Four centuries of return predictability

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Abstract

We combine annual stock market data for the most important equity markets of the last four centuries: the Netherlands/U.K. (1629-1812), U.K. (1813-1870) and U.S. (1871-2015). We show that dividend yields are stationary and consistently forecast returns. The documented predictability holds for annual and multi-annual horizons and works both in and out-of-sample, providing strong evidence that expected returns in stock markets are time-varying. Much of this variation is related to the business cycle, with expected returns increasing in recessions. We also find that, except for the period after 1945, dividend yields predict dividend growth rates.

Key words: Dividend-to-price ratio, return predictability, dividend growth predictability
JEL classification: G12, G17, N2

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1 Introduction

There is a large body of work suggesting that price multiples, such as the dividend-to-price ratio, predict stock returns.[1] As a result, modern asset pricing theory increasingly incorporates time-varying expected returns (Campbell and Cochrane, 1999; Bansal and Yaron, 2004; Albuquerque, Eichenbaum, Luo and Rebelo, 2016, among others). The majority of the empirical work underpinning these findings uses U.S. stock market data going back to 1926 or 1945.

In this paper, we examine whether dividend yields predict returns in a long sample that covers four centuries of data, going back to the stock market's earliest years in the 17th century. In doing so, we provide an out-of-sample test, asking whether results that hold in the recent U.S. period are generalizable to other times and places (Schwert 1990). Through the extended time-series, we also obtain more statistical power to reject the null of no return predictability (Stambaugh, 1999; Boudoukh, Richardson and Whitelaw, 2008).

In particular, we assemble annual stock market data for the most important equity markets of the last four centuries: the Netherlands/U.K. (1629-1812), U.K. (1813-1870) and U.S. (1871-2015). We analyze the data for each sub-period individually and for the sample as a whole. We consider the most basic form of predictability analyzed by Campbell and Shiller (1988a), Fama and French (1988) and Cochrane (1992; 2008) and ask whether the dividend-to-price ratio forecasts returns. There may be many other variables that predict returns. The purpose of this paper is not to come up with the best possible forecasting model. Instead, we take the most common predictive variable in the literature and evaluate its forecasting power in an extended sample. Additional variables would only strengthen the evidence for return predictability.

[1] Amongst other work, this includes Shiller (1981), LeRoy and Porter (1981), Campbell and Shiller (1988a), Fama and French (1988), Cochrane (2008), Binsbergen and Koijen (2010).

Our results confirm that dividend yields predict returns. With 384 annual observations, we have sufficient statistical power to reject the null hypothesis of no return predictability, both over short and long horizons. Our estimates are stable across the different markets and periods we consider. Moreover, returns are forecastable in real time, and in- and out-of-sample estimates have a similar fit (Goyal and Welch, 2008). This confirms that expected returns are time-varying. In line with earlier literature (Fama and French, 1989), we find that the documented predictability is related to the business cycle with expected returns increasing in recessions. Our results also indicate that the dividend-to-price ratio predicts dividend growth rates, but only for the period before 1945. In the final section of the paper, we conjecture what could explain the reduced ability of the dividend yield to forecast dividend growth rates in the recent period.

An alternative to using a longer sample is to look at a cross-section of countries.[2] Data for most countries typically span relatively short time periods, and markets exhibit a high degree of co-movement, especially in recent decades. This reduces the statistical power to reject the null of no return predictability. In contrast, extending the data backwards adds independent variation to the data. At the same time, many key characteristics of modern financial markets, such as separation of ownership and control and the ability to freely trade shares, were already present in the 17th century.

Apart from a large body of literature on return predictability, our paper is related to other studies analyzing stock markets in earlier periods. Schwert (1990) combines secondary sources to reconstruct a U.S. stock index for the 19th century and finds that both the volatility and seasonal patterns of stock returns are similar in the 19th and 20th centuries. Relying on primary sources,

[2] Campbell and Shiller (2005) and Rangvid, Schmeling and Schrimpf (2014). Santa-Clara and Maio (2015) perform a similar analysis on a cross-section of portfolios.

Goetzmann, Ibbotson and Peng (2001) estimate a new index for the New York stock market between 1815 and 1925. They find little evidence for return predictability, but data limitations force them to approximate dividends for the period before 1870. Chen (2009) analyzes the predictability of returns and dividend growth for the U.S. between 1872 and 2005 and documents that returns are largely unpredictable before 1926 or 1945. At the same time, dividend growth rates are strongly forecastable.[3] In comparison to these studies, we use a much longer sample period with complete data for dividend payments. Le Bris, Goetzmann and Pouget (2014) analyze six hundred years of dividend and price data for the Bazacle Company in France. They find evidence that both time-varying risk premia and changes in expected dividends affect share prices. In comparison, we analyze the aggregate market. Both studies find that the dividend-to-price ratio fluctuates around a long-run average of five percent in the early data.

The paper proceeds as follows. Section 2 provides a brief description of the data and discusses a number of summary statistics. Section 3 provides the main results. Sections 3.1 and 3.2 document the predictability of returns and dividends growth rates from dividend yields. Sections 3.3 to 3.5 provide additional statistical tests. Section 4 examines the link between recessions and predictability. Section 5 discusses the results and concludes.

2 Data

We extend the annual time series of stock prices and dividends back in time until 1629 using the most important financial market of a specific period. In particular, for the period 1629 through 1812, we look at the equity markets in the Netherlands and the U.K. Between 1813 and 1870, we focus on Great Britain exclusively. For the period after 1870, we rely on U.S. market

[3] Schwert (2003) and Goyal and Welch (2003) provide similar evidence.

data. The indices we use weigh individual stocks by their market capitalization. End-of-year dividends are obtained by summing dividends within the year.

2.1 Data description

Below, we provide a brief description of the markets we analyze and the main sources of the data. Details are in Appendix A.

2.1.1 Netherlands and U.K.: 1629-1813

Amsterdam was arguably the most important financial center of the 17th and 18th century. It was closely integrated with the market in London and featured trade in the largest English securities (Neal 1990). Although technologically less advanced, the market functioned similarly to today. Harrison (1998) provides evidence that the time series properties of returns in these markets were similar to more recent periods. Koudijs (2016) shows that stock prices responded to the arrival of news in an efficient way. The paper's calculations suggest that trading costs in the 1770s and 1780s were comparable to those on the NYSE between 1993 and 2005. We take the perspective of an Amsterdam investor who held a value-weighted portfolio of Dutch and English securities. We convert prices and dividends of English securities from Pounds Sterling to Dutch Guilders. Since both countries were on metallic standards, exchange rate fluctuations were relatively small with an annual standard deviation of 3%.

There is information available for up to nine securities, representing the near universe of traded equities in Amsterdam and London. All companies had limited liability for their shareholders and were widely traded. We collect all information available in the secondary literature, and supplement it with original archival material whenever possible. There are years where the information for a particular stock is missing, but data coverage is relatively comprehensive for the five largest securities (Appendix A.1 has details). These include the Dutch

East India Company (VOC, 1629-1794), the Dutch West Indies Company (WIC, 1719-1791), the (United) British East India Company (EIC, 1692-1813), the Bank of England (BoE, 1696-1813; at the time a private bank with strong ties to the government), and the South Sea Company (SSC, 1711-1813). Before 1692, our dataset consists of the VOC alone, which was by far the largest company in the Netherlands and the U.K. at that time. For example, in 1696, after both the EIC and BoE are added to the index, the VOC still accounts for 63% of total market capitalization. At the beginning of the 18th century, there is additional information for four smaller British companies.

Initially, dividend payments were highly irregular. Companies only started making annual dividend payments at the end of the 17th century. For the VOC, this seems to have been related to shareholders having different preferences for dividends. Depending on which shareholder group dominated in a particular year, dividends were either very high or foregone altogether (Van Lent and Sgourev, 2013). Following the literature on cyclically adjusted price-earnings ratios (Campbell and Shiller, 1988b; 2005), we use a ten-year trailing average to smooth out dividend payments before 1700. Returns are calculated using actual payout. To ensure that the adjustment of dividends does not drive our findings, we also report results using post-1700 data only.

To gauge the size of the market, we compare the aggregate value of the securities in our data with the GDP of the province of Holland, the richest and most populous region of the Netherlands (including cities like Amsterdam and Rotterdam), for which comprehensive GDP estimates are available (Van Zanden and Van Leeuwen, 2012). Using information from Bowen (1989) and Wright (1997), we estimate the fraction of English securities held by Dutch investors. Market capitalization to GDP ranged from 15% (during the 1630s and again in the early 1800s) to

64% (during the 1720s). In comparison, U.S. stock market capitalization amounted to 39% of GDP in 1913 and 152% in 1999 (Rajan and Zingales, 2003).

2.1.2 U.K: 1813-1870

For the period between 1813 and 1870, we focus on the U.K. market. After the Napoleonic Wars, London became the financial center of the world, with the United Kingdom its largest economy. Starting in the 1810s many new equities were issued. Initially, these were mainly canals and insurances companies. Later on, banks and railroad companies became the most important issuers of new stocks. The period includes the so-called Railroad Manias of the 1830s and 1840s. In contrast to the earlier period, securities issued between 1810 and 1855 generally had full shareholder liability (Hickson, Turner and Ye, 2011). After 1855, it became possible to issue shares with limited liability, but many banks and insurance companies continued to maintain full liability until the end of the sample period.

Starting in 1825, we use the value-weighted stock market index constructed by Acheson, Hickson, Turner and Ye (2009) that includes all frequently traded domestic equities in London. We extend their series backwards to 1813 using the same source material and methodology (details are in Appendix A.2). The final index covers between 50 (1813) and 250 (1870) different securities. Total market capitalization accounted for between 10 and 30 percent of English GDP.

2.1.3 U.S.: 1871-2015

To facilitate comparison with the existing literature, we rely on the U.S. stock market data starting in 1871 using data from Amit Goyal's website. For the period between 1871 and 1925, these data come from Cowles (1939), covering between 50 (1871) and 258 (1925) securities. From 1926, the data are based on the S&P 500 index provided by CRSP. Before 1957, this was actually the S&P 90.

In alternative estimates, we focus on the London market for the entire 19th century (relying on data from Grossman (2002) for the period after 1870), only switching to the U.S. after 1900 when it became the world's largest economy with New York as an international financial center. This has the additional advantage that London featured many more securities (~750) than New York in this period. In the Online Appendix (Table OA.2), we show that our results are robust to this alternative approach. In the same appendix, we also show that results are similar when using the broad based CRSP index after 1925 that, again, is comprised of a substantially larger number of securities (522 in 1926).

2.1.4 Inflation, business cycles, and the risk-free rate

To account for changes in purchasing power, we obtain data on inflation. For the Netherlands/U.K. period (1629-1809), we rely on information from the International Institute of Social History.[4] Clark (2015) provides price data for the U.K. period (1813-1870/1900). For the U.S. period, we use the inflation index (CPI) from Robert Shiller's webpage.

We also use data on recessions. For the U.S. period, we rely on the standard NBER chronology of expansions and contractions. The data are monthly. We classify a year as a recession if at least six months in that year are characterized as a downturn. For the period 1700-1870, we focus on recessions in the UK. We rely on peak and through dates from Ashton (1959), Gayer, Rostow and Schwartz (1953), and Rostow (1972) (details are in Appendix A.4). The latter data are annual. We let recessions start in the year following a peak and end in the year of a through. There is no business cycle information available for the 17th century.

Finally, we collect information on the risk-free rate. For most of the early periods, there were no liquid short-term government securities. Before 1871, we use returns on Dutch and

[4] http://www.iisg.nl/hpw/data.php#netherlands.

English annuities or consols (details are in Appendix A). Information for the years before 1650 and between 1720 and 1727 is missing due to data limitations. Between 1871 and 1919, we use U.S. interest rates on short-term commercial paper and long-term government bonds to estimate the risk-free rate (details on the estimation procedure are in Appendix A.3). Starting in 1920, we use the rate on U.S. T-bills. In sum, before 1920 we only have an estimate of the risk-free rate; the data are incomplete and the underlying securities were exposed to interest rate and sometimes even default risk. We therefore run all our regressions on raw instead of excess returns.

2.2 Summary statistics

Figure 1 plots annual real returns, dividend growth rates and dividend yields. Table 1 reports summary statistics, in both nominal (Panel A) and real (Panel B) terms. To facilitate comparison with the existing literature, we divide the data into four periods: 1629-1812 (Netherlands/U.K.), 1813-1870 (U.K.), 1871-1945 (U.S. early) and 1945-2015 (U.S. recent).

Annual nominal returns are 8% on average and vary between 6% in the early data and 12% in the recent U.S. period. Inflation, however, is much higher after 1945, and in real terms average returns across periods are more similar, varying between 6% and 8%. In all our main tests we use real data. Returns are more volatile after 1870; the standard deviation of real returns is roughly 50% higher compared to the earlier periods. Throughout all centuries, returns exhibit low autocorrelation. There is weak evidence for negative autocorrelation in the earliest period, possibly indicative of measurement error. However, the AR(1) coefficient is not statistically significant. Finally, the data indicate that, for the period as a whole, most of the real return to investors has come from dividend yields, with 37% coming from price appreciation. This has changed in the most recent period where price appreciation accounts for 57% of real returns.

Our estimates indicate that the annual risk premium was relatively low in the early part of our data, 2-3%, in comparison to 6-8% in the U.S. after 1870. These estimates need to be interpreted with caution, though, as we use a crude proxy for the risk-free rate before 1920. Also, because returns are more volatile in the later part of the data, Sharpe ratios differ much less across periods, although the recent U.S. period (1945-2015) still has a Sharpe ratio that is relatively high at 0.47, compared to 0.31 for the sample as a whole.

Annual real dividend growth rates are around 2% on average. In the 17th and 18th centuries they are below 1%. They start to pick up in the 19th century, with an average growth rate of 5%, falling to about 2% in the later part of the data. The volatility of dividend growth rates changes significantly after 1945. Before, its standard deviation lies between 13 and 15%. After 1945, this drops by approximately half. At the same time, dividend growth becomes much more persistent. Initially, the AR(1) coefficient for real dividend growth is negative and statistically insignificant. For the period after 1945, it becomes positive at 0.42 and significant with a *t*-statistic of 3.50.

