

Online Appendix for Battilossi S., Houpt S.O., Artola Blanco M.
“The Historical and Expected Equity Risk Premium in Spain: A
Long-Run View, 1900-2020”, published in *Cliometrica*
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Section A.1 Data and sources for the existing long-run series

We list below the data and relative sources used by [Dimson et al \(2016\)](#) [[DMS](#)], [Jordà et al \(2019\)](#); Appendix: A44 and A97) [[JST](#)], and the Macroeconomic History Database (Release 6, July 2022) [[MDv6](#)] to build their long-run series for Spain.

Equities

[DMS](#). 1900-1936: unpublished equity index (Valbuena 2000) sourced from Bolsa de Madrid. 1941-1985: IGBM from [Gonzalez and Suarez \(2004\)](#). 1986-2020: IBEX35 from Bolsa de Madrid (later BME-Bolsa y Mercados Españoles)
[JST](#). 1900-1936: data from the MSE bulletins (until 1926 based on [Moore 2010](#)). 1941-1985: IGBM and Historical IGBM total return index from [Tafunell \(2005\)](#). 1986-2020: IBEX35 from [Fernandez et al \(2007\)](#) and European Federation of Exchanges.

Bonds (long-term rate)

[DMS](#). 1900-1913: price of 4% perpetual bonds traded in London. 1914-1926: price of 4% perpetual bonds traded in Madrid. 1926-1957 and 1979-1987: estimates of bond prices retrieved from Global Financial Data. 1958-1978: a private bond index. 1988-2020: JP Morgan index of Spanish government bonds with 10-year maturity (after 1988).

[JST](#). 1900-1936: price information from the MSE bulletins (until 1926, based on [Moore 2010](#)). 1940-1972: price information from *Anuario Estadístico de España*. 1973-1987: price information from newspaper *La Vanguardia* (bonds traded in the Barcelona Stock Exchange). 1988-2020: total return on medium- and long-term government bonds reported by *Boletín Estadístico del Banco de España*.

[MDv6](#). 1880 – 1913: long-run interest rate from [Accominotti et al \(2011\)](#). 1914-1936: perpetual bonds (*deuda perpetua interior 4%*) from [Carreras and Tafunell \(2005\)](#), vol.1, Table 10.35, and Instituto Nacional de Estadística (INE). *Anuarios Estadísticos* (various issues). 1940-1971: perpetual bonds (*deuda perpetua interior 4%*) from *Instituto Nacional de Estadística* (INE), *Anuarios Estadísticos* (various issues). 1972-1978: average end of year yield of Spanish bonds, from Spanish newspaper ABC (<http://hemeroteca.abc.es/nav/Navigate.exe/hemeroteca>). 1979-2020: government bonds, percent per annum, from IMF, International Financial Statistics (IFS). Data reports “Economic indicators (IFS)”, Section “Interest rates” (<https://data.imf.org/>).

Bills (short-term rate)

DMS. 1900-1973: central bank rate. 1974-2020: Treasury bill rate. Sources are not specified.

IST. 1870-1921 and 1975-2020: money market rate. 1922-74: bank deposit rate. Sources are not specified.

MDv6. 1900-1914: open market rate (end of year) from [Neal and Weidenmier \(2003\)](#) (<http://ebutts05.tripod.com/nealweidenmiergsd/>). 1915-1919: Bank of Spain discount rate from Bank of Spain archive and MSE bulletins (annual average of monthly values). 1920-1923: discount rate (descuento comercial) from [Carreras and Tafunell \(2005\)](#), vol. 1, Table 9.17. 1924-1941: Bank of Spain's discount rate from League of Nations, International Statistical Yearbook (various issues). 1942-1974: Bank of Spain's discount rate (redescuento básico) from [Carreras and Tafunell \(2005\)](#), vol. 1, Table 9.17. 1975-2020: money market rate from IMF-International Financial Statistics database (IFS). Section "Economic indicators", Series "Interest Rates – money market rate" (<https://data.imf.org/>).

Inflation

DMS. 1900-1940: wholesale price index from [Mitchell \(2007\)](#). 1941-1985: consumer price index from [Sebastián Gonzalez and Suarez Barragato \(1992\)](#). 1986-2020: consumer price index from Instituto Nacional de Estadística (INE)

IST. No details.

MDv6. 1880-1996: consumer price index from [Taylor \(2002\)](#). 1997-2020: consumer price index from IMF

Section A.2 The IGBM (Índice General de la Bolsa de Madrid)

The general index of the Madrid Stock Exchange (IGBM, per the Spanish acronym) has been so far the most cited indicator of the performance of the Spanish stock market. The complete monthly series for the period 1941-1991 was published in [Bolsa de Madrid \(1992\)](#). An annual summary is also included in the Spanish Historical Statistics ([Tafunell 2005](#)). The IGBM has been used by Spanish scholars to study comparative returns of equities, bonds and government securities ([Sebastián González and Suárez Barragato 1992](#)), as well as stock market cycles and volatility ([Gómez Biscarri and Pérez de Gracia 2004](#)). It also has been used as a benchmark for Spanish data in cross-country studies of long-run asset returns and market capitalization ([Dimson et al 2016](#); [Jordà et al. 2019](#); [Kuvshinov and Zimmermann 2022](#)). However, the underlying characteristics of the IGBM index are typically overlooked. The most important fact to notice is that the IGBM index started in 1963 and was projected backwards in time to reflect its monthly evolution since December 1940. Yet, if one follows closely the

index composition for this first period (1940-1963), it is easy to spot that it was built with the same sectors as in the end date, and that their constituents were hardly rebalanced. The IGBM is thereby affected by a strong survival bias, as it is based only on the sectors and companies that existed in later periods. This bias works in two ways. First, by keeping a fix group of sectors, the IGBM overweighted industries that grew very rapidly (for example, construction) and omits those that ceased to be important (transportation was a key industry in 1940, but in 1963 it was grouped within the miscellaneous category). Secondly, by including only companies that survived, the IGBM tends to pick the successful individual cases, and omits those corporations that ended being delisted due to absorptions, nationalizations, or bankruptcies. An omission very easy to document is the absence of the *Compañía Hispano Americana de Electricidad*, which was in the early 1940s the biggest company in the MSE by market capitalization until it was nationalized and delisted in the early 1950s.

