1.021%	0.954%		(0.237)		
Number of Obs.	3,662	3,632				
<b>Dow Jones Bond Average</b>						
Mean Daily Return	0.0055%	-0.0004%	0.006	0.98	51.9%	0.424
Standard Deviation	0.256%	0.260%		(0.327)		
Number of Obs.	3,662	3,631				
<b>Interest rate on U.S. 3-Month Commercial Paper</b>						
Mean Daily Change (basis points)	-0.123	0.141	-0.264	-1.02	37.9%	0.097
Standard Deviation	11.15	10.87		(0.308)		
Number of Obs.	3,620	3,601				

New and full moon periods represent all trading observations falling within +/- seven calendar days of the new (full) moon date. For Panel A, we exclude all observations that do not fall in a calendar week that falls entirely within the pre-specified 15-day new moon and full moon windows (because we only have weekly observations for interest rates until 1970). Panel B includes all available observations. Years Difference > 0 is the percentage of years in the sample when the mean daily return (change) during the new moon period exceeds the mean daily return (change) during the full moon period. The Binomial Null p-value is the p-value from a binomial test of the null hypothesis that (Years Difference > 0) = 50%. Partial years of data are excluded from the binomial test. Stock and bond returns do not include dividends or interest payments. Data are from Global Financial Data. Lunar cycle dates are from [www.lunargoutreach.org](http://www.lunargoutreach.org).

**Table 5**  
**Mean Daily Stock Returns around New Moon and Full Moon Dates – Major Global Economies**

**Panel A: Individual countries**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>U.S. - New York, S&amp;P 500 (1973-2000)</b>						
Mean Daily Return	0.053%	0.021%	0.032	1.35	71.4%	0.012
Standard Deviation	1.011%	0.966%		(0.177)		
Number of Obs.	3,605	3,582				
<b>Japan – Tokyo, Nikkei Index (1962-2000)</b>						
Mean Daily Return	0.039%	0.011%	0.028	1.31	61.5%	0.075
Standard Deviation	1.092%	1.085%		(0.189)		
Number of Obs.	5,083	5,094				
<b>United Kingdom – London, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.055%	0.030%	0.025	1.05	53.6%	0.353
Standard Deviation	1.049%	0.989%		(0.294)		
Number of Obs.	3,707	3,707				
<b>Germany – Frankfurt, DAX Index (1965-2000)</b>						
Mean Daily Return	0.051%	0.013%	0.038	1.75	50.0%	0.500
Standard Deviation	1.048%	1.065%		(0.079)		
Number of Obs.	4,765	4,766				
<b>France - Paris, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.066%	0.035%	0.031	1.22	53.6%	0.353
Standard Deviation	1.091%	1.096%		(0.222)		
Number of Obs.	3,707	3,707				
<b>Italy – Milan, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.061%	0.046%	0.015	0.48	57.1%	0.225
Standard Deviation	1.315%	1.383%		(0.628)		
Number of Obs.	3,707	3,707				
<b>Canada – Toronto, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.051%	0.015%	0.036	1.88	64.3%	0.065
Standard Deviation	0.832%	0.799%		(0.060)		
Number of Obs.	3,706	3,707				

**Table 5 (Continued)**

**Panel B: Combined data**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>Pooled Data (1973-2000)</b>						
Mean Daily Return	0.055%	0.023%	0.032	3.43	57.1%	0.225
Standard Deviation	1.082%	1.083%		(0.001)		
Number of Obs.	25,835	25,864				
<b>Equally-Weighted Portfolio (1973-2000)</b>						
Mean Daily Return	0.056%	0.023%	0.033	2.18	57.1%	0.225
Standard Deviation	0.656%	0.641%		(0.029)		
Number of Obs.	3,710	3,716				

Countries included in this table are members of the G-7 Group of Nations. New and full moon periods represent all trading days within +/- seven calendar days of the new (full) moon date. Years Difference > 0 is the percentage of years in the sample when the mean daily return during the new moon period exceeds the mean daily return during the full moon period. The Binomial Null p-value is the p-value from a binomial test of the null hypothesis that (Years Difference > 0) = 50%. Partial years of data are excluded from the binomial test. Pooled Data includes all observations from all exchanges included in Panel A. The Equally-Weighted Portfolio includes all exchanges included in Panel A.