The dividend-to-price ratio is stationary over the sample as a whole, fluctuating around a long-term average of close to 5%; an augmented Dickey-Fuller test rejects a unit root at the one percent confidence level. Nevertheless, Figure 1 reveals that dividend yields have been falling since 1950 and became more persistent, with an AR(1) coefficient of 0.90, compared to 0.78 for the sample as a whole. The recent period is the only subsample where we cannot reject the presence of a unit root.

3 Results

3.1 Preliminary evidence

We start by previewing the key results of the paper in Figure 2. Panel A plots the dividend-to-price ratio and the subsequent 5-year real return. If dividend yields predict returns, we would expect that the two lines tend to rise and fall together. Panel B indicates whether specific data points help in predicting returns. The figure is based on regressions predicting one, three, and five-year real log returns using the log dividend-to-price ratio. The final points on the graph match the corresponding full-sample R-squares. The lines indicate where the fit improves or declines (details are in the caption of Figure 2). Shaded areas indicate recessions (information on recessions is only available after 1700).

Panel A confirms that the dividend-to-price ratio tends to increase before a period of high returns (and tends to decrease before a period of low returns), suggesting that returns are predictable by the dividend-to-price ratio. This is also apparent from Panel B, which shows that the fit of the predictive model improves in all four sub-periods. With the exception of the U.K. period (1813-1870), the fit of the model improves at longer horizons.

Panel A also suggests that return predictability from dividend yields is related to the business cycle. Both the dividend-to-price ratio and subsequent returns tend to increase in recessions. This pattern is strongest for the early U.S. period. Panel B confirms that recession periods contribute significantly to the fit of the predictive model. For example, the Depressions of 1709-1712 ("among the worst of the century", Ashton 1959, p. 141), 1873-1878 and 1929-1933 all lead to a higher R-square. In comparison, WWI and WWII do not add to the fit of the model. Neither do the 1990s, when exceptionally high returns coincide with a decrease in the dividend-to-price ratio.

Panels C and D present the same information for dividend growth rates. There is evidence for dividend yields predicting dividend growth rates in all but the final period, with the caveat that predictability in the Netherlands/U.K. period (1629-1812) is concentrated in the 17th century, where the data are largely based on a single company (the VOC). Panel D indicates that the fit of the model particularly improves during the two World Wars, indicating that the higher dividend-to-price ratio in these periods reflected a change in expected growth rates. Panel D also suggests that the increase in dividend yields during the Great Depression partly reflected a downward revision of expected dividend growth rates. In contrast to the return predictability results, the full-sample fit of the model is similar across different horizons.

3.2 Main regressions

In the next sections, we analyze the above results more formally. In Table 2, we report return and dividend growth predictability results over a one-year horizon and evaluate statistical significance using Newey-West (1987) *t*-statistics with one lag. The results show that in the sample as a whole, and in the four sub-periods individually, dividend yields predict returns with a positive coefficient. This holds true when we take logs. This relation is highly statistically significant for the sample as a whole (*t*-statistic of 3.17, 2.81 when we take logs). For certain sub-periods, *t*-statistics fall below two, in particular in the early U.S. period (1870-1945), but the difference with the full sample coefficient estimates is economically small (especially for the log results) and not statistically different from zero.

A different picture emerges from the regressions of dividend growth rates on the dividend-to-price ratio. For the sample as a whole, dividend yields negatively predict dividend growth rates (*t*-statistic of -4.82, -4.09 when we take logs), but this is largely driven by the period before 1945. In the late U.S. period (1945-2015), there is little evidence that dividend growth rates can be predicted using the dividend-to-price ratio. The predictive coefficient is close to zero, and the difference with the rest of the sample is statistically significant (*t*-statistic of 3.10, 4.12 when we take logs).

In the Online Appendix we replicate Table 2 using different variable definitions and specifications. Table OA.1 uses nominal data, Table OA.2 uses the U.K. stock market until 1900 and broad-based CRSP index (rather than the S&P 500 index) from 1925 onward, and Table OA.3 adds lagged returns and dividend growth rates as additional predictors. Results are qualitatively similar to our main findings in Table 2. In Table OA.4, to remedy the effects of possible measurement error, we use a trailing two-year rolling average of the dividend-to-price ratio as a predictor. This leads to more return predictability in the early U.S. period (1870-1945), while the evidence for dividend growth predictability in the Netherlands/U.K. period becomes weaker. The full sample estimates are virtually unchanged though.

3.3 Refined statistical tests

Nelson and Kim (1993), Stambaugh (1999) and others argue that return predictive coefficients reported in the previous section may overstate return predictability. In particular, there is a negative correlation between innovations in dividend yields and the errors in the predictive regression for returns, leading to an upward bias in the estimated coefficient. This bias is more pronounced when the negative correlation is stronger, the sample period is shorter, and the dividend-to-price ratio is highly persistent. In this section, we follow Cochrane (2008) to adjust test statistics for this issue and to develop additional tests.

Starting point for the analysis is a simple present value relation linking prices, returns and dividend growth rates. Define log return $ret_{t+1} = \log[(P_{t+1} + D_{t+1}) / P_t]$, log dividend growth rate $dg_{t+1} = \log(D_{t+1} / D_t)$ and log dividend-to-price ratio $dp_t = \log(D_t / P_t)$. Using a first-order Taylor expansion around the long-run mean of the dividend-to-price ratio $\overline{dp}$, Campbell and Shiller (1988a) show that the dividend-to-price ratio can be approximated by:

$$dp_t \simeq r_{t+1} - dg_{t+1} + \rho dp_{t+1}. \tag{1}$$

where all variables are demeaned and $\rho = \exp(-\overline{dp}) / \left(1 + \exp(-\overline{dp})\right)$ is the linearization constant. Eq. (1) shows that a high dividend-to-price ratio is related to high future returns, and/or low future dividend growth rates, and/or a high future dividend-to-price ratio. This can be formulated in terms of the following three predictive regressions:

$$r_{t+1} \simeq \alpha_r + \beta_r dp_t + \varepsilon_{t+1}^r \tag{2}$$

$$dg_{t+1} \simeq \alpha_{dg} + \beta_{dg} dp_t + \varepsilon_{t+1}^{dg} \tag{3}$$

$$dp_{t+1} \simeq \alpha_{dp} + \beta_{dp} dp_t + \varepsilon_{t+1}^{dp}, \tag{4}$$

where the coefficients are linked by the approximate identity

$$\beta_r - \beta_{dg} + \rho\beta_{dp} \simeq 1 \tag{5}$$

and errors from Eqs. (2) - (4) are linked according to

$$\varepsilon_{t+1}^r - \varepsilon_{t+1}^{dg} + \rho\varepsilon_{t+1}^{dp} \simeq 0. \tag{6}$$

Eq. (5) implies that we can always infer the third predictive coefficient from the other two. In Table 3 we run all three predictive regressions and report both the direct and implied coefficients. The identity holds well empirically. In most periods, the direct and indirect estimates are almost identical. The exception is the earliest period where the relative difference between estimates is approximately 15%. This is likely a result of the smoothing procedure we use for dividends before 1700; for the period 1700-2015 direct and implied coefficients are indistinguishable.

The return predictive coefficient is upward biased if the errors in Eq. (2) and (4) are negatively correlated: $corr(\varepsilon_{t+1}^r, \varepsilon_{t+1}^{dp}) < 0$. Table 3 indicates that, in the recent period, this correlation is indeed negative and high at -0.91. In the full sample, the correlation is less negative, but still substantial at -0.67. Following Cochrane (2008), we use Monte-Carlo simulations to construct test-statistics that take the resulting bias into account. We simulate the data using the empirical estimate for β_{dp} and impose $\beta_{ret} = 0$; β_{dg} follows from the restriction in Eq. (5). We rely on the sample covariance matrix of ε^{dp} and ε^{dg}, and we let ε^{ret} follow from Eq. (6). The null hypothesis of no return predictability corresponds to the following system of equations:

$$\begin{pmatrix} ret_{t+1} \\ dg_{t+1} \\ dp_{t+1} \end{pmatrix} = \begin{pmatrix} 0 \\ \rho\beta_{dp} - 1 \\ \beta_{dp} \end{pmatrix} dp_t + \begin{pmatrix} \varepsilon_{t+1}^{dg} - \rho\varepsilon_{t+1}^{dp} \\ \varepsilon_{t+1}^{dg} \\ \varepsilon_{t+1}^{dp} \end{pmatrix} \quad (7)$$

We simulate 50,000 data sets matching the length of the sample period. For each dataset, we then re-estimate Eqs. (1) - (3). This yields a distribution of β_{ret} coefficients that we use to evaluate the statistical significance of our empirical estimates.

The *p*-value "Sim. Direct" in Table 3 is the fraction of return coefficients from Monte Carlo simulations that are larger than the empirical estimate. Consistent with Stambaugh (1999) and Cochrane (2008), once the bias is accounted for, there is only weak evidence for return predictability in the recent U.S period; the simulated *p*-value is 0.24 in comparison to 0.05 based on the Newey-West standard error. In the early U.S. period, both *p*-values are insignificant. For the earlier samples, however, the simulated and Newey-West *p*-values are virtually the same and close to zero, consistent with a lower correlation of errors. Most importantly, for the sample as a whole, the simulated *p*-value is again close to zero. Thus, the long time period, in combination with a lower correlation of errors and less persistence in the dividend-to-price ratio, yields sufficient statistical power to strongly reject the null of no return predictability.

By the same logic, the dividend growth coefficient is downward biased if the errors in Eq. (3) and (4) are positively correlated: $corr(\varepsilon_{t+1}^{dg}, \varepsilon_{t+1}^{dp}) > 0$. Table 3 indicates that the correlation is relatively low in the recent period at 0.23, but gradually increases to 0.62 as we go back in time.

We thus run similar simulations for dividend growth rates, except that we now impose $\beta_{dg} = 0$ and let β_{ret} follow from Eq. (5). Also, differently from before, we now rely on the sample covariance matrix of ε^{dp} and ε^{ret}, and we infer ε^{dg} from Eq. (6). The *p*-values ("Sim., Direct") in Table 3 are the fraction of dividend growth coefficients from Monte Carlo simulations that are smaller than the empirical estimate. These *p*-values are qualitatively similar to the ones calculated from the Newey-West standard errors. The dividend-to-price ratio generally predicts dividend growth rates before 1945, but not afterwards.

Cochrane (2008) shows that one can also test for the predictability of returns by looking at (the absence of) dividend growth predictability. The intuition is that, if the dividend-to-price ration is stationary, it should either predict returns and/or dividend growth rates. If the forecastability of dividend growth rates is weak, dividend yields have to predict returns. Using the distribution of coefficients simulated under the null of no return predictability (Eq. 7), we report the fraction of dividend growth coefficients from Monte Carlo simulations that are larger than the estimate in Table 3 (*p*-value "Sim., Implied"). The equivalent *p*-value for dividend growth rates is the fraction of return coefficients simulated under the null of no dividend growth predictability that are smaller than their empirical estimate. Consistent with Cochrane (2008), we strongly reject the null that returns are not predictable for each individual period, including the recent U.S. period. Accordingly, the *p*-value associated with the full sample estimate of β_{ret} remains close to zero. This approach also strengthens the evidence for dividend growth predictability, with *p*-values close to zero for all but the recent period in which we reject it with a *p*-value of 0.14.

Finally, we calculate the long-run estimates implied by the coefficients from Table 3. Iterating Eq. (1) forward and excluding rational bubbles, the dividend-to-price ratio can be expressed as an infinite sum of discounted returns and dividend growth rates (since the relationship holds ex-ante and ex-post, an expectations operator can be added):

$$dp_t \simeq E_t \sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} - E_t \sum_{j=1}^{\infty} \rho^{j-1} dg_{t+j}. \tag{8}$$

Thus, ultimately, any variation in the dividend-to-price ratio is related to future changes in expected returns and/or expected dividend growth rates. We can express Eq. (8) in terms of regression coefficients (details are in Cochrane 2008):

$$\beta_r^{lr} = \sum_{j=1}^{\infty} \rho^{j-1} \beta_{dp}^{j-1} \beta_r = \frac{\beta_r}{1-\rho\beta_{dp}} \tag{9}$$

$$\beta_{dg}^{lr} = \sum_{j=1}^{\infty} \rho^{j-1} \beta_{dp}^{j-1} \beta_{dg} = \frac{\beta_{dg}}{1-\rho\beta_{dp}} \tag{10}$$

where $\beta_r^{lr} - \beta_{dg}^{lr} \simeq 1$. The two long-run coefficients capture the fraction of the variance of the dividend-to-price ratio that can be attributed to time-varying expected returns or dividend growth rates.

Table 3 reports the two long-run coefficients and corresponding *p*-values, either derived from Newey-West standard errors (using the Delta method) or simulations. Since we use direct estimates and do no impose the restriction from Eq. (5), the two coefficients do not necessarily add up to one. With the exception of the early U.S. period, dividend yields significantly predict returns. Dividend growth rates are predictable until 1945. The *p*-values for the full sample estimates are close to zero in both cases. The long-run estimates suggest that changes in expected returns account for about 40% of the variation of the dividend-to-price ratio in the full sample (around 45%, if we exclude the years before 1700 where identity (5) holds only approximately). The remainder, or 55% of price variation, is driven by changes in expected dividend growth rates.

3.4 Long horizon predictability

The previous long-run estimates assume that the underlying VAR model is correctly specified. In this section, we use the data to directly test whether dividend yields predict returns over longer horizons. Fama and French (1988) document that such an approach strengthens the evidence for return predictability. Boudoukh, Richardson and Whitelaw (2008) argue that the improved fit of predictive model is largely mechanical and is not statistically significant.