Secondly, in the most recent period (1962-present), the IGBM is not constrained in the number of companies included, as it tries to have a better coverage of all companies and sectors listed in the Madrid Stock Exchange. At the time of its creation, the IGBM had 70 constituents, but then it grew to up to more than 100 companies in the 1990s. In the year 2024 it has 118 constituents. Only for this reason one would expect the IGBM to overperform in the last decades, as it gives more weight to small firms, which overall have higher returns in part to compensate for their lower liquidity and larger risks. A third major point is that the selection process for the IGBM had a discretionary component in the past, which meant choosing companies both sufficient in number and as representative as possible, thereby departing from the principal of including the most liquid equities traded and those with the highest capitalization.

It is worth stressing that the index is an average of sector indices, each weighted by the total market capitalization of its sector (e.g., utilities, banking, etc.) on the Madrid Stock Exchange. However, sector indices include only a selected subset of companies considered representative by their market capitalization, trading volume, and liquidity (five or six firms per sector), and not all companies. Within each sector index, each company's weight is based on its market capitalization. The overall index, therefore, represents an aggregation of these sector indices, weighted by the total market capitalization of each sector, making the IGBM index effectively a sector-based stock index.

Finally, its methodology, based on prices adjusted for expected dividends, complicated its connection with IBEX35, which is a pure price index. In fact, the index of each constituent stock of the IGBM was corrected by subtracting from

daily quotations a fraction of the dividends that the firm was expected to pay in the next year (estimated at year end on the base of their past dividend payout). Another inconvenience was the inclusion of a significant number of illiquid stocks, which interfered with arbitrage and price formation (Fernández 1993). These characteristics made it difficult to

Section A.3 The IBEX35 and H-IBEX methodology

The IBEX35

The IBEX35 index is the present-day reference index of the Spanish stock market and is designed to represent the real-time evolution of the performance of the 35 most liquid and significant companies listed on that stock exchange for use as an underlying index for trading in financial derivatives. According to the methodological guidelines (Bolsas y Mercados Españoles 2024), the IBEX-35 weights returns by market capitalization, as detailed in equation 1:

$$IBEX35 = \sum_{i=1}^{35} Market\ cap_i(t) \quad (1)$$

The IBEX35 was originally created under the name FIEX35 by the independent consultant company Findata, at the request of OM Ibérica, which demanded the following conditions: the index had to be composed of the most liquid shares traded on the four Spanish stock exchanges, it had to include a reduced number of companies, and it had to be a good market indicator (Fernández 1993: 7). There was also another index, the MEFF30, also used to operate with futures and options built with the 30 most representative companies on the continuous market. The merger of these two indexes gave rise to the IBEX35, the Spanish Stock Index with the most highly market-capitalized and liquid Spanish company equities listed on the stock market. It was released for the first time in January 14, 1992, but it was subsequently reconstructed back to January 1987. December 29th, 1989 was taken as the base date, with the index beginning at a value of 3,000.

The IBEX35 was therefore thought for a period with high market turnover, but the pricing formula can be applied for longer periods of time (say, days, weeks or months). As detailed in equation 2, it basically requires taking the last spot price, and chaining it to the next one. When a price is missing, the last transaction price is recorded. The consistency of this process is ensured by using a divisor which adjusts to consider changes in the number of shares outstanding, alterations in the nominal values of stocks, and other capital operations. These

capital operations are recorded in the coefficient J , that represents the capitalization adjustment required to assure that the index value is not altered by such financial transactions.

$$Ibex35(t) = Ibex35(t-1) \times \frac{\sum_{i=1}^{35} Market\ cap(t)}{\sum_{i=1}^{35} Market\ cap(t-1) \pm J} \quad (2)$$

The IBEX35 index does not adjust equity prices for the impact of dividend payments, as it is done in variant of the index: the IBEX35 with dividends (IBEX35-NET RETURN). In this alternative index, dividends paid by constituent companies are automatically reinvested by investors, making the index reflect both capital appreciation and dividend income, net of taxes. Consequently, the IBEX35 with dividends provides a more complete picture of the total return earned by holding equities. Furthermore, there is a dividend impact index (IBEX-35 IMPACTO DIV), which reflects the accumulated amount of the dividends, in index points, paid throughout the year by the IBEX 35 components. The details about these three indices are presented in the present-day methodological guidelines, which we follow when computing an equivalent historical index (the H-IBEX).

The H-IBEX

The H-IBEX index is constructed based on the following principles. First, at the beginning of each year, we record all the equity securities listed in the Madrid Stock Exchange and select the 35 stocks with the highest capitalization to be included in the index over the following year. This is a key rule to ensure that the H-IBEX eliminates the problems introduced by survivor bias. Then, for companies included in the index we gather all available data in terms of number of end-of-month stock prices, shares in circulation, par-value, dividends, nominal and paid-up capital, and capital operations (rights issues). We mainly use two official sources of the Madrid Stock Exchange: the daily bulletins ([Colegio de Agentes de Cambio y Bolsa 1886](#)) and the yearbooks ([Colegio de Agentes de Cambio y Bolsa 1919](#); [Colegios de Agentes de Cambio y Bolsa 1950](#)). Only in the exceptional cases in which this information was missing, we rely on other similar sources, such as private financial yearbooks ([AFSAE 1916](#)) or tax statistics ([Ministerio de Hacienda 1958](#)).

At a second stage, we consider only common stocks and thereby exclude preferred shares. We include only Spanish firms –those registered in Spain– irrespective on the main location of its business operations. Also, whenever a company has different classes of common stock, we select the one that was most frequently traded (which almost always is also the one with the highest market value). Finally, we impose a basic liquidity minimum requirement by excluding

stocks that had zero returns over 90 percent of the trading period through the year. This rule is especially important for the first decades of the 20th century when trading was thin, and there were very large cross-sectional differences in the liquidity of stocks. Given these criteria, the H-Ibex starts with 9 companies in 1900, but by World War I the index steadily maintains 25 liquid stocks in its calculations and becomes fully operative with 35 equities by 1930. The data for these first decades are provided to cover the full century but should be interpreted with care as they are based on the reduced number of liquid shares available.

Rights issues and stock market indices

In the basic formula to compute the IBEX-35, capital operations are factored into the denominator's J component. One of the most common types of capital operations included in this component is the issuance of subscription rights. When a company issues new shares, existing shareholders are often given the option (but not the obligation) to purchase these additional shares, impacting the index calculation. This process entails an increase in the total number of shares, and also, implicitly a dilution of undistributed profits. To compensate for this last fact, shareholders are granted a subscription right, which can either be used to buy the new shares or be sold in the market. In both cases, rights issues affect equity returns and need to be considered in our study.