**Table 6**  
**Mean Daily Stock Returns around Full and**  
**New Moon Dates – Rest of the World**

**Panel A: Individual countries**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Differ ence</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt; 0</b>	<b>Binomial p-value</b>
<b>Netherlands - Amsterdam, CBS All Share General Index (1973-2000)</b>						
Mean Daily Return	0.062%	0.019%	0.043	1.99	60.7%	0.128
Standard Deviation	0.960%	0.914%		(0.047)		
Number of Obs.	3,707	3,707				
<b>Thailand – Bangkok, S.E.T. Index (1975-2000)</b>						
Mean Daily Return	0.027%	0.027%	0.001	0.02	52.0%	0.421
Standard Deviation	1.497%	1.476%		(0.986)		
Number of Obs.	3,309	3,310				
<b>Belgium – Brussels, BBL 30 Index (1971-2000)</b>						
Mean Daily Return	0.034%	0.022%	0.011	0.62	53.3%	0.358
Standard Deviation	0.823%	0.830%		(0.535)		
Number of Obs.	3,969	3,976				
<b>Denmark – Copenhagen, SE General Index (1973-2000)</b>						
Mean Daily Return	0.039%	0.037%	0.002	0.10	59.3%	0.168
Standard Deviation	0.783%	0.738%		(0.920)		
Number of Obs.	3,572	3,580				
<b>Ireland – Dublin, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.070%	0.027%	0.043	1.75	60.7%	0.128
Standard Deviation	1.052%	1.060%		(0.080)		
Number of Obs.	3,707	3,707				
<b>Hong Kong - Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.082%	0.037%	0.044	0.96	55.6%	0.282
Standard Deviation	1.991%	1.929%		(0.339)		
Number of Obs.	3,582	3,588				
<b>Indonesia – Jakarta, Composite Index (1973-2000)</b>						
Mean Daily Return	0.103%	0.005%	0.098	1.86	66.7%	0.079
Standard Deviation	1.816%	1.807%		(0.063)		
Number of Obs.	2,353	2,346				

**Table 6, Panel A (Continued)**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt;0</b>	<b>Binomial p-value</b>
<b>South Africa – Johannesburg, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.071%	0.057%	0.014	0.44	50.0%	0.500
Standard Deviation	1.318%	1.352%		(0.660)		
Number of Obs.	3,707	3,707				
<b>Malaysia - Kuala Lumpur, Composite Index (1980-2000)</b>						
Mean Daily Return	0.054%	0.007%	0.048	1.10	57.1%	0.256
Standard Deviation	1.600%	1.639%		(0.272)		
Number of Obs.	2,779	2,779				
<b>Spain - Madrid, SE General Index (1974-2000)</b>						
Mean Daily Return	0.050%	0.010%	0.040	1.61	66.7%	0.042
Standard Deviation	1.070%	1.008%		(0.108)		
Number of Obs.	3,572	3,578				
<b>Australia – Melbourne, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.043%	0.033%	0.010	0.40	67.9%	0.029
Standard Deviation	1.107%	1.079%		(0.687)		
Number of Obs.	3,707	3,707				
<b>Norway – Oslo, Datastream Market Index (1980-2000)</b>						
Mean Daily Return	0.053%	0.053%	0.000	<0.001	42.9%	0.256
Standard Deviation	1.435%	1.364%		(0.997)		
Number of Obs.	2,779	2,779				
<b>South Korea – Seoul, KOSPI Index (1975-2000)</b>						
Mean Daily Return	0.062%	0.026%	0.036	0.97	61.5%	0.120
Standard Deviation	1.551%	1.532%		(0.332)		
Number of Obs.	3,442	3,440				
<b>Singapore - Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.059%	-0.012%	0.071	2.18	75.0%	0.004
Standard Deviation	1.464%	1.357%		(0.029)		
Number of Obs.	3,707	3,707				

**Table 6, Panel A (Continued)**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Differ ence</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt;0</b>	<b>Binomial p-value</b>
<b>Sweden – Stockholm, Datastream Market Index (1982-2000)</b>						
Mean Daily Return	0.084%	0.049%	0.035	0.97	63.2%	0.126
Standard Deviation	1.286%	1.288%		(0.334)		
Number of Obs.	2,514	2,517				
<b>Taiwan - Taipei, SE Weighted Index (1971-2000)</b>						
Mean Daily Return	0.093%	0.031%	0.062	1.50	63.3%	0.072
Standard Deviation	1.766%	1.929%		(0.134)		
Number of Obs.	3,968	3,974				
<b>Austria – Vienna, ATX 50 (1973-2000)</b>						
Mean Daily Return	0.035%	0.023%	0.012	0.64	53.6%	0.353
Standard Deviation	0.834%	0.815%		(0.520)		
Number of Obs.	3,707	3,707				
<b>Switzerland – Zurich, Datastream Market Index (1973-2000)</b>						
Mean Daily Return	0.048%	0.021%	0.027	1.39	71.4%	0.012
Standard Deviation	0.818%	0.832%		(0.164)		
Number of Obs.	3,706	3,707				