In Table 4, we directly estimate the predictability of three and five-year real log returns and dividend growth rates. For comparison, we also report the one-year results. We report *t*-statistics based on overlapping and non-overlapping data. In the non-overlapping case, we run three or five different regressions using alternative samples of non-overlapping observations and report the average *t*-statistic across those samples. Additionally, we report Monte Carlo *p*-values ("Sim., Direct"). For comparison with the direct estimates, we report the three and five year coefficients implied from the annual VAR, using $\beta_{x,h} = \beta_x \left(1-\beta_{dp,1}^h\right)/(1-\beta_{dp,1})$, where h is the length of the horizon and x stands for returns or dividend growth rates.

The evidence for dividend yields predicting returns is strong across the different horizons. When we increase the horizon from one to five years, the estimated coefficients increase monotonically and the full-sample R-square increases from 3% to 12%. The *t*-statistics based on non-overlapping observations increase from 2.81 to 3.17. Simulated *p*-values are always close to zero. Also, the three and five-year coefficients are close to those implied by the VAR. All in all, the evidence for return predictability is largely aligned across horizons. When we break the sample in 1945, the estimates for 1629-1945 and 1945-2015 are quantitatively similar.

The dividend growth results are somewhat different. The coefficients increase when we move from a one to three-year horizon, but relatively less so than for returns. Moving from three to five years leaves the coefficients virtually unchanged. The full-sample R-square is approximately the same across all horizons. All coefficients are statistically significant. Simulated *p*-values remain close to zero, but the *t*-statistics based on non-overlapping observations actually decrease with the increase of the horizon, from -4.09 to -2.23. The long horizon coefficients are also substantially smaller (in absolute value) than those implied from the annual VAR. This suggests that there is some mean-reverting component in expected dividend growth rates that the VAR does not capture. It also means that the implied long-run coefficient β_{dg}^{lr} from Table 3 likely overstates the importance of expected dividends for price movements. The full-sample five-year coefficient on dividend growth implies an annual coefficient that is half the size of the actual coefficient (-0.05, rather than -0.10). It also suggests that around 60% (rather than 40%) of the variation in the dividend-to-price ratio can be attributed to discount rate news. Consistent with earlier results, we find no evidence that dividend yields predict dividend growth rates after 1945.

Results are similar if we discount future returns and dividend growth rates by the linearization constant ρ (Online Appendix, Table OA. 5).

3.5 Out-of-sample predictability

Goyal and Welch (2003, 2008) show that the dividend-to-price ratio is a poor out-of-sample predictor of returns compared to simply using the historical average return; the out-of-sample R-square is typically negative. This does not necessarily mean that expected returns do not vary over time. Simulations in Cochrane (2008) indicate that even when all variation in the dividend yield comes from changes in expected returns, out-of-sample R-squares are seldom positive. The critique does suggest, however, that dividend yields may not help predicting returns in real time.

In this section, we present estimates for out-of-sample predictability in our data. Following Goyal and Welch (2008), we calculate the out-of-sample R-square as:

$$ROOS = 1 - \frac{\sum_{\tau=1}^{T} (y_\tau - \hat{y}_\tau)^2}{\sum_{\tau=1}^{T} (y_\tau - \overline{y}_\tau)^2}, \tag{13}$$

where y_τ is the actual return, $\hat{y}_\tau$ is the return predicted by the dividend-to-price ratio using a coefficient estimated on the sample up to $\tau - 1$, and $\overline{r}_\tau$ is the mean return up to $\tau - 1$. In our main run, the first training sample is from 1629 through 1700, with the first out-of-sample prediction in 1701; the final prediction is based on the coefficient estimated on data from 1629 to 2014. Besides one year returns, we also calculate ROOS for predicting three and five-year returns. We use real returns and express all the variables in logs. We assess the statistical significance of our results with a Clark and West (2007) *t*-statistic. We also report the fraction of ROOSs from Monte Carlos simulations that are larger than the empirical estimate of ROOS ("*p*-value, Sim.").

Table 5 reports the results. The ROOS is always positive and increases with the return horizon, between 2% and 10%. This compares to 3% and 13% for the in-sample R-squares for this period (Table 4). According to the statistical tests, the out-of-sample predictions based on the dividend-to-price ratio present a significant improvement over the historical mean.

In Figure 3, we plot where ROOS increases or declines, analogous to Figure 2, Panel B. The patterns in Figure 3 are similar to the in-sample statistics reported in Figure 2, Panel B. Overall, there is strong evidence for return predictability at both the annual and multi-annual horizons, with the possible exception of the U.K. period (1812-1870) for longer horizons and the most recent years of the sample.

We also consider two adjustments proposed by Campbell and Thompson (2008). In the second column, we set the predictive coefficient on the dividend-to-price ratio equal to zero if the regression generates a negative estimate. ROOS is identical to the first column, indicating that this scenario never materializes. In the third column we set return forecast to zero if the model predicts it to be negative. This happens occasionally in the recent U.S. period where the dividend-to-price ratio is very low. As a result, ROOS increases from 2% to 3% for one-year returns and from 10% to 11% for five-year returns.

Finally, we address the concern that out-of-sample evidence may depend on the exact sample split (Rossi and Inoue, 2012; Karapandza and Kolev, 2016). Instead of letting the first training sample end in 1700, we consider all the possible splits with at least 20% and at most 80% of observations used for the initial training period. In Table 5, we report the average ROOS across those sample splits. The out-of-sample R-square decreases somewhat. This is consistent with Figure 3 that suggests that the out-of-sample evidence is somewhat weaker in the more recent data. However, ROOS remains positive and statistically significant, at least at the 10% level.

4 Business cycle variation

The previous results indicate that dividend yields predict returns and, therefore, that discount rates vary over time. What drives these fluctuations in expected returns? One explanation is that the market has less risk-bearing capacity in downturns, giving rise to counter-cyclical discount rates (Fama and French 1989). In this section, we study to what degree return predictability and business cycle fluctuations are related.

Table 6 first provides summary statistics related to the business cycle. Because recession dates are only available from 1700 onwards, results are based on the period 1700-2015. We also look at the sub-periods 1700-1945 and 1945-2015 separately. In total, there are 62 individual recession events in the data, ten of which take place after 1945. Realized returns are lower in recessions than in expansions. The same holds for dividend growth rates, but the difference is only statistically significant for returns. A visual inspection of Figure 2, Panels A and C, suggests that the dividend-to-price ratio tends to peak in recessions. Table 6 confirms this pattern. The average dividend yield is 4.86% in downturns and 4.16% in expansions. The difference is statistically significant with a *t*-statistic of 4.58. Looking at 1700-1945 and 1945-2015 separately yields broadly similar results. In line with Fama and French (1989), these results suggest that the predictability of returns from dividend yields stems, at least in part, from business cycle fluctuations. During recessions, prices fall and expected returns go up.

To explore this further, we include a recession dummy as an additional predictor variable in the forecasting regressions:

$$r_{t+1} \simeq \alpha_r + \beta_r dp_t + \delta_r Recession_t + \varepsilon^r_{t+1} \tag{14}$$

$$dg_{t+1} \simeq \alpha_{dg} + \beta_{dg} dp_t + \delta_{dg} Recession_t + \varepsilon^{dg}_{t+1} \tag{15}$$

$$dp_{t+1} \simeq \alpha_{dp} + \beta_{dp} dp_t + \delta_{dp} Recession_t + \varepsilon^{dp}_{t+1}. \tag{16}$$

Similar to before, the coefficients in Eqns. 14-16 are linked by the approximate identities $\beta_r - \beta_{dg} + \rho\beta_{dp} \simeq 1$ and $\delta_r - \delta_{dg} + \rho\delta_{dp} \simeq 0$. We are particularly interested in how β_r, the coefficient on the dividend-to-price ratio in the return regression, changes after conditioning on the business cycle. If it falls, it would suggest that the business cycle is one of the channels through which dividend yields predict returns. A caveat here is that the dating of recessions happens ex post, relying on turning points in important macro-economic series. Information about the start or end of a recession is therefore not necessarily available in real time. Also, a simple classification of contractions versus expansions does not capture the intensity of business cycles, and misses long-term changes in business conditions (Fama and French, 1989).

Results are in Table 7. The approximate identities hold well in the data. Recessions are associated with higher expected returns. When we condition on the business cycle, β_r decreases – in the full sample it changes from 0.08 to 0.06. This confirms that dividend yields predict returns because, in part, prices are lower in recessions. This explains around 25% of the annual return predictability from dividend yields. Recessions are also associated with a lower dividend-to-price ratio next period, consistent with expected returns falling when the economy recovers. Controlling for the business cycle makes dividend yields more persistent; β_{dp} increases from 0.86 to 0.88. Finally, recessions appear unrelated to next period annual dividend growth rates and coefficient β_{dg} in the dividend growth regression is unchanged at -0.10. Findings are similar for the sub-period 1700-1945. For 1945-2015, conditioning on the business cycle only has a limited effect on β_r.

Next, we explore whether the inclusion of a recession dummy in the predictive regressions changes the long-run coefficients on dividend yields. Following Cochrane (2011), we complete the VAR system by estimating a predictive regression for recessions:

$$Recession_{t+1} \simeq \alpha_{Rec} + \beta_{Rec} dp_t + \delta_{Rec} Recession_t + \varepsilon_{t+1}^{Rec}, \tag{17}$$

and we calculate the long-run coefficients from Eqns. 14-17 as:

$$\begin{bmatrix} \beta_r^{lr} & \delta_r^{lr} \\ \beta_{dg}^{lr} & \delta_{dg}^{lr} \end{bmatrix} = \frac{B}{(I-\rho\phi)}, \; where\ B = \begin{bmatrix} \beta_r & \delta_r \\ \beta_{dg} & \delta_{dg} \end{bmatrix} \text{ and } \phi = \begin{bmatrix} \beta_{dp} & \delta_{dp} \\ \beta_{Rec} & \delta_{Rec} \end{bmatrix}. \tag{18}$$

Long-run coefficients are linked approximately by $\beta_r^{lr} - \beta_{dg}^{lr} \simeq 1$ and $\delta_r^{lr} - \delta_{dg}^{lr} \simeq 0$. Results are in Table 7.

Despite the ability of recessions to predict annual returns, the associated long-run coefficients δ_r^{lr} and δ_{dg}^{lr} are small. In addition, the inclusion of a recession dummy only leads to a small change in the long-run coefficients on the dividend-to-price ratio β_r^{lr}. This is largely due to the combination of two facts. Recessions or expansions have little persistence. They are also not a strong predictor of future dividend yields. Business cycles therefore mainly affect the short end of discount rates' term structure (Cochrane 2011). Dividend yields are much more persistent and capture long-term variation in business conditions that goes beyond a simple classification of contractions versus expansions (Fama and French, 1989).

5 Summary and Discussion

The results in this paper indicate that return predictability from dividend yields has been a robust characteristic of financial markets over the last four centuries. Our findings are robust to a number of statistical tests proposed in the literature, including Monte Carlo simulations that take the Stambaugh (1999) bias into account. The implied variation in expected returns lines up well with the business cycle, with on average high returns following downturns. This is true for both early and more recent data. Finally, we find that roughly until the mid-20th century the dividend-to-price ratio also predicts dividend growth rates, especially at a shorter (annual) horizon.

These results are supportive of modern asset pricing models that incorporate time-varying expected returns. At the same time, the failure of the dividend-to-price ratio to predict dividend growth rates in the recent period poses a puzzle (Cochrane, 2011). What changed after WWII so that movements in dividend yields stopped reflecting expected dividends?

We leave this for future research. A possible explanation lies in the observation that, as a fraction of earnings, firms have substantially reduced their dividends in the recent period (Fama and French, 2001). To illustrate this, Figure 4 tracks the development of the dividend-to-earnings ratio for the Netherlands/U.K. period (1651-1812) and the U.S. period (1871-2015) for which the data are available. We sum dividends and earnings over 20-year (trailing) periods and take the ratio. During the 17th and 18th centuries, firms paid out close to a 100% of their earnings to shareholders. In 1945, this number was still around 80%. By 1982, however, the dividend-to-earnings ratio had fallen to approximately 45%. (The payout ratio fell even more after 1982, but this is partly related to the increased use of repurchases.) This pattern is consistent with Figure 1 and Table 1 that show that the dividend-to-price ration has decreased in the recent period and that returns to investors have increasingly come from capital appreciation in lieu of dividends.

The growing disconnect between earnings and dividends can reduce the ability of dividend yields to predict dividend growth rates in at least two ways. First, it enables firms to smooth dividends more, and, as argued by Chen, Da and Priestley (2012), this can make changes in dividend yields less informative about future growth rates. Figure 1, Panel B shows that dividends were indeed least volatile in the recent U.S. period. Second, a lower dividend-to-earnings ratio implies that firms push the eventual payouts to shareholders into the future. Given that expected returns appear to be less persistent than expected dividend growth rates,[5] postponing dividend payments increases the relative sensitivity of dividend yields to shocks in expected returns and reduces the ability of dividend yields to predict dividend growth rates.

[5] Fama and French (1988), Binsbergen and Koijen (2010), Koijen and Van Nieuwerburgh (2011), and Golez (2014). Our results in Section 3.4 are also supportive of this finding.

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Table 1: Summary statistics

This table reports summary statistics for the annual variables in nominal (Panel A), and real terms (Panel B). Column (1) reports the statistics for the 1629-1812 period based on the Netherlands/U.K. data. Annual dividend growth rates and the dividend-to-price ratio before 1700 are based on 10-year trailing averages of nominal or real dividends; column (1a) reports statistics for the 1700-1812 period separately. Column (2) reports the same statistics for the U.K. period 1813-1870; column (3) and (4) present the statistics for the U.S. before and after 1945; column (5) reports the statistics based on the full sample. DY/RET is the ratio of the dividend yield (D_t/P_{t-1}) to total returns. The risk-free rate is the return on government securities before 1870, the average return on commercial paper and government securities between 1871 and 1920, and the return on T-bills thereafter (details are in Appendix A). The Sharpe ratio is calculated assuming zero variation in the risk-free rate. We calculate standard errors for the AR(1) coefficients as *1/sqrt(T)*. We present augmented Dickey-Fuller (ADF) tests for the presence of a unit root. Three and one asterisk(s) denote statistical significance of the ADF at the one and ten percent levels.