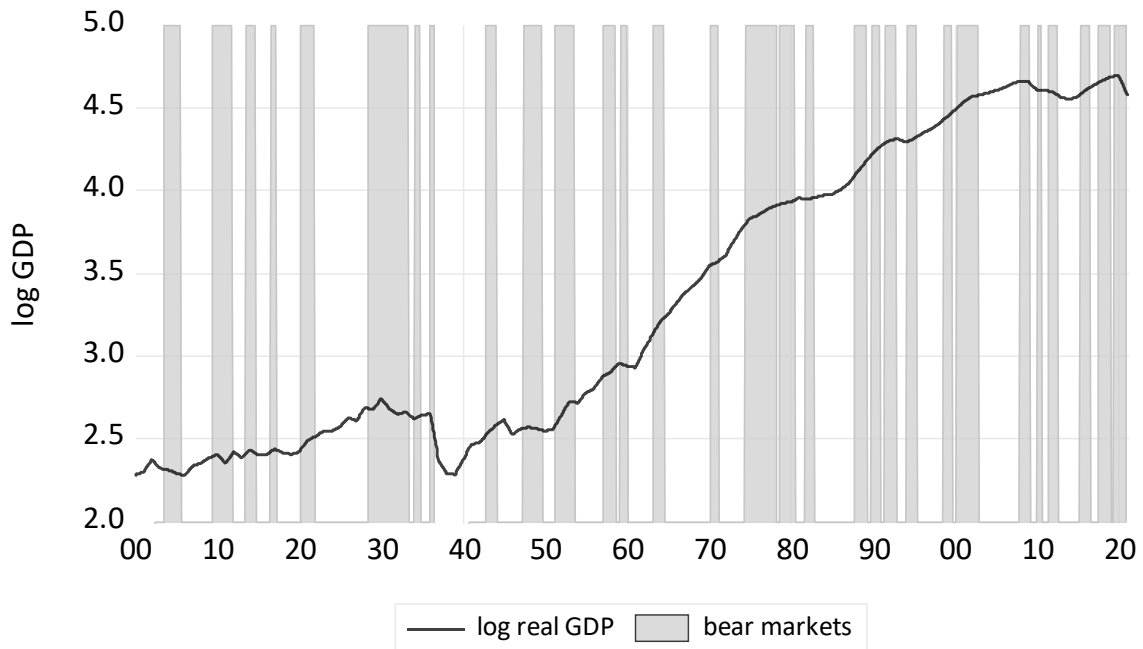
Rights issues are intrinsic to the stock market; however, their relative importance varies across time, and between sectors and countries. In Spain, all gathered evidence points that they become more important from the late 1940s, and especially in the 1960s and early 1970s, but were almost inexistant before the Civil War. This difference is mostly explained because of their tax treatment. At that time, an investor that received a cash dividend had to pay first both capital income tax (normally a flat rate of 15 % that was withheld at source by the company) and, also, the general income tax (if the aggregate income of that individual stood above the minimum threshold). The general income tax worked on progressive tax rate scale. Rights issues, in principle did not entail a distribution of profits as it was considered a dilution of capital reserves. The Spanish tax agency did qualify it as a form of capital income, but one that was taxed at a tax rate (normally 6-10%, below the prevailing rate levied on dividends). Generally, it should have also be taxed by general income tax, but a significant number of investors used this scheme to go undeclared (Gota Losada 1971). Furthermore, rights issues were a convenient way to obtain new funding a relatively low cost. Rights issue provide a liquidity window for the company,

and the operation had a relatively low cost, as the company need not hire banks to ensure that the new shares were subscribed (as in an Initial Public Offering).

Rights issues are relatively easy to compute. From 1961 onwards, the Madrid Stock Exchange published a Yearbook (Colegio de Agentes de Cambio y Bolsa 1962) which includes a chapter on capital increases and rights issues. In this chapter, for each year, we know the operation carried by each corporation, and specifically the dates, a summary of conditions (say, at par with the nominal value, or at par + 250 pesetas), the aggregate nominal value paid-in, and most importantly, the theoretical value of the subscription rights. In a few number cases when this theoretical value is unavailable, we use the last traded price. Prior to 1961, we can identify the dates in which subscription rights were granted to shareholders, as they do appear in another official publication (the *Anuario oficial de valores de la Bolsa de Madrid*), (Colegio de Agentes de Cambio y Bolsa 1919; Colegios de Agentes de Cambio y Bolsa 1950) from which we can also calculate a theoretical value of subscription rights.

Section A.4 Equity market cycles and the real economy

Figure A.4.I Bear markets and real GDP



This figure shows the log of real GDP from [Prados de la Escosura \(2017\)](#) and the equity market cycles obtained from applying apply to the nominal H-IBEX price series the Bry-Boschan algorithm adapted to asset prices by [Pagan and Sossounov \(2003\)](#).

Section A.5 Financial asset returns and inflation

Equities provided domestic investors with a better protection against inflation compared to bonds. However nominal returns on equities and bonds were positively correlated in the long run (and especially before the Civil War and since 1980), and had no or even negative (in 1940-80) correlation with inflation, as shown in Table 2. Only bills had positive co-movement with inflation after 1980, reflecting the impact on short-term interest rates of a more active use of monetary policy to fight inflation.

Table A.5.I Correlation of asset returns and inflation

	Correlation of nominal equity total returns with		Correlation with inflation of			
	nominal bill rate	nominal bond total returns	nominal equity capital gain	nominal equity total return	nominal bill rate	nominal bond total return
1900-2020	0.088 (0.94)	0.379*** (4.26)	-0.001 (-0.01)	0.011 (0.11)	0.383*** (4.43)	-0.139 (-1.50)
1900-1936	-0.086 (-0.50)	0.525*** (3.59)	-0.013 (-0.08)	-0.033 (-0.19)	0.075 (0.44)	-0.219 (-1.31)
1940-1980	-0.277* (-1.78)	0.277* (1.77)	-0.274* (-1.76)	-0.258 (-1.65)	0.491*** (3.47)	-0.370** (-2.46)
1980-2020	0.236 (1.51)	0.390** (2.65)	0.145 (0.91)	0.226 (1.45)	0.870*** (11.0)	0.187 (1.19)

The left quadrant of this table shows the correlation of nominal equity total returns with nominal bill rates and nominal bond total returns. The right quadrant shows the correlation of nominal equity capital gains and total returns, nominal bill rates and nominal bond total returns with the inflation rate (measured by the deflator of households' consumption from [Prados de la Escosura ...](#)). Annual data. T-statistics are reported among parentheses. ***, ** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Section A.6 Comparison with Spanish data in the Macroeconomic Database (v.6, 2022)

The Spanish data included in the last version of the Macroeconomic Database (v.6, 2022) tend systematically to overestimate nominal capital gains and total returns (with the exception of the period 1940-80), and to underestimate nominal bond total returns (throughout the whole sample). The consumer price index used in the Database also tends slightly to overestimate the inflation rate. As a consequence, in real terms equity return differentials are slightly lower, and bond return differentials slightly higher than the corresponding nominal values.