**Table 6 (Continued)**

**Panel B: Combined Data - All available exchanges**

	<i>Difference results</i>				<i>Persistence results</i>	
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Differ ence</b>	<b>t-statistic (p-value)</b>	<b>Years Difference &gt;0</b>	<b>Binomial p-value</b>
<b>Pooled Data (1973-2000)</b>						
Mean Daily Return	0.059%	0.025%	0.034	5.35	67.9%	0.029
Standard Deviation	1.258%	1.255%		(<0.001)		
Number of Obs.	80,132	80,235				
<b>Equally-Weighted Portfolio (1973-2000)</b>						
Mean Daily Return	0.057%	0.023%	0.034	2.60	67.9%	0.029
Standard Deviation	0.573%	0.559%		(0.009)		
Number of Obs.	3,707	3,714				

New and full moon periods represent all trading days within +/- seven calendar days of the new (full) moon date. Years Difference > 0 is the percentage of years in the sample when the mean daily return during the new moon period exceeds the mean daily return during the full moon period. The Binomial Null p-value is the p-value from a binomial test of the null hypothesis that (Years Difference > 0) = 50%. Partial years of data are excluded from the binomial test. Pooled Data includes all observations from all exchanges included in Panel A of Tables 5 and 6. The Equally-Weighted Portfolio includes all exchanges included in Panel A of Tables 5 and 6. Except for the S&P 500 returns, which are from Global Financial Data, returns are calculated from Datastream price data. Lunar cycle dates are from [www.lunaroutreach.org](http://www.lunaroutreach.org).

**Table 7**  
**Standard Deviation of Returns around Full Moon and New Moon Dates**  
**Around the World**

**Panel A: Individual countries**

	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>p-value</b>
U.S. - S&P 500 (1928-2000)	1.01%	0.97%	0.045	0.007
Japan - Nikkei Index (1962-2000)	1.09%	1.09%	0.007	0.649
U.K. - Datastream Mkt. Index (1973-2000)	1.05%	0.99%	0.060	<0.001
Germany - DAX Index (1965-2000)	1.05%	1.07%	-0.017	0.267
France - Datastream Mkt. Index (1973-2000)	1.09%	1.10%	-0.005	0.785
Italy - Datastream Mkt. Index (1973-2000)	1.32%	1.38%	-0.068	0.002
Canada - Datastream Mkt. Index (1973-2000)	0.83%	0.80%	0.033	0.012
Netherlands - CBS All Share Index (1973-2000)	0.96%	0.91%	0.046	0.003
Thailand - S.E.T. Index (1975-2000)	1.50%	1.48%	0.021	0.426
Belgium - BBL 30 Index (1971-2000)	0.82%	0.83%	-0.007	0.556
Denmark - SE General Index (1973-2000)	0.78%	0.74%	0.045	<0.001
Ireland - Datastream Market Index (1973-2000)	1.05%	1.06%	-0.008	0.658
Hong Kong - Datastream Market Index (1973-2000)	1.99%	1.93%	0.062	0.059
Indonesia - Composite Index (1973-2000)	1.82%	1.81%	0.009	0.812
South Africa - Datastream Market Index (1973-2000)	1.32%	1.35%	-0.034	0.119
Malaysia - Composite Index (1980-2000)	1.60%	1.64%	-0.039	0.204
Spain - SE General Index (1972-2000)	1.07%	1.01%	0.062	<0.001
Australia - Datastream Market Index (1973-2000)	1.11%	1.08%	0.028	0.115
Norway - Datastream Market Index (1973-2000)	1.44%	1.36%	0.071	0.008