	(1)	(1a)	(2)	(3)	(4)	(5)
	Neth./U.K. 1629-1812	Neth./U.K. 1700-1812	U.K. 1813-1870	U.S. 1871-1945	U.S. 1945-2015	Full period 1629-2015
Panel A: Nominal data						
RET (%)	6.11	5.64	6.91	9.05	12.00	7.87
Std. (%)	10.94	9.31	8.90	19.76	16.87	14.11
AR(1)	-0.11	-0.05	-0.03	0.04	-0.04	-0.01
t-stat.	(-1.51)	(-0.57)	(-0.24)	(0.36)	(-0.30)	(-0.14)
DY/RET	0.79	0.86	0.63	0.59	0.30	0.59
RF (%)	3.35	3.16	4.21	2.57	4.06	3.47
Risk Premium (%)	2.76	2.48	2.69	6.48	7.94	4.40
Sharpe Ratio	0.25	0.27	0.30	0.33	0.47	0.31
Inflation (%)	0.49	0.57	-0.67	0.73	3.79	0.96
DG (%)	0.90	0.96	3.40	2.46	6.38	2.57
Std. (%)	11.32	10.74	11.24	15.44	6.81	11.72
AR(1)	-0.21	-0.24	-0.05	0.22	0.44	0.03
t-stat.	(-2.79)	(-2.57)	(-0.37)	(1.88)	(3.67)	(0.56)
Panel B: Real data						
RET (%)	6.15	5.51	8.29	8.42	8.13	7.27
Std. (%)	13.36	11.06	12.20	19.11	17.28	15.20
AR(1)	-0.10	0.03	0.13	0.01	0.01	-0.02
t-stat.	(-1.37)	(0.27)	(0.99)	(0.10)	(0.12)	(-0.47)
DY/RET	0.78	0.87	0.53	0.63	0.43	0.63
DG (%)	0.71	0.88	4.61	1.89	2.58	1.86
Std. (%)	12.75	12.74	13.28	15.09	7.01	12.53
AR(1)	-0.10	-0.10	-0.07	0.07	0.42	-0.01
t-stat.	(-1.33)	(-1.11)	(-0.52)	(0.59)	(3.50)	(-0.16)
DP (%)	4.84	4.57	4.27	5.34	3.39	4.59
Std. (%)	1.24	0.96	0.79	1.45	1.41	1.42
AR(1)	0.78	0.77	0.65	0.47	0.90	0.78
ADF	-4.08***	-3.41*	-4.92***	-4.90***	-2.38	-6.28***

Table 2: Return and dividend growth predictability

This table reports OLS estimates of regressing annual real returns and dividend growth rates on the lagged dividend-to-price ratio. Lower case letters are logs of corresponding capital letters. All regressions include a constant (not reported). Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with one lag. In brackets are the *t*-statistics for the difference of the estimated coefficient from the rest of the sample (based on a full-period regression with an interaction term).

	(1)	(2)	(3)	(4)	(5)	(6)
	Neth./U.K.	U.K.	U.S.	U.S.	Full period	Full period
	1629-1812	1813-1870	1871-1945	1945-2015	1700-2015	1629-2015
Dependent variable: RET_{t+1}						
DP_t	2.72	4.32	1.50	3.14	2.00	1.96
t-stat.	(3.13)	(2.01)	(1.11)	(2.30)	(2.71)	(3.17)
Diff. (*t*-stat.)	[0.76]	[1.08]	[-0.41]	[0.56]	[-0.23]	
R2	0.06	0.08	0.01	0.07	0.03	0.03
Dependent variable: DG_{t+1}						
DP_t	-2.25	-3.86	-7.03	-0.11	-2.79	-2.64
t-stat.	(-2.36)	(-1.36)	(-7.80)	(-0.12)	(-4.45)	(-4.82)
Diff. (*t*-stat.)	[0.44]	[-0.46]	[-4.99]	[3.10]	[-0.41]	
R2	0.05	0.05	0.45	0.00	0.09	0.09
Dependent variable: ret_{t+1}						
dp_t	0.12	0.22	0.09	0.09	0.08	0.07
t-stat.	(2.97)	(2.21)	(1.14)	(2.03)	(2.47)	(2.81)
Diff. (*t*-stat.)	[0.96]	[1.44]	[0.10]	[-0.29]	[-0.27]	
R2	0.06	0.10	0.01	0.06	0.03	0.03
Dependent variable: dg_{t+1}						
dp_t	-0.12	-0.16	-0.42	-0.01	-0.10	-0.10
t-stat.	(-2.73)	(-1.26)	(-6.83)	(-0.40)	(-3.45)	(-4.09)
Diff. (*t*-stat.)	[-0.64]	[-0.50]	[-5.39]	[4.12]	[0.37]	
R2	0.06	0.05	0.48	0.00	0.07	0.07

Table 3: Return and dividend growth predictability: Additional tests

This table reports OLS estimates of regressing annual real returns, dividend growth rates and the dividend-to-price ratio on the lagged dividend-to-price ratio. All variables are in logs. We calculate 'implied coefficients' using the identity $\beta_{ret} - \beta_{dg} + \rho\beta_{dp} = 1$ and $\rho = \exp(-\overline{dp}) / \left(1 + \exp(-\overline{dp})\right)$. The 'correlation of errors' is the correlation between innovations in the dividend-to-price ratio and errors in the predictive regression for returns or dividend growth rates. The *p*-values are based on Newey-West (1987) *t*-statistics with one lag '*p*-value (N-W)' or Monte Carlo simulations '*p*-value (Sim.)'; 'Direct' tests for the presence of return or dividend growth predictability; 'Implied' infers return (dividend growth rate) predictability from the lack of dividend growth (return) predictability. The 'long-run coefficient' is implied from the short-run coefficient using $\beta_x^{lr} = \beta_x / (1 - \rho\beta_{dp})$. The *p*-values for the long-run coefficient are based on the Delta method '*p*-value (Delta m.)' and Monte Carlo simulations '*p*-value (Sim., Direct)'. All regressions include a constant (not reported).

	(1)	(2)	(3)	(4)	(5)	(6)
	Neth./U.K. 1629-1812	U.K. 1813-1870	U.S. 1871-1945	U.S. 1945-2015	Full period 1700-2015	Full period 1629-2015
Dependent variable: ret_{t+1}						
dp_t	0.12	0.22	0.09	0.09	0.08	0.07
Implied coefficient	0.14	0.22	0.08	0.09	0.08	0.08
Correlation of errors	-0.48	-0.46	-0.85	-0.91	-0.72	-0.67
p-value (N-W)	0.00	0.03	0.26	0.05	0.01	0.01
p-value (Sim., Direct)	0.00	0.03	0.24	0.24	0.01	0.00
p-value (Sim., Implied)	0.00	0.00	0.04	0.00	0.00	0.00
Long-run coefficient	0.46	0.57	0.17	0.90	0.43	0.41
p-value (Delta m.)	0.00	0.01	0.24	0.00	0.00	0.00
p-value (Sim., Direct)	0.00	0.00	0.19	0.00	0.00	0.00
Dependent variable: dg_{t+1}						
dp_t	-0.12	-0.16	-0.42	-0.01	-0.10	-0.10
Implied coefficient	-0.14	-0.16	-0.42	-0.01	-0.10	-0.11
Correlation of errors	0.62	0.59	0.44	0.23	0.53	0.54
p-value (N-W)	0.01	0.21	0.00	0.69	0.00	0.00
p-value (Sim., Direct)	0.01	0.11	0.00	0.40	0.00	0.00
p-value (Sim., Implied)	0.00	0.02	0.00	0.14	0.00	0.00
Long-run coefficient	-0.47	-0.43	-0.83	-0.10	-0.55	-0.55
p-value (Delta m.)	0.00	0.05	0.00	0.58	0.00	0.00
p-value (Sim., Direct)	0.00	0.04	0.00	0.32	0.00	0.00
Dependent variable: dp_{t+1}						
dp_t	0.77	0.65	0.52	0.93	0.86	0.85
Implied coefficient	0.79	0.64	0.52	0.93	0.86	0.86
p-value (N-W)	0.00	0.00	0.00	0.00	0.00	0.00

Table 4: Long-horizon predictability

This table reports OLS estimates of regressing sum of annual real returns $\left(\sum_{j=1}^{h} ret_{t+j}\right)$ or dividend growth rates $\left(\sum_{j=1}^{h} dg_{t+j}\right)$ on the dividend-to-price ratio. All variables are in logs. Horizon *h* is either 1, 3, or 5 years. Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with the number of lags equal to the length of the horizon. In brackets are *t*-statistics based on non-overlapping observations, calculated as the mean across alternative non-overlapping samples (e.g. in case of 5-year predictions, we report the mean across five different non-overlapping samples starting in years 1 through 5). The *p*-values '(Sim., Direct)' are based on Monte Carlo simulations. The 'implied coefficient' for longer horizon predictions is based on the 1-year coefficient and calculated using $\beta_{x,h} = \beta_x \left(1 - \beta_{dp,1}^{h}\right) / (1 - \beta_{dp,1})$. All regressions include a constant (not reported).

	(1)	(2)	(3)	(4)
	1629-1945	1945-2015	1700-2015	1629-2015
Dependent variable: 1-year ret				
dp_t	0.11	0.09	0.08	0.07
t-stat.	(3.22)	(2.03)	(2.47)	(2.81)
p-value (Sim., Direct)	0.00	0.24	0.01	0.00
R2	0.04	0.06	0.03	0.03
Dependent variable: 3-year ret				
dp_t	0.29	0.25	0.21	0.20
t-stat. (Overlap.)	(4.40)	(2.84)	(3.12)	(3.41)
t-stat. (Non-overlap.)	[3.44]	[2.83]	[2.81]	[3.01]
p-value (Sim., Direct)	0.00	0.25	0.01	0.00
Implied coefficient	0.24	0.26	0.20	0.19
p-value (Sim., Direct)	0.00	0.20	0.00	0.00
R2	0.10	0.15	0.08	0.07
Dependent variable: 5-year ret				
dp_t	0.44	0.44	0.34	0.32
t-stat. (Overlap.)	(4.51)	(5.25)	(4.02)	(4.29)
t-stat. (Non-overlap.)	[3.46]	[3.70]	[2.99]	[3.17]
p-value (Sim., Direct)	0.00	0.20	0.00	0.00
Implied coefficient	0.31	0.40	0.29	0.28
p-value (Sim., Direct)	0.00	0.15	0.00	0.00
R2	0.15	0.28	0.13	0.12
Dependent variable: 1-year dg				
dp_t	-0.20	-0.01	-0.10	-0.10
t-stat.	(-5.30)	(-0.40)	(-3.45)	(-4.09)
p-value (Sim., Direct)	0.00	0.40	0.00	0.00
R2	0.14	0.00	0.07	0.07
Dependent variable: 3-year dg				
dp_t	-0.33	0.01	-0.15	-0.18
t-stat. (Overlap.)	(-4.82)	(0.09)	(-2.59)	(-3.29)
t-stat. (Non-overlap.)	[-3.79]	[0.10]	[-2.19]	[-2.75]
p-value (Sim., Direct)	0.00	0.62	0.01	0.00
Implied coefficient	-0.44	-0.03	-0.25	-0.26
p-value (Sim., Direct)	0.00	0.39	0.00	0.00
R2	0.15	0.00	0.06	0.08
Dependent variable: 5-year dg				
dp_t	-0.35	0.00	-0.15	-0.20
t-stat. (Overlap.)	(-3.58)	(-0.04)	(-2.48)	(-3.12)
t-stat. (Non-overlap.)	[-2.60]	[-0.04]	[-1.63]	[-2.23]
p-value (Sim., Direct)	0.00	0.57	0.08	0.02
Implied coefficient	-0.57	-0.04	-0.37	-0.38
p-value (Sim., Direct)	0.00	0.38	0.00	0.00
R2	0.12	0.00	0.05	0.08

Table 5: Out-of-sample return predictability

This table reports out-of-sample R-square 'ROOS' and Clark and West (2007) *t*-statistics for out-of-sample predictions of 1-, 3-, and 5- year real returns. All variables are in logs. The *p*-values (Sim.) are from Monte Carlo simulations. All predictions are based on an expanding window. In the left panel, the initial training period is 1629-1700, and the rest of the sample period 1701-2015 is used for the calculation of the out-of-sample statistics. In the right panel, we report average statistics across all the sample splits with at least 20% and at most 80% of observations used in the estimation of initial parameters. The 'unconstrained' ROOS compares the forecast errors of the historical mean against the forecasts from the dividend-to-price ratio predictive regression. 'Positive coefficient' imposes a restriction that the coefficient on the dividend-to-price ratio is positive, or else the historical mean is used as a forecast. 'Positive forecast' requires that the forecast is positive, or else we use zero as a forecast.

	Sample split in 1700			Many sample splits (20%-80%)		
	Unconstrained	Positive coefficient	Positive forecast	Unconstrained	Positive coefficient	Positive forecast
1-year predictions						
ROOS	0.02	0.02	0.03	0.01	0.01	0.02
t-stat.	(2.37)			(1.72)		
p-value (Sim.)	0.00					
3-year predictions						
ROOS	0.06	0.06	0.06	0.03	0.03	0.04
t-stat.	(2.57)			(1.89)		
p-value (Sim.)	0.00					
5-year predictions						
ROOS	0.10	0.10	0.11	0.07	0.07	0.08
t-stat.	(2.97)			(2.28)		
p-value (Sim.)	0.00					

Table 6: Business cycle variation: Summary statistics

This table reports summary statistics for real returns, real dividend growth rates and the dividend-to-price ratio over the business cycle. From 1870 through 2015, recession and expansion dates come from the NBER. From 1700 until 1870 these dates are based on secondary sources that use NBER criteria to determine business cycle peaks and troughs in the U.K. (details are in Appendix A). In brackets are paired sample *t*-tests for the difference in mean.