Table A.6.I shows that the average differential for nominal equity total returns is +0.6% p.a. against an average real return differential of +0.3% p.a. On the contrary, the average differential for nominal bond total returns is -0.8% p.a. against an average real differential of -1.0% p.a. Nominal total return differentials for equities are especially large in the periods 1900-36 and 1981-2020 (+1.2% and +1.4% p.a. respectively) and negative (-0.7% p.a.) in the period 1940-80. The return differential for bonds increases over time, from -0.3% in the first subperiod to -0.6% p.a. in the last subperiod.

Figure A.6.I shows that positive total returns differentials in favor of the data in the Macrohistory Database are especially large for the years 1935, 1947, 1957 and 1987, and were only partially offset by subsequent negative differentials. Therefore, in those years there are big upward “jumps” in the nominal total return index for equities, making the series drift away from our H-IBEX series.

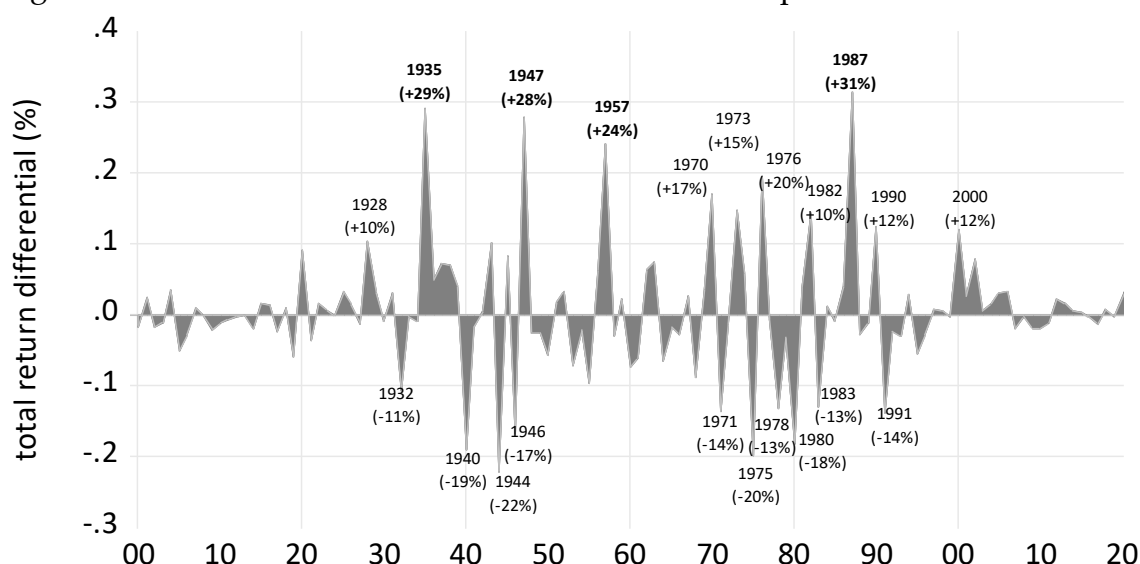
The subsequent figures compare the long-run nominal and real performance of equities and bonds. For instance, Figure A.6.II shows that the long-run nominal appreciation of equities with respect to the initial value of the index (including reinvested dividends) according to the Macrohistory Database (50,361.7 time the initial value) is twice our estimate on the base of the H-IBEX series (25,187.7). The corresponding values in real terms (Figure A.6.III) are 74.4 and 49.9. For bonds (Figure A.6.IV), our estimate of long-run real appreciation (5.94) is three times the estimate based on data in the Macrohistory Database (1.92).

Table A.6.I Nominal and real return differentials for equities and bonds

	equity capital gain (nominal)	equity dividend return (nominal)	equity total return (nominal)	bond total return (nominal)	inflation rate	equity capital gain (real)	equity dividend return (real)	equity total return (real)	bond total return (real)
Macroeconomy Database v.6									
1900-2020	7,0%	4,5%	11,2%	6,5%	5,8%	1,6%	4,0%	5,6%	1,1%
1900-36	2,7%	4,2%	6,9%	5,2%	2,2%	1,2%	4,1%	5,3%	3,8%
1940-80	6,8%	4,4%	10,5%	4,1%	10,1%	-2,5%	3,4%	0,9%	-5,2%
1981-2020	10,9%	5,1%	16,0%	10,3%	4,3%	6,4%	4,8%	11,2%	5,8%
This paper									
1900-2020	5,8%	4,8%	10,6%	7,1%	5,5%	0,7%	4,5%	5,2%	1,9%
1900-36	0,8%	4,9%	5,7%	5,5%	1,9%	-0,6%	4,9%	4,3%	4,0%
1940-80	7,4%	4,3%	11,7%	5,0%	9,7%	-1,7%	4,0%	2,3%	-4,1%
1981-2020	9,4%	5,2%	14,6%	10,9%	4,1%	5,0%	5,0%	10,0%	6,5%
Differential									
1900-2020	1,2%	-0,3%	0,6%	-0,6%	0,3%	0,9%	-0,5%	0,4%	-0,8%
1900-36	1,9%	-0,7%	1,2%	-0,3%	0,3%	1,8%	-0,8%	1,0%	-0,2%
1940-80	-0,6%	0,1%	-1,2%	-0,9%	0,4%	-0,8%	-0,6%	-1,4%	-1,1%
1981-2020	1,5%	-0,1%	1,4%	-0,6%	0,2%	1,4%	-0,2%	1,2%	-0,7%