**Table 7 (continued)**

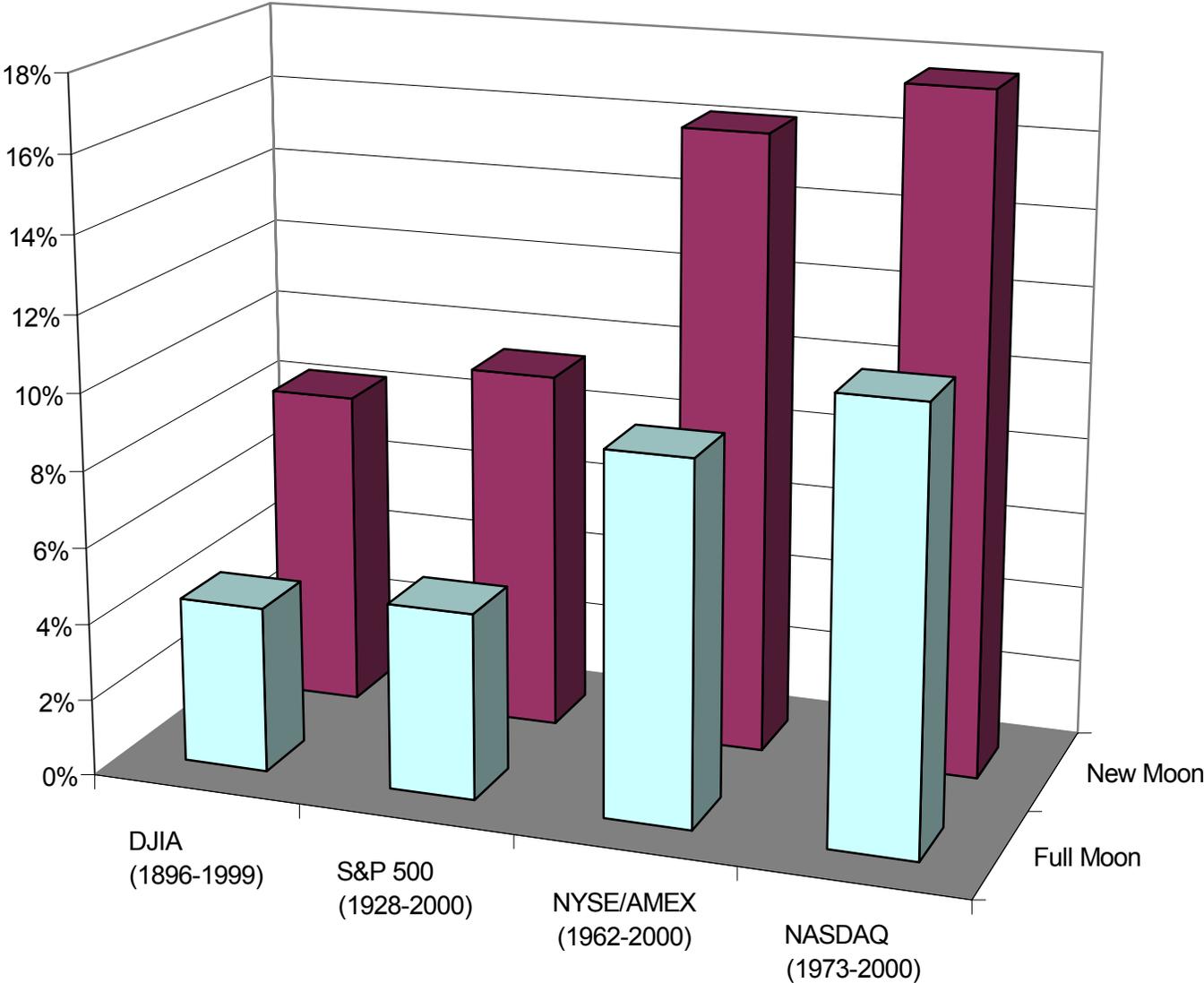
	<b>New Moon Period</b>	<b>Full Moon Period</b>	<b>Difference</b>	<b>p-value</b>
South Korea - KOSPI Index (1975-2000)	1.55%	1.53%	0.019	0.466
Singapore - Datastream Market Index (1973-2000)	1.46%	1.36%	0.107	<0.001
Sweden - Datastream Market Index (1973-2000)	1.29%	1.29%	-0.002	0.942
Taiwan - SE Weighted Index (1971-2000)	1.77%	1.93%	-0.163	<0.001
Austria - ATX 50 (1973-2000)	0.83%	0.82%	0.019	0.168
Switzerland - Datastream Market Index (1973-2000)	0.82%	0.83%	-0.014	0.314