	(1)		(2)		(3)	
	1700-1945		1945-2015		1700-2015	
	Recession	Expansion	Recession	Expansion	Recession	Expansion
RET (%)	4.88	8.78	-2.88	10.41	4.10	9.27
Std. (%)	14.92	13.47	19.74	15.99	15.55	14.25
t-stat.	[-2.12]		[-2.19]		[-2.95]	
DG (%)	1.85	2.24	-0.47	3.21	1.62	2.53
Std. (%)	14.76	12.73	10.90	5.85	14.40	11.11
t-stat.	[-0.21]		[-1.14]		[-0.59]	
DP (%)	4.94	4.56	4.14	3.22	4.86	4.16
Std. (%)	1.28	1.05	1.60	1.34	1.33	1.29
t-stat.	[2.48]		[1.85]		[4.58]	
N	108	135	12	58	120	193

Table 7: Business cycle variation: Predictability results

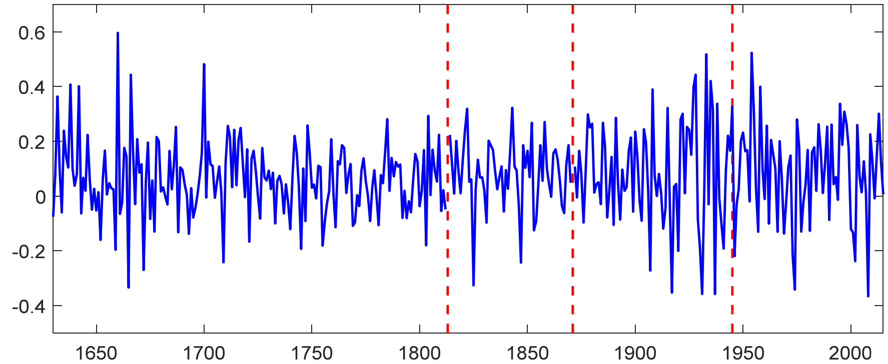
This table reports OLS estimates of regressing annual real returns, dividend growth rates, the dividend-to-price ratio and the recession dummy on the lagged dividend-to-price ratio and the lagged recession dummy. The main variables are in logs. 'Recession' takes a value one for recessions, and zero otherwise. Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with one lag. All regressions include a constant (not reported). The long-run coefficients are implied from the short-run coefficients using $B^{lr} = B \ / (I - \rho\Phi_{dp})$, where B is a matrix of predictive coefficients from the return and dividend growth regressions, and Φ is a matrix of predictive coefficients from the dividend-to-price ratio and the recession regressions.

	(1)		(2)		(3)	
	1700-1945		1945-2015		1700-2015	
Dependent variable: ret_{t+1}						
dp_t	0.12	0.10	0.09	0.09	0.08	0.06
t-stat.	(2.73)	(2.24)	(2.03)	(1.85)	(2.47)	(1.75)
$Recession_t$		0.06		0.03		0.06
t-stat.		(3.64)		(0.59)		(3.17)
R2	0.04	0.09	0.06	0.06	0.03	0.06
Dependent variable: dg_{t+1}						
dp_t	-0.24	-0.24	-0.01	0.00	-0.10	-0.10
t-stat.	(-5.18)	(-5.15)	(-0.40)	(-0.04)	(-3.45)	(-3.24)
$Recession_t$		0.00		-0.05		0.00
t-stat.		(0.19)		(-1.73)		(-0.30)
R2	0.16	0.16	0.00	0.07	0.07	0.07
Dependent variable: dp_{t+1}						
dp_t	0.67	0.69	0.93	0.94	0.86	0.88
t-stat.	(11.76)	(11.99)	(20.23)	(19.52)	(22.24)	(22.37)
$Recession_t$		-0.06		-0.08		-0.06
t-stat.		(-2.97)		(-1.28)		(-2.90)
R2	0.46	0.48	0.85	0.86	0.73	0.74
Dependent variable: $Recession_{t+1}$						
dp_t		0.13		0.10		0.23
t-stat.		(0.86)		(0.94)		(2.91)
$Recession_t$	0.12	0.11	0.07	0.05	0.16	0.12
t-stat.	(2.34)	(2.06)	(0.56)	(0.38)	(3.25)	(2.35)
R2	0.02	0.02	0.01	0.02	0.03	0.05
Long-run coefficient: ret_{t+1}						
dp_t	0.34	0.31	0.90	0.94	0.43	0.41
$Recession_t$		0.05		-0.04		0.03
Long-run coefficient: dg_{t+1}						
dp_t	-0.67	-0.70	-0.10	-0.06	-0.55	-0.57
$Recession_t$		0.05		-0.04		0.03

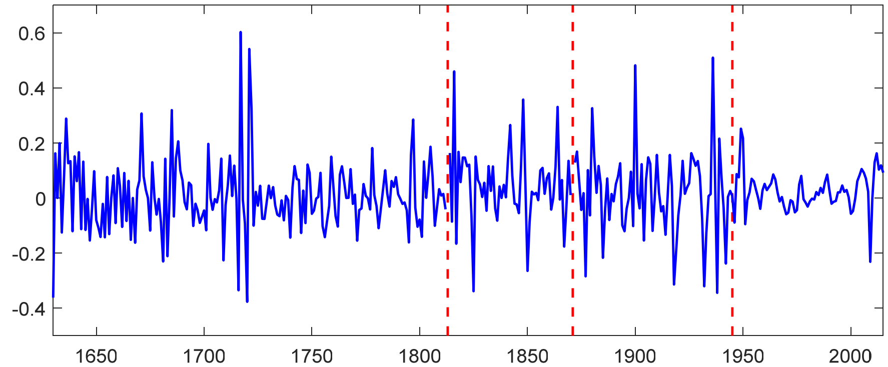
Figure 1: Returns, dividend growth rates, and the dividend-to-price ratio

This figure plots real returns, real dividend growth rates, and the dividend-to-price ratio over time. The data are annual. Dashed vertical lines denote the time periods: Netherlands and U.K. (1629-1812), U.K. (1813-1870), U.S. early (1871-1945), and U.S. recent (1945-2015).

Panel A: Annual real returns



Panel B: Annual real dividend growth rates



Panel C: Dividend-to-price ratio

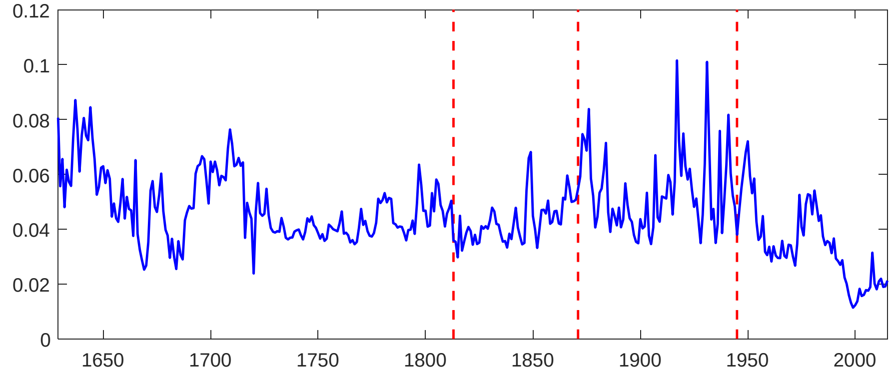
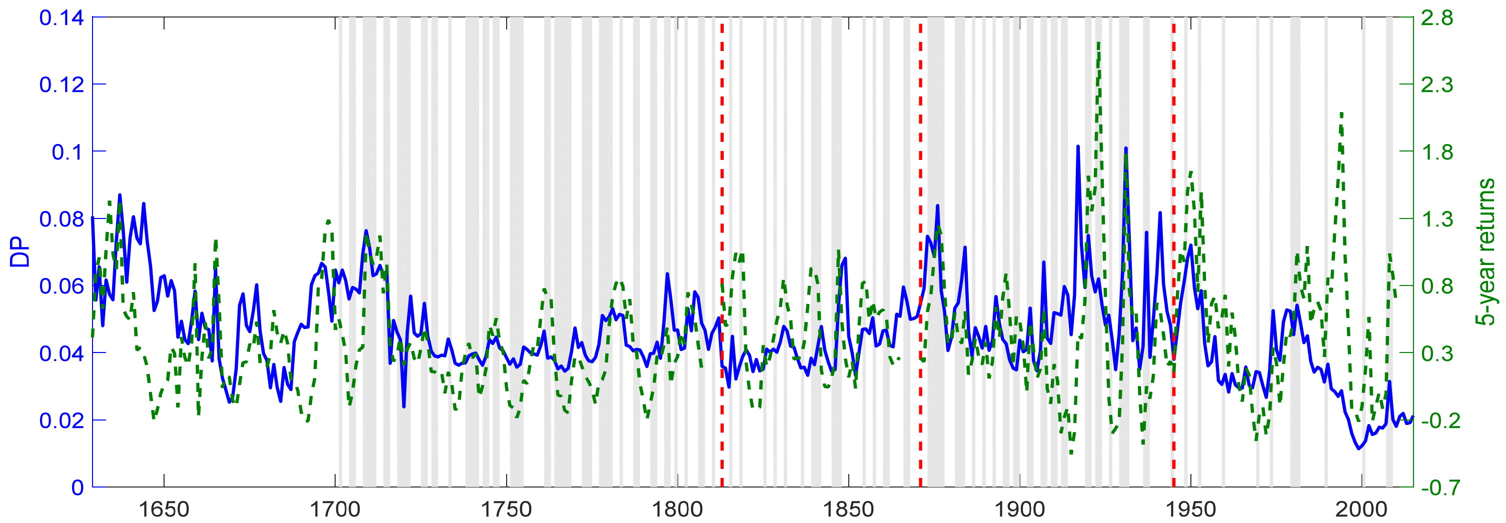


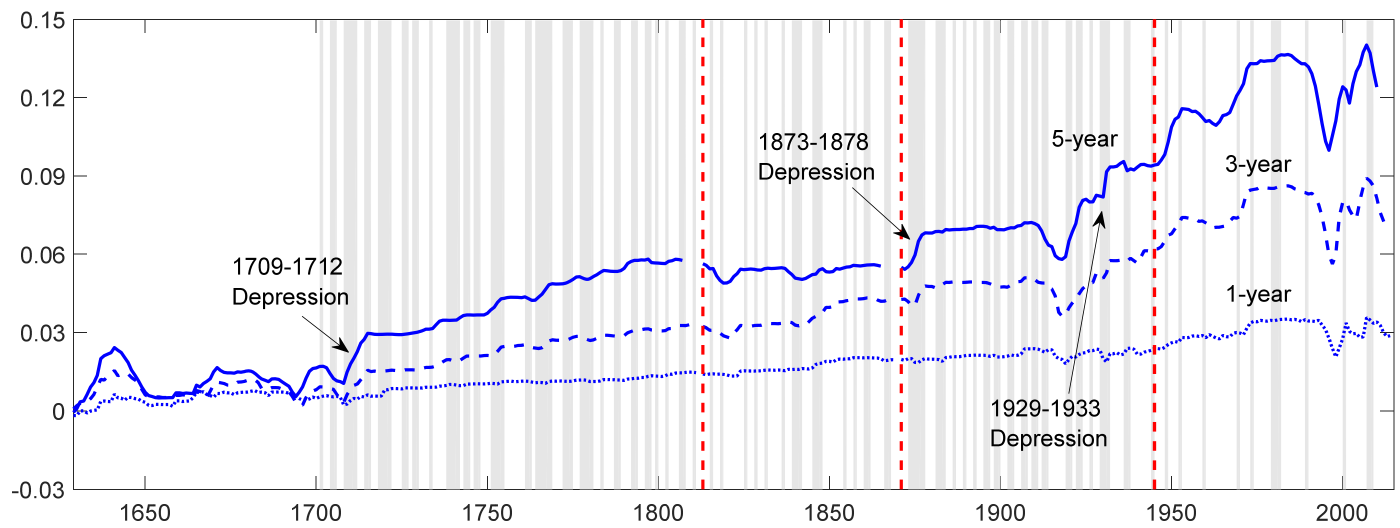
Figure 2: Dividend-to-price ratio, recessions and in-sample predictive regressions

In Panels A and C we plot the dividend-to-price ratio along with the 5-year ahead returns and dividend growth rates. Panels B and D track where the fit of the (full sample) predictive regression improves or declines. We plot the difference in the cumulative sum of squared errors between a model with a constant only and a model with a constant and the dividend-to-price ratio. The difference is normalized by the total sum of squared errors from the constant-only model, so that the last observation corresponds to the in-sample R-square. Apart from 5-year returns, we also present this for 1- and 3-year returns. In particular, each line in Panels B and D plots $\left(SST_1^t - SSE_1^t\right)/SST_1^T$, where $SST_1^t = \sum_{\tau=1}^{t}(y_\tau - \overline{y})^2$, $SSE_1^t = \sum_{\tau=1}^{t}(y_\tau - \hat{y}_\tau)^2$ and $SST_1^T = \sum_{\tau=1}^{T}(y_\tau - \overline{y})^2$, with y_τ the 1-, 3-, or 5-year ahead return (or dividend growth rate), $\hat{y}_\tau$ the return (dividend growth rate) predicted by a constant and dp_τ using coefficients estimated on the full sample, and $\overline{y}$ the full sample mean return (dividend growth rate). Dashed vertical lines denote the time periods: Netherlands and U.K. (1629-1812), U.K. (1813-1870), U.S. early (1871-1945), and U.S. recent (1945-2015). Shaded areas indicate recessions (data for recessions are only available after 1700).