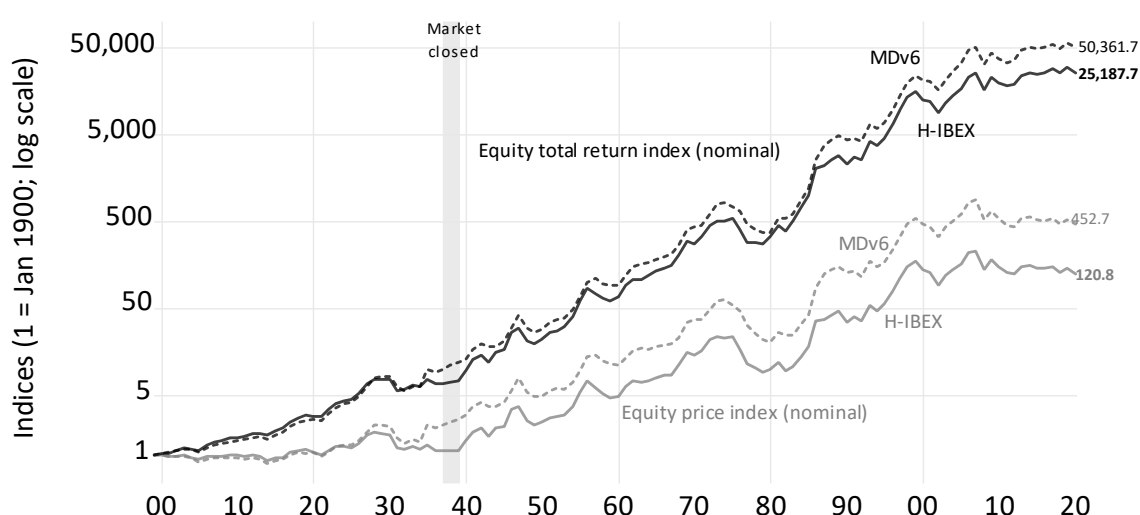
This table compares our estimates of equity and bond returns with the Spanish data available in the last version of the Macrohistory Database (v.6, 2022). For inflation, we use the household consumption deflator of Prados de la Escosura; using the consumer price inflation of Maluquer de Mote has a trivial impact on the estimated averages.

Figure A.6.I Differentials in nominal total returns for equities



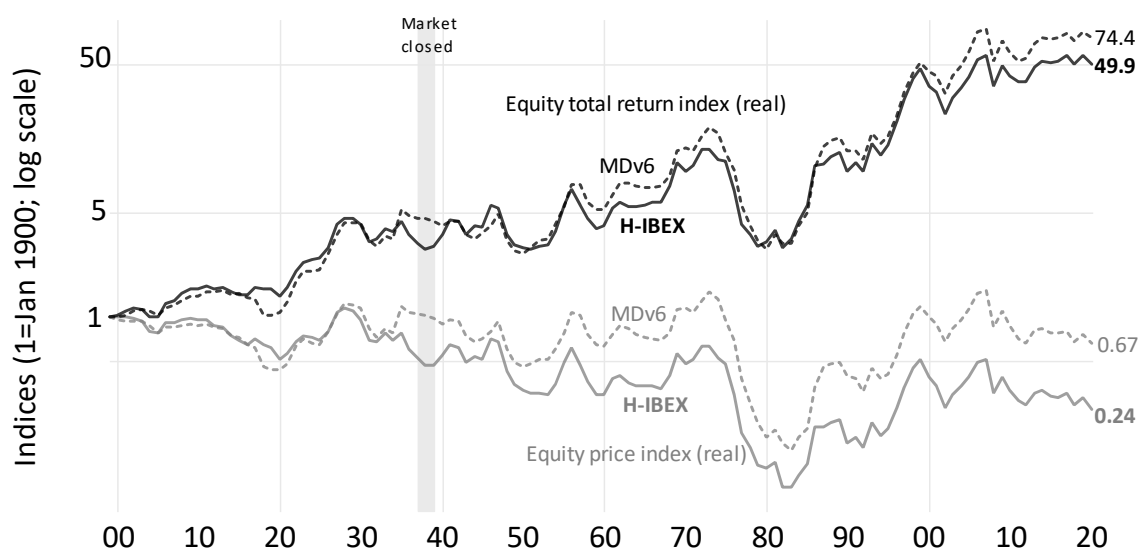
This figure shows the differential between nominal annual total returns of equities in the Macrohistory Database and in our H-IBEX series. Positive differentials are in favor of the Macrohistory Database; for instance, in 1935 their total return is 29 percentage points higher than ours.

Figure A.6.II Equity price and total return indices (nominal)



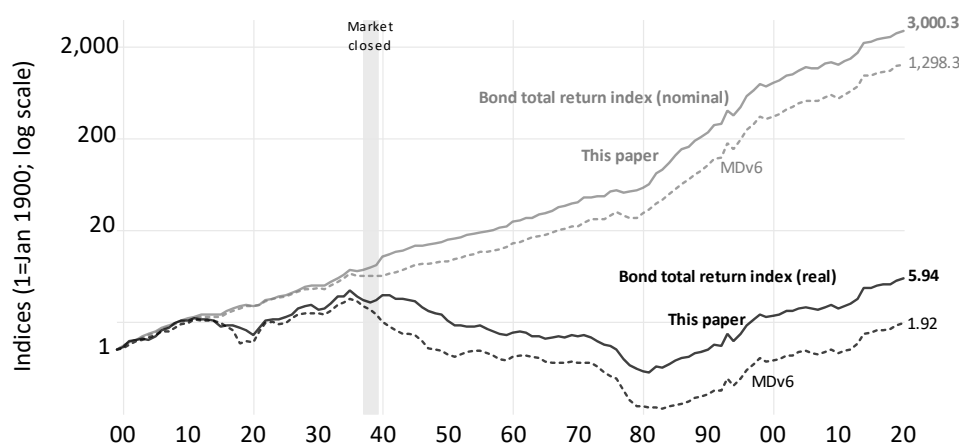
This figure shows the long-run nominal appreciation of equity prices and total returns (including reinvested cash flows) based on the H-IBEX series against the equity price and total return data from the Macrohistory Database (MDv6).

Figure A.6.III Equity price and total return indices (real)



This figure shows the long-run real appreciation of equity prices and total returns (including reinvested cash flows) based on the H-IBEX series against the equity price and total return data from the Macrohistory Database (MDv6). Nominal series from MDv6 are deflated using the consumer price index included in the database. As a deflator for the H-IBEX nominal series, we use the household consumption deflator of Prados de la Escosura; using the consumer price inflation of Maluquer de Mote has a trivial impact.