**Panel B: Combined data**

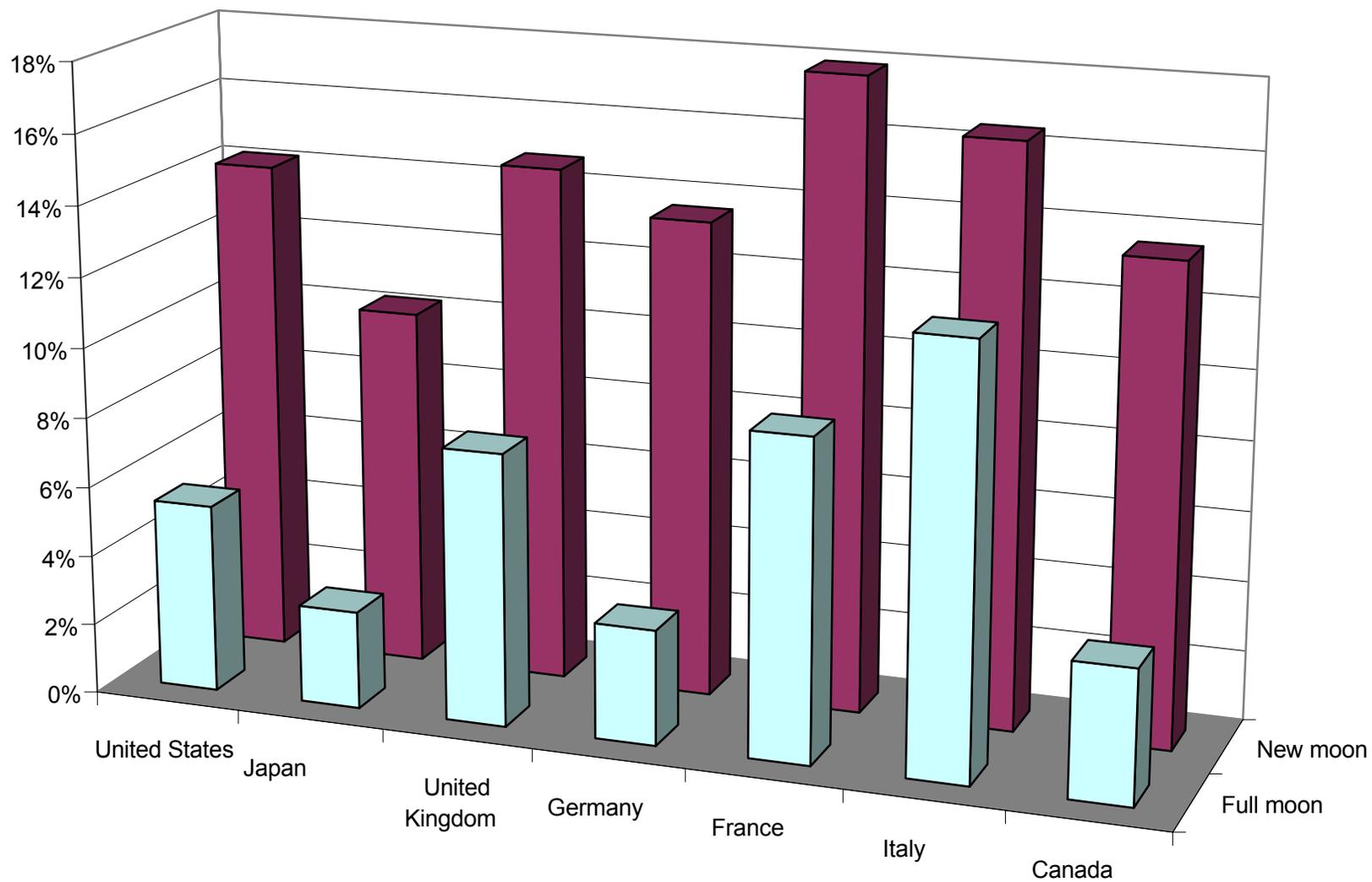
Pooled data	1.258%	1.255%	0.003	0.447
Equally-weighted portfolio	0.573%	0.559%	0.014	0.128

Results are from a 15-day trading window specification. The 15-Day window represents all trading days within +/- seven calendar days of the new (full) moon date. The p-values are from folded F-value tests of difference in standard deviation (see the SAS manuals for more details). The number of observations for each index is the same as those in Tables 5 and 6. The pooled data specification pools all available country-day return observations together, splits them into new moon and full moon groups, and tests for difference in standard deviations. The equally weighted portfolio specification computes a cross-country, equally weighted return for each day in the sample, and then proceeds as for any individual country. The S&P 500 data are from Global Financial Data and international return data are from Datastream. Lunar cycle dates are from [www.lunargoutreach.org](http://www.lunargoutreach.org).