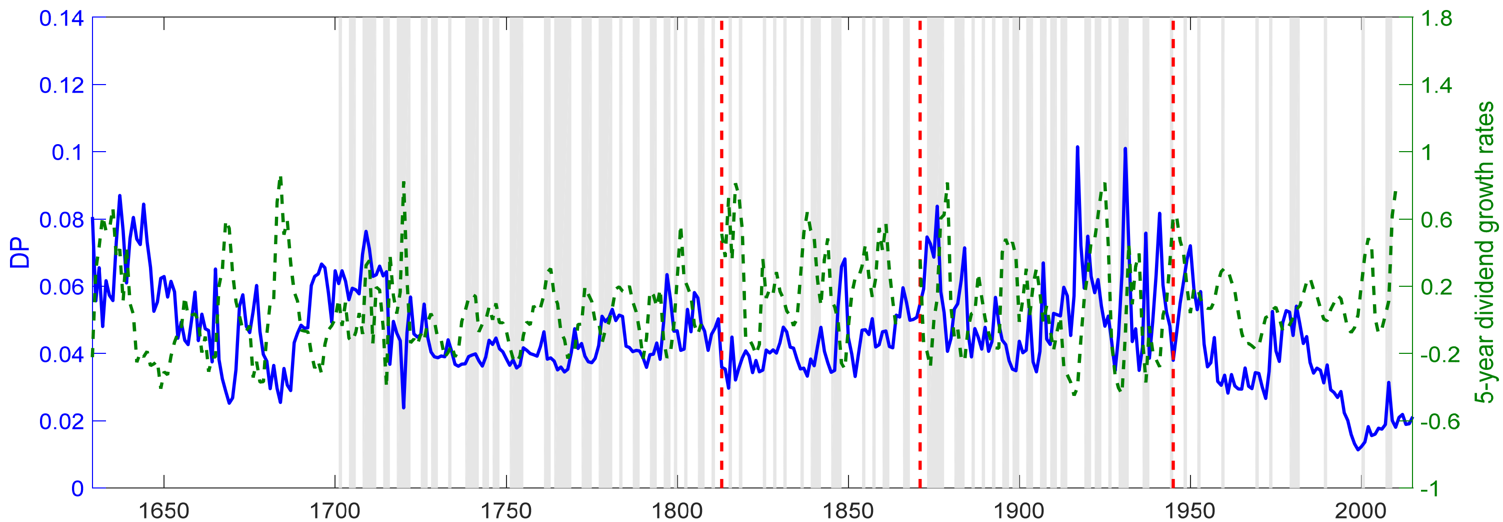
Panel A: Dividend-to-price ratio and 5-year ahead returns



Panel B: $\left(SST_1^t - SSE_1^t\right) / SST_1^T$ for returns



Panel C: Dividend-to-price ratio and 5-year ahead dividend growth rates



Panel D: $\left(SST_1^t - SSE_1^t\right) / SST_1^T$ for dividend growth rates

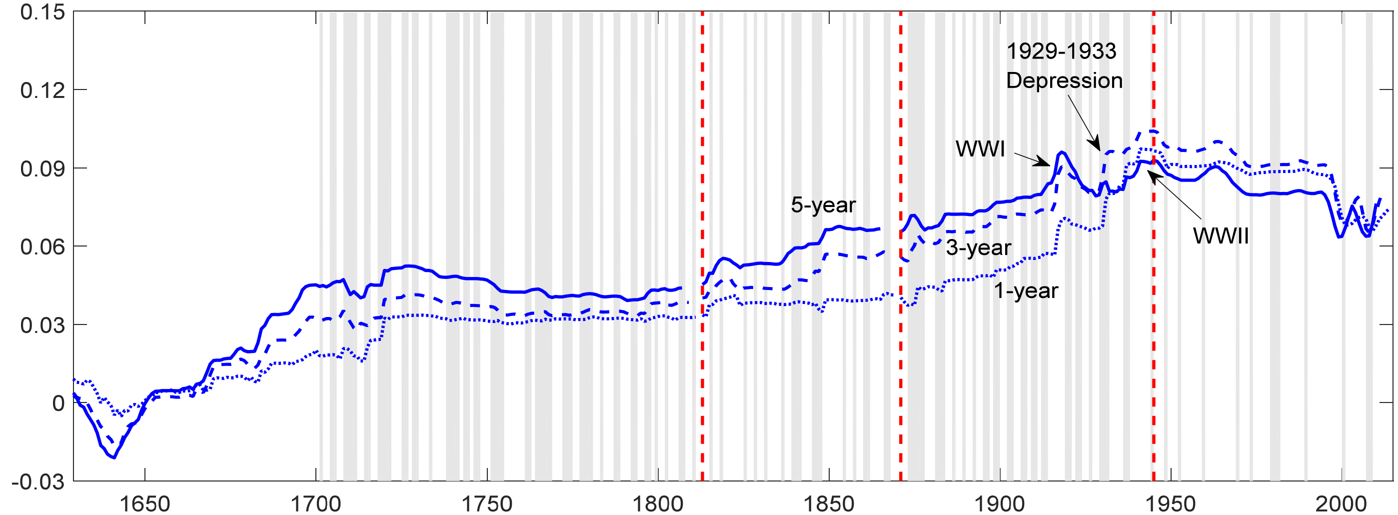


Figure 3: Out-of-sample return predictive regressions

This figure is based on out-of-sample predictive regressions for 1-,3-, and 5-year returns. Out-of-sample predictions are based on an expanding window. The initial training period is 1629-1700 and the first out-of-sample prediction in 1701. Each line plots $\left(SST_1^t - SSE_1^t\right)/SST_1^T$, where $SST_1^t = \sum_{\tau=1}^{t}(y_\tau - \bar{y}_\tau)^2$, $SSE_1^t = \sum_{\tau=1}^{t}(y_\tau - \hat{y}_\tau)^2$ and $SST_1^T = \sum_{\tau=1}^{T}(y_\tau - \bar{y}_\tau)^2$, with y_τ the 1-, 3-, or 5-year ahead return, $\hat{y}_\tau$ the return predicted by a constant and dp_τ using coefficients estimated on the sample up to $\tau - 1$, and $\bar{y}_\tau$ the mean return up to $\tau - 1$. The last observation (T) corresponds to the out-of-sample R-square. Shaded areas denote recessions. Dashed vertical lines denote the time periods: Netherlands and U.K. (1629-1812), U.K. (1813-1870), U.S. early (1871-1945), and U.S. recent (1945-2015).

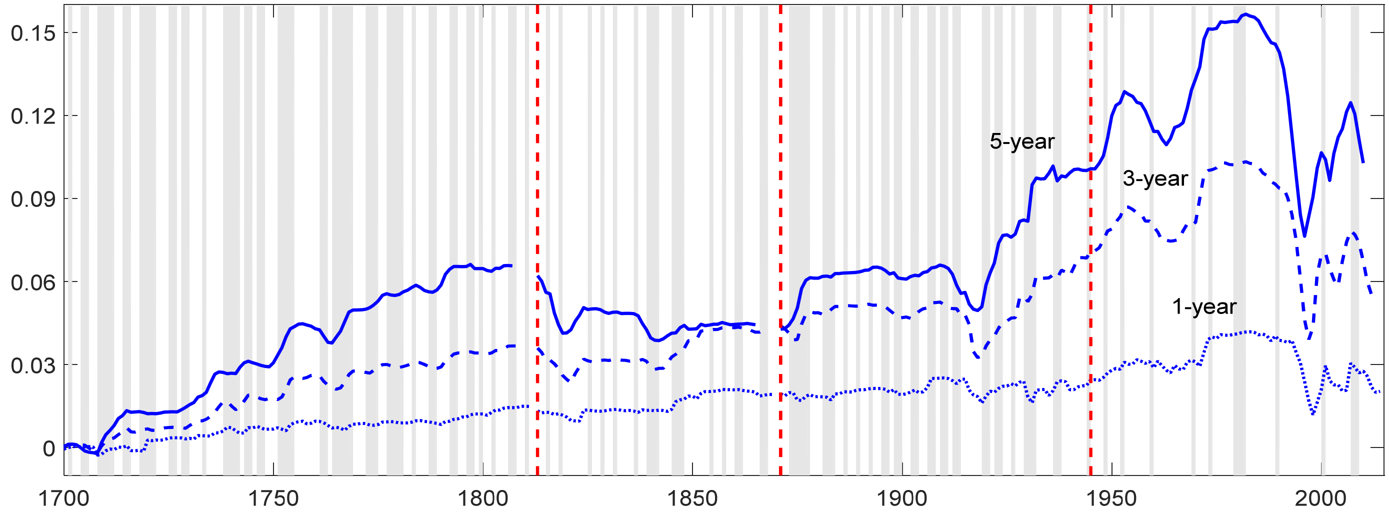
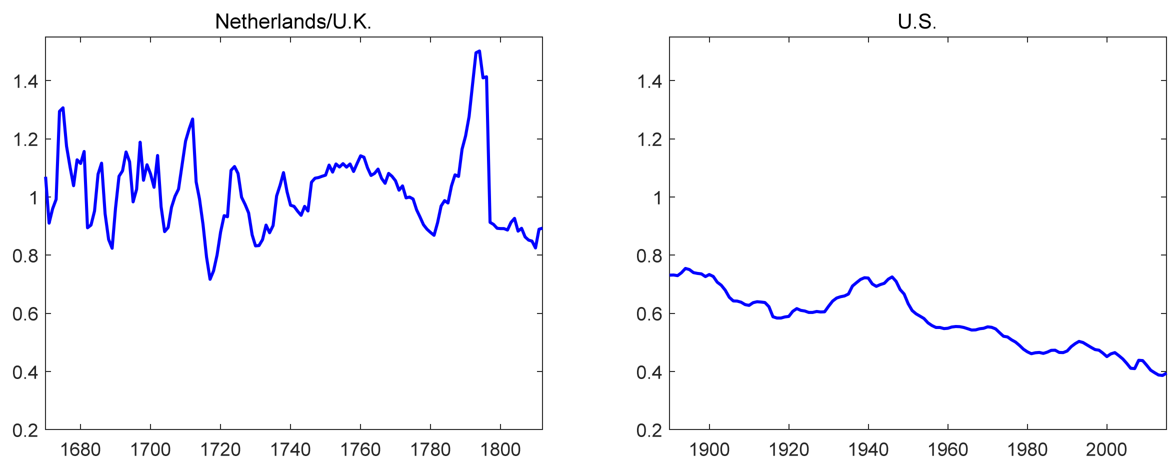


Figure 4: Dividends-to-earnings ratio

This figure plots the ratio of 20-year trailing sum of dividends to 20-year trailing sum of earnings for the Netherlands/U.K. period (1651-1812) and the combined U.S. period (1871-2015). The first observations are in 1670 and 1890, respectively.



Appendix A: Data sources

This Appendix provides details on all the data sources used in the paper. Sections A.1 through A.3 describe the main data for the different periods. Section A.4 provides details on the dating of recessions.

A.1 Amsterdam and London 1629-1812

The data for the period 1629-1812 cover all actively traded securities in Amsterdam and London for which the necessary data are available. Our dataset covers (at most) nine securities, two of which are Dutch, seven English. Table A.1 gives an overview of the securities we use and the years they are in our dataset. Below we discuss the individual securities and the different sources we use to construct the data. Index returns are value-weighted.

A.1.1 Amsterdam

There were two widely traded Dutch stocks in the 17th and 18th centuries: the Dutch East India (VOC) and West Indies (WIC) companies. Shares of both companies were freely tradable, and shareholders enjoyed limited liability. The VOC was the world's first publicly traded corporation. It was founded in 1602, and its capital became permanent in 1613 (Gelderblom, De Jong and Jonker, 2013). The company held the Dutch monopoly on trade with Asia, where it operated an extensive trade network. The Dutch government nationalized the company in 1796. The WIC was founded in 1675 and was involved in slave trade and the administration of colonies in Africa and the Caribbean. The company was nationalized in 1791.

From 1719 onwards, we obtain stock prices from the newspapers of the time. For 1719-1722, we follow Frehen, Goetzmann and Rouwenhorst (2013) and use information from the *Leydse Courant*. Starting in 1723, we rely on Van Dillen (1931) which reports price information from the

Amsterdamsche Courant. Coverage continues until 1791 and 1795 when the WIC and VOC were nationalized.

Before 1719, newspapers did not publish Amsterdam stock prices. For the VOC there are a number of alternative sources that we use to construct continuous end-of-year stock prices back to 1629. We start with Amsterdam notary records that often contain information about share transactions. Van Dillen (1931) and Petram (2011) provide two largely independent sets of share prices extracted from these records. In addition, the Amsterdam City Archives provide an (incomplete) index to the notary records that also contain price observations (City Archives Amsterdam 30452).

From 1629 to 1652 the end-of-year prices from the notary records are complete. Between 1653 and 1719 there are occasional gaps. We fill these gaps by reconstructing transaction prices from the VOC's dividend ledgers and the Bank of Amsterdam's account books. In the 17th and 18th centuries, the title to a share was formalized by an entry in the Company's dividend ledgers. These books keep track of changes in ownership but do not report the associated transaction price. We infer stock prices by comparing share transfers in the dividend books of the VOC chamber in Amsterdam (Dutch National Archives, 1.04.02) with payments in the Bank of Amsterdam (City Archives Amsterdam, 5077). During this time, all important economic agents had the equivalent of a checking account at this institution (Quinn and Roberds, 2014). Most of the Bank's ledgers have survived, and we can reconstruct individuals' bank transfers, including payments for shares.

For the WIC we were not able to reconstruct a continuous annual price before 1719 (at which point it accounted for 1.1% of total market capitalization). There are few notarized transactions, and the WIC's dividend ledgers have not survived.

Dividends are available for the entire period and come from two sources. For the VOC, we rely on Klerk de Reus (1894) which provides information on the exact dates dividends were payable to investors; for the WIC, we use Luzac (1780).

A.1.2 London

We have information available for seven English securities. The first group of securities includes the most important English companies of the time: the Bank of England (BoE), the English East India Company (EIC), and the South Sea Company (SSC). The BoE was founded in 1694 to help finance the English government debt. It held an effective monopoly on the issuance of banknotes and provided short-term credit to merchants and other financial intermediaries. It was an important lender to the EIC as well. The EIC started in 1657 and held the English monopoly on trade with Asia. Around 1700 the trade on Asia was opened up, and in 1708 the government allowed the “old” EIC to merge with its main competitor, the “new” EIC, to restore its monopoly. For the period before 1708 there is only information available for the old EIC. The SSC started in 1711 after receiving a monopoly on the trade with South America. These activities never materialized, and the Company was mainly a vehicle to finance the English government debt. It performed a number of debt-for-equity swaps; the final one resulted in the South Sea Bubble in 1720. In that year the company accounted for 61% of total market capitalization. After the bubble burst, the company was largely liquidated; in 1733, it constituted only 6% of our index. Remaining shares were largely backed by government debt.