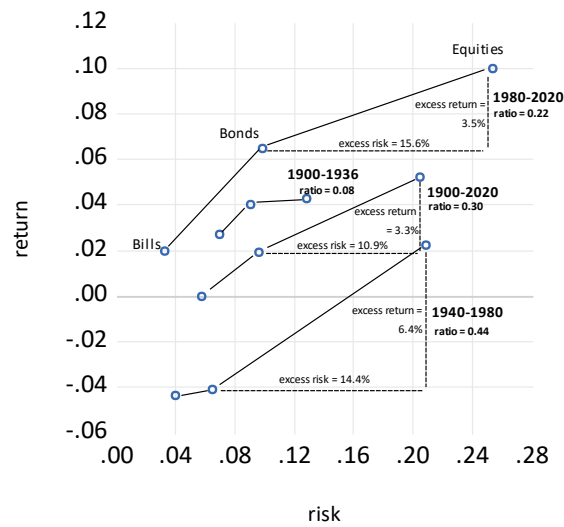
Figure A.6.IV Bond total return indices (nominal and real)



This figure shows the long-run nominal and real appreciation of bonds (including reinvested cash flows) for our weighted index against the bond index based on data from the Macrohistory Database (MDv6). As a deflator, we use the household consumption deflator of Prados de la Escosura; using the consumer price inflation of Maluquer de Mote has a trivial impact.

Section A.7 The risk-return trade off

Figure A.7.I Shifts in risk-return



This figure shows the risk-return trade off in the MSE in the long-period (1900-2020) and its shifts in three sub-periods (1900-1936, 1940-1980 and 1980-2020). Risk is measured as the standard deviation of returns.

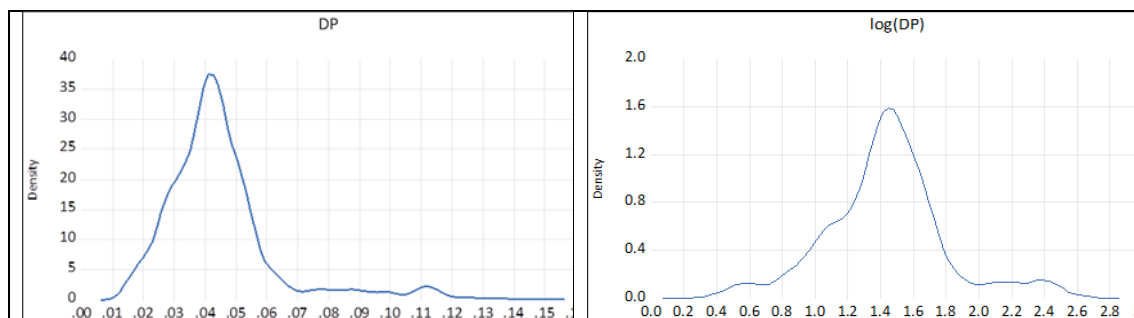
Section A.8 The dividend-price ratio

Table A.8.I Descriptive statistics

	obs	mean	median	max	min	s.d.	skewness	kurtosis	ar(1)	ar(12)
1900-2020	1386	4.5	4.2	15.0	1.2	1.90	1.99	8.29	0.98	0.86
1900-1936	428	4.8	4.7	7.2	3.3	0.68	0.46	2.98	0.95	0.51
1941-2020	958	4.4	3.8	15.0	1.2	2.25	1.94	6.77	0.98	0.87
1980-2020	492	4.8	4.1	15.0	1.2	2.70	1.48	4.59	0.98	0.83

This table shows descriptive statistics of the DP ratio in the full sample (1900-2020) and in three sub-samples (1900-1936, 1941-2020 and 1980-2020). Values are in percent. AR(1) and AR(12) are autoregressive coefficients for 1-month and 12-month lags, respectively.

Figure A.7.I Distribution



This figure shows the distribution of values of the DP ratio (left hand) and its log transformation (right hand).

Section A.9 Unit root and multiple break tests for the (log) DP ratio

Table A.9.I Results of unit root tests

Test		Monthly		Annual		critical value 5%	critical value 1%
		DP	log DP	DP	log DP		
	Null	t-stats	t-stats	t-stats	t-stats		
Augmented Dickey-Fuller	unit root	-3.09**	-3.18**	-2.80*	-2.75*	-2.86	-3.43
Dickey-Fuller GLS (ERS)	unit root	-3.01***	-3.17***	-2.77***	-2.79***	-1.94	-2.57
Phillips-Perron	unit root	-2.90**	-3.93**	-3.08**	-3.03**	-2.86	-3.43
CPSS (Kwiatkowski-Philips-Schmidt-Shen)	stationary	0.11	0.17	0.054	0.081	0.46	0.74
ERS (Elliot-Rothenberg-Stock)	unit root	1.19***	1.15***	1.87***	1.91***	3.26	1.99
Ng-Perron	unit root	1.12***	1.06***	1.82**	1.88**	3.17	1.78

Tests for unit root in level (only intercept, no trend); lag length automatically selected on the base of the Akaike info criterion.

Table A.9.II Results of multiple break tests in OLS regressions ($dp_t = c + \varepsilon_t$) with up to m breaks in the intercept

Break Test	DP		log DP	
	F-stats	F-stats	F-stats	Critical value
Bai-Perron (L+1 vs. L sequentially determined breaks)	0 vs. 1	1.14	0.82	8.58
Bai (breaks in all recursively determined partitions)	0 vs. 1	1.14	0.82	8.58
Bai-Perron (l+1 vs. L globally determined breaks)	0 vs. 1	1.14	0.82	8.58
	1 vs. 2	1.39	1.14	10.13
	2 vs. 3	19.95*	19.31*	11.14
	3 vs. 4	4.43	3.53	11.83
	4 vs. 5	0.04	0.07	12.25
*Dates: 1941m03, 1976m08, 1993m11				
Breaks	F-stats	F-stats	F-stats	Critical value
Bai-Perron (1 to M globally determined breaks)	1	1.14	0.82	8.58
	2	0.94	1.14	7.22
	3	7.36*	7.23*	5.96
	4	6.48	6.12	4.99
	5	5.47	5.07	3.91
*Dates: 1941m03, 1976m08, 1993m11				
Breaks	LWZ criterion			
Information criteria for 0 to M globally determined breaks	0	-8.893	-1.948	
	1	-7.917	-1.992	
	2	-8.188	-2.152	
	3	-8.257	-2.278	
	4	-8.240	-2.260	
	5	-8.211	-2.232	
*Dates: 1941m03, 1976m08, 1993m11				

Trimming 0.15, max n. of breaks 5, significance 0.05; error distribution allowed to differ across breaks.