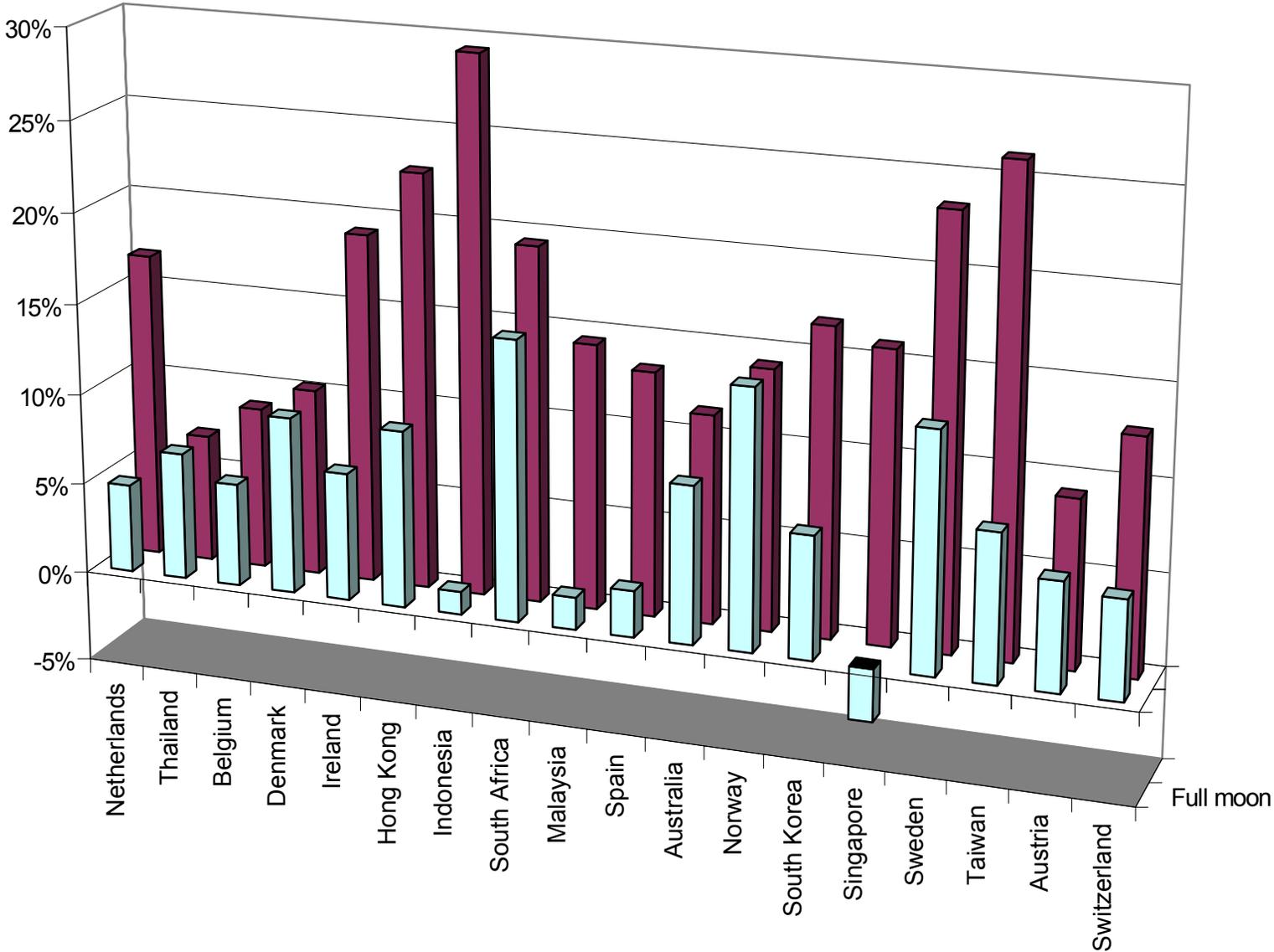
**Figure 1**  
**New moon vs. full moon annualized returns for four major U.S. stock indexes**