The second group of stocks includes the London Assurance Company (LA), the Million Bank (MB), the Royal African Company (RAC), and the Royal Exchange Assurance Company (REA). These companies were substantially smaller, and their coverage is mostly limited to the first few decades of the 18th century. Both LA and the REA were set up as insurance companies in the run-up to the South Sea Bubble. They mainly dealt in marine insurance, but also set up ventures in fire and life insurance. Similar to the SSC, the MB was a vehicle to help fund the government debt. Finally, the RAC was set up as an English equivalent to the WIC and was mainly active in the slave trade between Africa and the Caribbean (Scott, 1912).

Data coverage for the first group of securities is relatively complete. Starting in 1698, Neal (1990) provides detailed price data collected from the *Course of the Exchange*. For earlier years, we rely on Thorold Rogers (1902) and Scott (1912) who report prices from a series of English newspapers. For the BoE and SSC, available stock prices go back to their inception; 1696 and 1711, respectively. For the EIC, prices are only available from 1692 onwards. Between 1657 and 1692 price observations are too infrequent to construct an annual series (Scott 1912, II, p. 178-9). We take prices for the old EIC until its merger with the new EIC in 1708, using prices for the newly formed United EIC thereafter. For all three companies, stock prices are available up to 1812. Information on dividends and stocks outstanding was kindly provided by Gary Shea (*in preparation*).

Data coverage is more limited for the second group of companies. In general, prices go back to the initial issuance of each security, but coverage ends in 1734 when the *Course of Exchange* stops reporting their prices (Neal 1990). Early prices come from Scott (1912); information after 1698 is from Neal (1990), where necessary supplemented with information from Frehen, Goetzmann and Rouwenhorst (2013). We collected information on dividends and stocks outstanding from a host of sources. Table A.1 gives and overview. This information is complete for all companies, with the exception of the REA, for which dividend information is only available for 1718-1720 as the company’s financial records were almost entirely destroyed in a fire in 1838

(Supple, 1970). For all four securities we have full data coverage in 1720, the year of the South Sea Bubble when these securities appreciated substantially in value.

The English companies have a complicated history of capital calls, rights issues, repurchases, stock dividends and share splits ("capital events"). We use the sources listed in Table A.1 to adjust stock prices where necessary. In particular, we define dividends as regular dividends only. This approach closely follows Acheson et al. (2009), Cowles (1939) and S&P (the sources that we use for the 19th and early 20th century). To ensure that total returns capture actual outcomes to investors, price appreciation is adjusted for other payments such as rights issues, repurchases at non-market values and capital calls. For example, if a company is trading at 100 and has a rights issue at a price of 98 at a one-to-one basis, we add two percentage points to the capital appreciation in that year.

Table A.1 Overview of securities, 1629-1812

Security	Home market	Years with available data	Sources: Prices	Sources: Dividends and shares outstanding
Dutch East India Co. (VOC)	Amsterdam	1629 – 1794	Van Dillen (1931), Petram (2011), *Leydse Courant*, City Archives Amsterdam (5077, 30452) and Dutch National Archives (1.04.02)	Klerk de Reus (1894)
Dutch West Indies Co. (WIC)	Amsterdam	1719 – 1791	Van Dillen (1931), *Leydse Courant*	Luzac (1780)
Bank of England (BoE)	London	1696 – 1813	Rogers (1902), Neal (1990)	Shea (*in preparation*)
English East India Co. (EIC)	London	1692 – 1813	Rogers (1902), Neal (1990)	Shea (*in preparation*)
London Assurance Co. (LA)	London	1719 – 1734	Neal (1990), Frehen et al (2013)	Scott (1912), Guildhall Library

				(0074 CLC/B/192-26)[6]
Million Bank (MB)	London	1700 – 1734	Neal (1990), Frehen et al (2013)	Scott (1912)
Royal African Co. (RAC)	London	1691 – 1734	Scott (1912), Neal (1990)	Scott (1912), Anonymous (1749), House of Commons (1803)
Royal Exchange Assurance Co. (REA)	London	1718 – 1721	Neal (1990), Frehen et al (2013)	Scott (1912), Supple (1970)
South Sea Company (SSC)	London	1711 – 1813	Neal (1990)	Shea (*in preparation*)

A.1.3 Exchange rates

For most of the period, the English securities were also traded in the Amsterdam market (but not the other way around). We take the perspective of a Dutch investor and convert all price and dividend data into Dutch guilders. Exchange rate information comes from Posthumus (1946), where necessary supplemented with information from Frehen, Goetzmann and Rouwenhorst (2013).

A.1.4 Risk-free rate

Our estimates of the risk rate are based on returns on Dutch and English government bonds that are available from 1650 onwards. Between 1650 and 1720 we use returns on Dutch (redeemable) annuities. This was the most liquid form of Dutch government debt of the time. Data come from Gelderblom and Jonker (2010). There is a gap in our data between 1720 and 1727. Starting in 1727 we use returns on the English 3% Annuities reported in Neal (1990).

[6] We thank Rik Frehen for sharing his scans of the London Assurance dividend books with us.

A.1.5 Earnings

We are able to (partially) reconstruct earnings for the VOC, EIC and BoE. Data for the VOC are available in De Korte (1984) and start in 1651. Information for the EIC comes from Chaudhuri (1978) for 1710 – 1745 and Bowen (2006) for 1757 – 1812. For the BoE, we obtain data from Clapham (1945) for 1721 – 1797 and *Report on the Bank Charter* (1832) for 1798 – 1812.

A.2 England 1813-1870

A.2.1 Stock market data

Starting in 1825, we use the value-weighted return and dividend series from Acheson, Hickson, Turner, and Ye (2009), hereafter AHTY. Their data are based on all frequently traded domestic equities in London. Returns and dividends are constructed in the standard way with two exceptions. First, they omit all securities that were traded for less than 12 months. There were many new issuances in this period, and investors were allowed to spread IPO payments over an extended period of time. This gave investors the option to withdraw if they thought the company would not survive. Many firms failed to raise the required capital, and the 12 month cut-off is meant to exclude such cases. Second, there were many capital calls, rights issues, and other capital events. It is often unclear what the impact of these events was on investors' returns. AHTY therefore omit individual security returns for the months in which these events took place. AHTY and Hickson, Turner and Ye (2011) have more details.

AHTY try to correct their stock market index for survivorship bias arising from delistings. They propose a number of alternatives. We use the index constructed using "definition 2 (upper bound)." This series adjusts for survivorship bias in a simple way that we can easily replicate when we extend the data back to 1813. In particular, AHTY set returns on securities that disappear to -

100%, but only if they were listed for at least 36 months. The underlying assumption is that such securities "were never fully established in the market." "Upper bound" means that delisted securities disappear from the sample afterwards, as opposed to the "lower bound" strategy where delisted securities are retained in the index, setting subsequent returns to 0. In untabulated results we find that using alternative series from AHTY that adjust for survivorship bias in slightly different ways affects the level of the risk premium, but does not materially impact the predictability results.

We extend AHTY's series back to 1813 using the same source material and methodology. In particular, for each individual security, we construct monthly price and dividend payments using information from Wetenhall's *Course of the Exchange* (available on microfilm at the University of Illinois, Urbana-Champaign) using the last available observation within each month. We then follow the same approach as AHTY to construct annual returns and dividends.

A.2.2 Risk free rate

For the risk free rate between 1813 and 1870, we use returns on 3% Consols from Homer and Sylla (2005, Table 19). This was the most liquid form of government debt at the time (Grossman 2002, AHTY).

A.3 U.S. 1871-2015

To facilitate comparison with the existing literature, we rely on the U.S. stock market data starting in 1871, using data from Amit Goyal's website. For the period between 1871 and 1925, these data come from Cowles (1939), covering between 50 (1871) and 258 (1925) securities. For 1926-2015, the data are based on the S&P 500 index provided by CRSP. Before 1957, this was actually the S&P 90. Both Cowles (1939) and S&P only report ordinary dividends. Prices are adjusted for non-regular payouts to investors. We also obtain aggregate earnings data from Amit Goyal's webpage.

A.3.2 Risk free rate

Rates on U.S. Treasury bills are only available from 1920 onwards; for 1920-1945, we use Homer and Sylla (2005, Table 49); for the 1945-2015 period, we rely on the dataset on Amit Goyal's website. Before 1920, there are two interest rates that we use to estimate the risk free rate: the rate on so-called call loans and yields on long term government debt. Call loans were the most important short term debt instruments of the time. They were collateralized with liquid securities and could be called in by the lender at any point in time. For the period between 1920 and 1945, the different interest rate series overlap, and we predict the T-bill rate with the call loan rate and the government bond yield. We use the resulting coefficient estimates to construct a hypothetical T-bill rate for 1871-1919. Call loan rates and yields on government securities come from Homer and Sylla (2005), tables 44, and 49, and 42, 43, 46 and 48, respectively.

A.4 Recession dates

As is standard, we classify a recession as the period between a peak and a trough in the economic cycle. We collect peak and trough dates from the secondary literature. All sources use the NBER definition that identifies a peak or trough when a large number of macro-economic variables have a turning point in their time series (Diebold and Rudebusch, 1996). This approach goes back to the seminal work of Burns and Mitchell (1946) who describe this approach as follows:

> "A [business] cycle consists of expansions **occurring at about the same time in many economic activities**, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle." (Burns and Mitchell 1946, p.3)

Which specific macro-variables to look at is at the discretion of the NBER's committee members and can vary over time. In the committee's own words, "the committee does not have a fixed definition of economic activity."[7]

For the period 1870-2015, we rely on information from the NBER website that lists the months the U.S. economy was at a peak or trough.[8] Before 1945, the data come from Burns and Mitchell (1946); from 1946 onwards, the data come directly from the NBER. We classify a year as a recession if at least six months in that year feature a contraction.

For the period before 1870, we rely on recessions in the U.K. A number of publications reconstruct British peak and trough dates using the same methodology as Burns and Mitchell. For 1700-1802 we rely on the work of Ashton (1959), and for 1803-1870 we use the dates from Rostow (1972), who incorporates the earlier work by Gayer, Rostow and Schwartz (1953) for 1803-1850. These dates are considered the best available estimates in the literature (Broadberry and Van Leeuwen, 2010). The identification of peaks and troughs is primarily based on cyclical fluctuations in exports, investment (particularly in buildings and ships) and textile production. All three contributions use qualitative evidence from contemporary sources to help identify the exact timing of the economy's turning points (Gayer, Rostow and Schwartz, 1953, p. 342-53 and 532; Ashton 1959, p.138-40). The early data are annual. We let recessions start in the year following a peak and end in the year of a trough. For the period before 1700, we are not aware of any data on peak and trough dates.

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[7] http://www.nber.org/cycles/recessions.html, retrieved August 1, 2016

[8] http://www.nber.org/cycles/cyclesmain.html, retrieved August 1, 2016

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Four centuries of return predictability

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Online Appendix

This Online Appendix reports supporting evidence for the results reported in the main paper. We first report the sensitivity analysis of our main results based on annual real data from Table 2. Table OA.1 uses nominal data. In Table OA.2, we extend the U.K. period until 1900, and we use the broad-based CRSP index rather than the S&P 500 from 1925 onward. In Table OA.3, we add lagged returns and dividend growth rates as additional predictors. In Table OA.4, we smooth the dividend-to-price ratio by taking a trailing two-year rolling average. In Table OA.5, we report the sensitivity of longer horizon predictability results from Table 6. Instead of predicting simple sum of future returns and dividend growth rates, we weigh them by "rho." Finally, in Figure OA.1, we plot annual real dividends along with the smoothed dividends for the Netherlands/U.K. period.

Nominal data (Table OA.1)

Our main analysis is based on real data. Here, we repeat the analysis using nominal prices and dividends. As reported in Table OA.1, results are qualitatively similar. The only important difference is that returns are less predictable, and the dividend growth is more predictable in the U.K period. The full sample results remain qualitatively the same.

Extended U.K. period and CRSP index (Table OA.2)

In the main text, we switch from U.K. to U.S. data in 1871 (for better comparability with recent studies). One can argue that it was not until the beginning of the 20th century that that the U.S. became the world's largest economy. Also, the Cowles (1939) data, which we use between 1871 and 1925, includes only 50 companies in 1871 (258 in 1925). Many more companies were traded in the U.K. at the end of the 19th century. Moreover, after 1925 we use the S&P 500 in the main analysis, which was effectively the S&P 90 till March 1957. Again, one may wonder if results change by using an index with a broader coverage.

Here, we present results where we switch from the U.K. to the U.S. market in 1900. The U.K. data for the period 1870-1900 come from Grossman (2002). These data include 520 companies in 1870 and around 1,000 companies in 1900. We also use the CRSP value-weighted index from 1925 onward rather than the S&P 500. The CRSP index includes 533 companies in January 1926 (rather than 90) and 7,178 in December 2015 (rather than 500). As before, end-of-year dividends are simple sums of within-year dividends.

Results are reported in Table OA.2 and are qualitatively similar to the baseline results reported in Table 2. There is some more evidence for dividend growth predictability in the extended U.K. period as the estimated parameter is now significant. Results for the U.S. period, however, are unchanged. The same is true for the full sample results.

Lagged returns and dividend growth rates as additional predictors (Table OA.3)

In the main analysis, we predict returns and dividend growth rates using the lagged dividend-to-price ratio only. Here, we add lagged returns and lagged dividend growth rates as additional predictors. Lagged variables occasionally strengthen the overall evidence for return or dividend growth predictability (for example, in the recent period dividend growth is persistent and predicts itself), but they do not importantly affect the coefficients on the dividend-to-price ratio. If anything, return predictability from dividend yields becomes somewhat stronger, especially in the early U.S. period 1871-1945, although the coefficient remains insignificant.