Table A.9.III Results of multiple break tests in OLS regressions $\left(\left(\frac{12}{j}\right) \Sigma_{j=1}^k \left(r_{t+j}^{\text{eq}} - r_{t+j}^{\text{safe}}\right) = \alpha_r + \beta_r dp_t + \varepsilon_{t+j}^r\right)$ with up to m breaks in the slope of the β_r coefficient

ERP over Bills					
Break type	12m	24m	36m	48m	60m
Bai-Perron (L+1 vs. L sequentially determined breaks)	no	no	no	no	no
Bai (breaks in all recursively determined partitions)	no	no	no	no	no
Bai-Perron (1 to M globally determined breaks; sequential selection)	no	no	no	no	no
Bai-Perron (L+1 vs. L globally determined breaks; sequential selection)	no	no	no	no	no
Information criteria for 0 to M globally determined breaks (Schwarz and LWZ criteria)	1944m08, 1974m08, 1993m05	1944m10, 1975m03, 1993m09	1944m06, 1975m12, 1993m07	1945m03, 1976m06, 1996m01	1946m03, 1976m11, 1996m03
ERP over Bonds					
Break type	12m	24m	36m	48m	60m
Bai-Perron (L+1 vs. L sequentially determined breaks)	no	no	no	no	no
Bai (breaks in all recursively determined partitions)	no	no	no	no	no
Bai-Perron (1 to M globally determined breaks; sequential selection)	no	no	no	no	no
Bai-Perron (L+1 vs. L globally determined breaks)	no	no	no	no	no
Information criteria for 0 to M globally determined breaks (Schwarz and LWZ criteria)	1944m08, 1974m08	1944m12, 1975m05, 1993m11	1945m10, 1975m12, 1994m10	1945m04, 1976m06, 1996m01	1946m03, 1976m09, 2002m06

Trimming 15%, max n. of breaks 5, significance 0.05; error distribution allowed to differ across breaks.

Table A.9.IV Coefficient estimates of OLS regressions $\left(\left(\frac{12}{j}\right) \Sigma_{j=1}^k \left(r_{t+j}^{\text{eq}} - r_{t+j}^{\text{safe}}\right) = \alpha_r + \beta_r dp_t + \varepsilon_{t+j}^r\right)$ with unadjusted (log) DP ratio, full sample (1900m01-2020m12)

	12m	24m	36m	48m	60m	12m	24m	36m	48m	60m
excess return over bills						excess return over bonds				
β_r	0.072*	0.093***	0.101***	0.094***	0.088***	0.078**	0.095***	0.097***	0.088***	0.080***
(s.e.)	(0.040)	(0.032)	(0.026)	(0.017)	(0.021)	(0.031)	(0.025)	(0.025)	(0.023)	(0.021)
[t-stats]	[1.78]	[2.95]	[3.82]	[5.53]	[5.06]	[2.57]	[3.84]	[3.95]	[3.83]	[3.90]
R2	0.02	0.06	0.10	0.12	0.13	0.03	0.07	0.11	0.13	0.15
Obs	1362	1338	1314	1290	1266	1362	1338	1314	1290	1266

Table A.9.V Coefficient estimates of OLS regressions $\left(\left(\frac{12}{j}\right) \sum_{j=1}^k \left(r_{t+j}^{\text{eq}} - r_{t+j}^{\text{safe}}\right) = \alpha_r + \beta_r dp_t + \varepsilon_{t+j}^r\right)$ across regimes for the β_r coefficient identified by break tests

	12m	24m	36m	48m	60m	12m	24m	36m	48m	60m
	excess return over bills					excess return over bonds				
	1901-44	1902-44	1903-44	1904-45	1905-46	1901-44	1902-44	1903-45	1904-45	1905-46
β_r	0.143***	0.163***	0.167***	0.149***	0.136**	0.106***	0.138***	0.134***	0.119***	0.091*
(s.e.)	(0.038)	(0.044)	(0.049)	(0.052)	(0.063)	(0.040)	(0.039)	(0.041)	(0.041)	(0.051)
[t-stats]	[3.80]	[3.75]	[3.42]	[2.83]	[2.16]	[2.62]	[3.53]	[3.25]	[2.91]	[1.80]
Obs	445	423	395	380	368	445	425	411	381	368
	1944-74	1944-75	1944-75	1945-76	1946-76	1944-74	1944-75	1945-75	1945-76	1946-76
β_r	0.239***	0.261***	0.260***	0.235***	0.216***	0.195***	0.230***	0.220***	0.197***	0.159***
(s.e.)	(0.047)	(0.052)	(0.060)	(0.063)	(0.076)	(0.050)	(0.047)	(0.049)	(0.049)	(0.041)
[t-stats]	[5.04]	[4.97]	[4.34]	[3.70]	[2.83]	[3.90]	[4.86]	[4.46]	[4.02]	[3.94]
Obs	360	365	378	375	368	360	365	362	374	366
	1974-93	1975-93	1975-93	1976-95	1976-96	1974-2020	1975-93	1975-94	1976-95	1976-2002
β_r	0.101**	0.123**	0.130**	0.121***	0.111**	0.103***	0.122***	0.121***	0.111***	0.098***
(s.e.)	(0.044)	(0.050)	(0.052)	(0.041)	(0.055)	(0.034)	(0.036)	(0.039)	(0.034)	(0.026)
[t-stats]	[2.27]	[2.46]	[2.50]	[2.97]	[2.02]	[3.02]	[3.42]	[3.12]	[3.28]	[3.82]
Obs	225	222	211	235	232	557	222	226	235	309
	1993-2020	1993-2020	1993-2020	1996-2020	1996-2020		1993-2020	1994-2020	1996-2020	2002-2020
β_r	0.192***	0.216***	0.218***	0.201**	0.185**		0.154***	0.148**	0.131*	0.076**
(s.e.)	(0.042)	(0.051)	(0.064)	(0.081)	(0.081)		(0.051)	(0.073)	(0.070)	(0.039)
[t-stats]	[4.61]	[4.20]	[3.43]	[2.48]	[2.28]		[3.04]	[2.03]	[1.88]	[1.97]
Obs	332	328	330	300	298		326	315	300	223
R2	0.132	0.252	0.341	0.397	0.452	0.106	0.227	0.315	0.359	0.416

All regressions use a Newey-West estimator with Bartlett kernel, pre-whitened residuals up to j lags, and NW automatic bandwidth and j lags, where j is the forecasting horizon in months. HAC standard errors are in parentheses, and the corresponding t-stat in square brackets. *, ** and *** connote statistical significance at the 10%, 5% and 1% level, respectively.