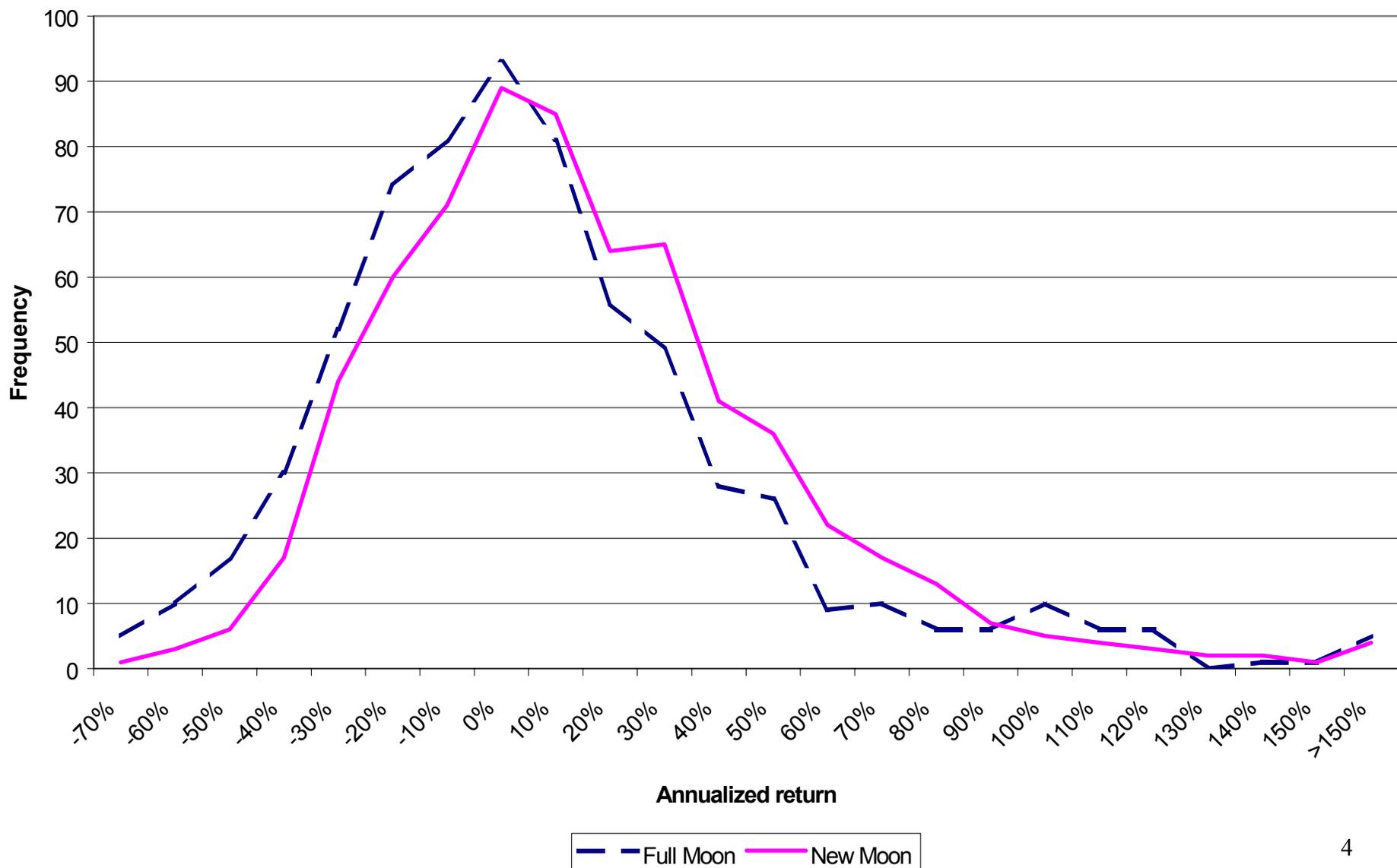
**Figure 2**  
**New moon vs. full moon annualized returns for major stock indexes of the G-7 countries**



**Figure 3**  
**New moon vs. full moon annualized returns for smaller stock exchanges around the world**



**Figure 4**  
**Distribution of annualized new and full moon returns**  
**for pooled sample of all exchanges and years**



**Figure 5**  
**Scatter plot of return differences vs. standard deviation of daily returns across countries**  
**(Return difference is country-specific mean of new moon daily returns minus country-specific mean of full moon daily returns)**