Two-year trailing average of dividend-to-price ratio (Table OA.4)

To address the concern that our results are influenced by measurement error, we redo Table 2 using a smoothed version of dividend-to-price ratio. That is, we predict returns and dividend growth rates by the lagged two-year trailing average of dividend-to-price ratio. Under this specification, the evidence for dividend growth predictability in the earliest period (1629-1812) becomes weaker. Using the raw data, the predictive coefficient on the dividend-to-price ratio goes down from -2.25 to -1.32 and becomes insignificant (*t*-statistic of -1.57). In log terms, it falls from -0.12 to -0.08 and remains significant (*t*-statistic of -1.91). The evidence for the predictability of returns is largely unchanged. The only exception is the early U.S. period (1871-1945), where the evidence for dividend yields predicting returns becomes stronger and significant. Thus, using the smoothed dividend-to-price ratio, annual returns are predictable in all the subperiods and in the full period. Dividend growth remains predictable in the full sample.

Long-horizon predictability: Weighted returns and dividend growth rates (Table OA.5)

In Table 4, we consider predicting 1-, 3-, and 5- year returns and dividend growth rates. That is, we predict simple sum of log returns over subsequent years. Now, we consider weighting future returns and dividend growth rates by the linearization constant ρ. This is motivated by the present value model linking the dividend-to-price ratio to the discounted sum of future returns and dividend growth rates (Eq. 8 in the main paper). Results are reported in Table OA. 5. Weighting only has a marginal effect on our estimates, and all the main results are qualitatively similar to Table 4.

Table OA.1: Nominal data

This table reports OLS estimates of regressing annual nominal returns and dividend growth rates on the lagged dividend-to-price ratio. Lower case letters are logs of corresponding capital letters. All regressions include a constant (not reported). Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with one lag.

	(1)	(2)	(3)	(4)	(5)	(6)
	Neth./U.K. 1629-1812	U.K. 1813-1870	U.S. 1871-1945	U.S. 1945-2015	Full period 1700-2015	Full period 1629-2015
Dependent variable: RET_{t+1}						
DP_t	3.11	2.42	1.11	3.86	1.60	1.70
t-stat.	(4.23)	(1.56)	(0.75)	(2.93)	(2.16)	(2.70)
R2	0.11	0.05	0.01	0.10	0.02	0.03
Dependent variable: DG_{t+1}						
DP_t	-1.89	-5.62	-7.45	0.49	-3.21	-2.93
t-stat.	(-1.90)	(-2.76)	(-7.09)	(0.55)	(-5.26)	(-5.27)
R2	0.04	0.15	0.49	0.01	0.14	0.12
Dependent variable: ret_{t+1}						
dp_t	0.14	0.13	0.06	0.11	0.06	0.06
t-stat.	(4.16)	(1.89)	(0.67)	(2.59)	(1.86)	(2.22)
R2	0.10	0.07	0.01	0.10	0.02	0.02
Dependent variable: dg_{t+1}						
dp_t	-0.11	-0.25	-0.45	0.01	-0.12	-0.12
t-stat.	(-2.32)	(-2.46)	(-6.83)	(0.43)	(-4.05)	(-4.55)
R2	0.05	0.15	0.51	0.00	0.11	0.10

Table OA.2: Extended U.K. period and CRSP index

This table reports OLS estimates of regressing annual real returns and dividend growth rates on the lagged dividend-to-price ratio. Lower case letters are logs of corresponding capital letters. All regressions include a constant (not reported). Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with one lag.

	(1)	(2)	(3)	(4)	(5)	(6)
	Neth./U.K. 1629-1812	U.K. 1813-1900	U.S. 1900-1945	U.S. 1945-2015	Full period 1700-2015	Full period 1629-2015
Dependent variable: RET_{t+1}						
DP_t	2.72	3.50	1.86	3.47	2.04	1.94
t-stat.	(3.13)	(2.72)	(0.98)	(2.36)	(2.61)	(3.10)
R2	0.06	0.08	0.02	0.07	0.03	0.03
Dependent variable: DG_{t+1}						
DP_t	-2.25	-5.60	-8.00	-0.25	-3.17	-2.84
t-stat.	(-2.36)	(-2.32)	(-7.70)	(-0.30)	(-4.64)	(-4.88)
R2	0.05	0.08	0.61	0.00	0.09	0.09
Dependent variable: ret_{t+1}						
dp_t	0.12	0.14	0.11	0.10	0.07	0.07
t-stat.	(2.97)	(2.84)	(1.03)	(2.09)	(2.36)	(2.72)
R2	0.06	0.07	0.02	0.06	0.03	0.03
Dependent variable: dg_{t+1}						
dp_t	-0.12	-0.24	-0.48	-0.01	-0.11	-0.11
t-stat.	(-2.73)	(-2.47)	(-7.44)	(-0.45)	(-3.67)	(-4.29)
R2	0.06	0.09	0.64	0.00	0.07	0.08

Table OA.3: Lagged returns and dividend growth rates as additional predictors

This table reports OLS estimates of regressing annual real returns and dividend growth rates on the lagged dividend-to-price ratio, lagged returns, and lagged dividend growth rates. Lower case letters are logs of corresponding capital letters. All regressions include a constant (not reported). Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with one lag.

	(1)	(2)	(3)	(4)	(5)	(6)
	Neth./U.K. 1629-1812	U.K. 1813-1870	U.S. 1871-1945	U.S. 1945-2015	Full period 1700-2015	Full period 1629-2015
Dependent variable: RET_{t+1}						
DP_t	3.04	4.12	2.28	3.18	2.35	2.18
t-stat.	(3.47)	(1.97)	(1.47)	(2.35)	(3.22)	(3.55)
RET_t	-0.07	0.12	0.13	0.03	0.09	0.03
t-stat.	(-0.94)	(1.29)	(0.80)	(0.31)	(1.38)	(0.55)
DG_t	-0.06	0.15	-0.29	0.20	-0.04	-0.05
t-stat.	(-0.70)	(1.67)	(-1.86)	(0.94)	(-0.48)	(-0.81)
R2	0.09	0.14	0.08	0.08	0.04	0.04
Dependent variable: DG_{t+1}						
DP_t	-1.67	-4.02	-5.64	-0.12	-2.22	-2.13
t-stat.	(-1.89)	(-1.51)	(-4.15)	(-0.15)	(-3.97)	(-4.33)
RET_t	0.10	-0.09	0.17	0.09	0.18	0.15
t-stat.	(1.24)	(-0.50)	(1.51)	(1.51)	(3.24)	(3.06)
DG_t	-0.09	0.03	0.01	0.39	-0.01	-0.02
t-stat.	(-0.89)	(0.15)	(0.08)	(2.81)	(-0.16)	(-0.34)
R2	0.05	0.05	0.48	0.24	0.13	0.11
Dependent variable: ret_{t+1}						
dp_t	0.13	0.22	0.13	0.10	0.09	0.08
t-stat.	(3.23)	(2.28)	(1.47)	(2.30)	(2.81)	(3.02)
ret_t	-0.07	0.12	0.13	0.04	0.07	0.02
t-stat.	(-0.88)	(1.30)	(0.77)	(0.41)	(1.16)	(0.43)
dg_t	-0.06	0.11	-0.29	0.21	-0.05	-0.06
t-stat.	(-0.76)	(1.34)	(-1.86)	(0.95)	(-0.58)	(-0.89)
R2	0.08	0.15	0.08	0.08	0.04	0.03
Dependent variable: dg_{t+1}						
dp_t	-0.09	-0.18	-0.30	-0.00	-0.07	-0.08
t-stat.	(-2.16)	(-1.43)	(-3.88)	(-0.21)	(-3.13)	(-3.71)
ret_t	0.10	-0.11	0.24	0.12	0.23	0.18
t-stat.	(1.21)	(-0.64)	(2.36)	(1.63)	(3.87)	(3.56)
dg_t	-0.11	0.06	0.03	0.34	-0.02	-0.04
t-stat.	(-1.16)	(0.31)	(0.39)	(2.45)	(-0.35)	(-0.64)
R2	0.06	0.05	0.53	0.25	0.14	0.11

Table OA.4: Two-year trailing average of dividend-to-price ratio

This table reports OLS estimates of regressing annual real returns and dividend growth rates on the lagged two-year trailing average of dividend-to-price ratio. Lower case letters are logs of corresponding capital letters. All regressions include a constant (not reported). Below the estimated coefficients (in parentheses) are Newey-West (1987) *t*-statistics with one lag.

	(1)	(2)	(3)	(4)	(5)	(6)
	Neth./U.K. 1629-1812	U.K. 1813-1870	U.S. 1871-1945	U.S. 1945-2015	Full period 1700-2015	Full period 1629-2015
Dependent variable: RET_{t+1}						
$(DP_t + DP_{t-1})/2$	2.96	4.69	3.28	3.16	2.45	2.30
t-stat.	(3.63)	(2.16)	(1.92)	(2.28)	(3.18)	(3.64)
R2	0.07	0.08	0.05	0.07	0.04	0.04
Dependent variable: DG_{t+1}						
$(DP_t + DP_{t-1})/2$	-1.32	-4.63	-6.49	0.03	-2.17	-2.00
t-stat.	(-1.57)	(-1.85)	(-6.06)	(0.03)	(-3.50)	(-3.87)
R2	0.02	0.06	0.29	0.00	0.05	0.05
Dependent variable: ret_{t+1}						
$(dp_t + dp_{t-1})/2$	0.13	0.23	0.19	0.10	0.09	0.08
t-stat.	(3.35)	(2.29)	(2.10)	(2.21)	(2.76)	(3.11)
R2	0.06	0.09	0.05	0.07	0.04	0.03
Dependent variable: dg_{t+1}						
$(dp_t + dp_{t-1})/2$	-0.08	-0.19	-0.37	0.00	-0.08	-0.08
t-stat.	(-1.91)	(-1.51)	(-5.55)	(-0.10)	(-2.90)	(-3.42)
R2	0.02	0.05	0.29	0.00	0.04	0.04

Table OA.5: Long-horizon predictability: Weighted returns and dividend growth rates

This table reports OLS estimates of regressing the weighted sum of annual real returns $\left(\sum_{j=1}^{h} \rho^{j-1} ret_{t+j}\right)$ or dividend growth rates $\left(\sum_{j=1}^{h} \rho^{j-1} dg_{t+j}\right)$ on the dividend-to-price ratio. All variables are in logs. Horizon h is either 1, 3, or 5 years. Below the estimated coefficients (in parentheses) are Newey-West (1987) t-statistics with the number of lags equal to the length of the horizon. In brackets are t-statistics based on non-overlapping observations, calculated as the mean across alternative non-overlapping samples (e.g. in case of 5-year predictions, we report the mean across five different non-overlapping samples starting in years 1 through 5). The p-values '(Sim., Direct)' are based on Monte Carlo simulations. The 'implied coefficient' for longer horizon predictions is based on the 1-year coefficient and calculated using $\beta_{x,h} = \beta_x \left(1 - \rho^h \beta_{dp,1}^h\right) / (1 - \rho\beta_{dp,1})$. All regressions include a constant (not reported).

	(1)	(2)	(3)	(4)
	1629-1945	1945-2015	1700-2015	1629-2015
Dependent variable: 1-year ret				
dp_t	0.11	0.09	0.08	0.07
t-stat.	(3.22)	(2.03)	(2.47)	(2.81)
p-value (Sim., Direct)	0.00	0.24	0.01	0.00
R2	0.04	0.06	0.03	0.03
Dependent variable: 3-year ret				
dp_t	0.28	0.24	0.20	0.19
t-stat. (Overlap.)	4.45	2.85	3.13	3.43
t-stat. (Non-overlap.)	3.48	2.82	2.82	3.03
p-value (Sim., Direct)	0.00	0.25	0.01	0.00
Implied coefficient	0.23	0.25	0.19	0.19
p-value (Sim., Direct)	0.00	0.20	0.01	0.00
R2	0.10	0.15	0.08	0.07
Dependent variable: 5-year ret				
dp_t	0.41	0.42	0.32	0.30
t-stat. (Overlap.)	4.57	5.24	4.04	4.32
t-stat. (Non-overlap.)	3.50	3.67	3.00	3.18
p-value (Sim., Direct)	0.00	0.20	0.00	0.00
Implied coefficient	0.29	0.37	0.27	0.26
p-value (Sim., Direct)	0.00	0.16	0.00	0.00
R2	0.15	0.28	0.14	0.13
Dependent variable: 1-year dg				
dp_t	-0.20	-0.01	-0.10	-0.10
t-stat.	(-5.30)	(-0.40)	(-3.45)	(-4.09)
p-value (Sim., Direct)	0.00	0.40	0.00	0.00
R2	0.14	0.00	0.07	0.07
Dependent variable: 3-year dg				
dp_t	-0.32	0.01	-0.15	-0.17
t-stat. (Overlap.)	-4.88	0.09	-2.61	-3.31
t-stat. (Non-overlap.)	-3.83	0.10	-2.21	-2.76
p-value (Sim., Direct)	0.00	0.61	0.01	0.00
Implied coefficient	-0.43	-0.03	-0.24	-0.25
p-value (Sim., Direct)	0.00	0.39	0.00	0.00
R2	0.15	0.00	0.06	0.08
Dependent variable: 5-year dg				
dp_t	-0.34	0.00	-0.15	-0.19
t-stat. (Overlap.)	-3.77	-0.01	-2.54	-3.17
t-stat. (Non-overlap.)	-2.73	-0.02	-1.68	-2.27
p-value (Sim., Direct)	0.00	0.58	0.07	0.02
Implied coefficient	-0.53	-0.04	-0.34	-0.35
p-value (Sim., Direct)	0.00	0.38	0.00	0.00
R2	0.13	0.00	0.05	0.08

Figure OA.1: Actual and smoothed dividends: Netherlands/U.K. (1629-1812)

This figure plots annual real dividends along with the smoothed dividends for the Netherlands/U.K. period. Smoothed dividends are based on a 10-year moving average of real annual dividends until 1700 and annual real dividends thereafter.