Section A.10 Long-run relationship between (log) real dividends and (log) real prices: cointegration, unit root and multiple break tests

We test the existence of a long-run equilibrium between dividends and prices ($d_t = \alpha + \beta p_t$, where β is the drift ratio between the two $I(1)$ series) and derive the DP ratio from their cointegrating vector (Polimenis and Neokosmidis 20016 and 2019). We are unable to reject the null of no cointegration under alternative estimators (Table A.9.I). Unit root tests applied to the residuals of the cointegrating relationship fail to reject systematically the null of unit root (Table A.9.II), while break tests consistently identify the same break dates (Table A.9.III).

Table A.10.I Results of cointegration tests

				Cointegration Tests			
				Engle-Granger		Philips-Ouliaris	
				null: no cointegration			
				tau-stat (p-val)	z-stat (p-val)	tau-stat (p-val)	z-stat (p-val)
CCR (Canonical Cointegrating Regression)	[1, -0.95]	7.83	0.64	-2.57 (0.248)	-15.73 (0.130)	-2.84 (0.155)	-17.31 (0.096)
FOLS (Fully Modified OLS)	[1, -1.05]	6.92	0.60				
DOLS (Dynamic OLS)	[1, -0.42]	2.75	0.43	-2.03 (0.513)	-9.42(0.398)	-2.64 (0.223)	-14.05 (0.178)
				Cointegrating relationship	t-stat	Bound test	
						Critical values 10%	Critical values 5%
						F-stat	I(0)
						I(1)	I(0)
ARDL (12,2)	[1, -0.58]	4.42	2.788	3.020	3.510	3.620	I(1)
							4.160

Table A.10.II Results of unit root tests for the cointegrating relationship

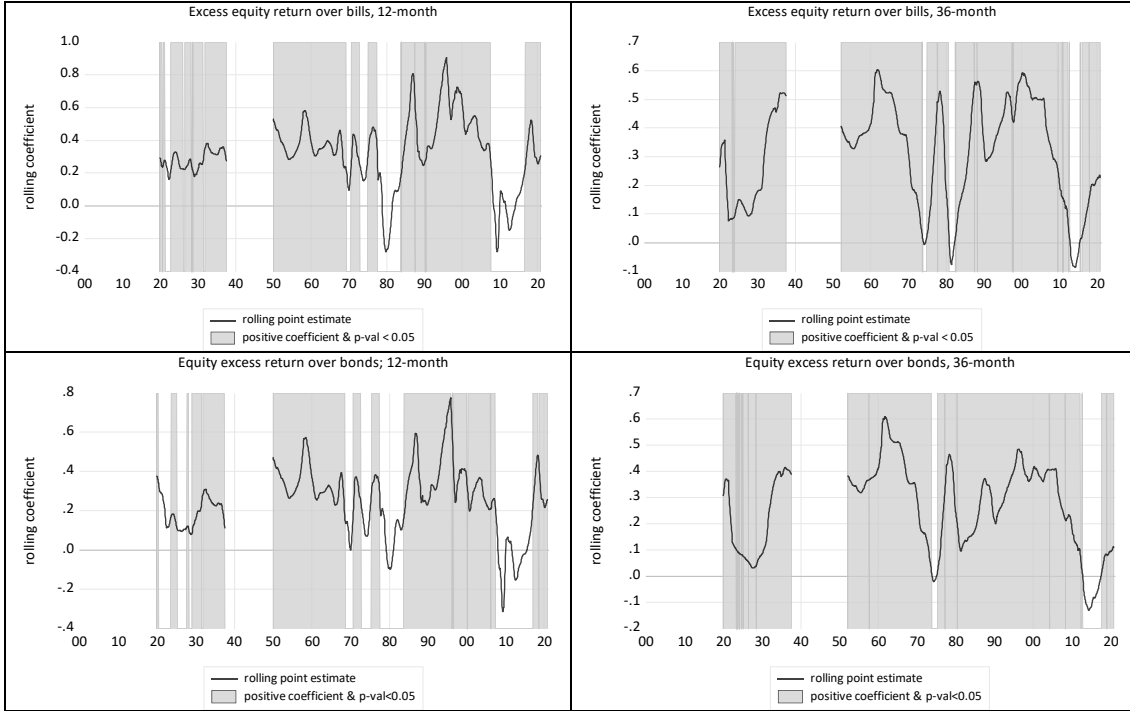
Test	CCR		FMOLS		DOLS		ARDL	
	Null	t-stats	t-stats	t-stats	t-stats	t-stats	critical value 5%	critical value 1%
Augmented Dickey-Fuller	unit root	-3.07**	-2.69*	-2.49	-2.79*	-2.86	-3.43	
Dickey-Fuller GLS (ERS)	unit root	-3.07***	-2.56***	-1.98**	-2.43**	-1.94	-2.57	
Phillips-Perron	unit root	-2.84*	-3.00**	-2.64*	-3.23**	-2.86	-3.43	
KPSS (Kwiatkowski-Philips-Schmidt-Shen)	stationary	0.28	0.10	0.68**	0.10	0.46	0.74	
ERS (Elliot-Rothenberg-Stock)	unit root	1.26***	2.00**	3.07**	2.04**	3.26	1.99	
Ng-Perron	unit root	1.18***	1.81**	3.53*	1.99**	3.17	1.78	

Table A.10.III Results of multiple break tests for the cointegrating relationship

		CCR	FMOLS	DOLS	ARDL	
	Break Test	F-stats	F-stats	F-stats	F-stats	Critical value
Bai-Perron (L+1 vs. L sequentially determined breaks)	0 vs. 1	0.94	0.61	7.00	0.43	8.58
Bai (breaks in all recursively determined partitions)	0 vs. 1	0.94	0.61	6.78	0.48	8.58
	0 vs. 1	0.94	0.61	7.00	0.48	8.58
	1 vs. 2	1.40	2.37	3.42	7.79	10.13
Bai-Perron (L+1 vs. L globally determined breaks)	2 vs. 3	8.90	9.83	3.42	7.80	11.14
	3 vs. 4	3.33	3.71	3.42	2.56	11.83
	4 vs. 5	0.03	0.07	0.01	0.08	12.25
	Breaks	F-stats	F-stats	F-stats	F-stats	Critical value
	1	0.94	0.62	7.00	0.48	8.58
	2	0.58	1.55	2.97	1.31	7.22
Bai-Perron (1 to M globally determined breaks)	3	3.34	4.26	15.75*	3.41	5.96
	4	4.29	3.73	11.99	3.10	4.99
	5	3.32	3.05	7.61	2.59	3.91
	*Break dates: 1942m03, 1977m05, 1993m11					
	Breaks	LWZ criterion				
	0	-2.009	-1.809	-2.309	-1.761	
	1	-2.080	-1.828	-2.540	-1.788	
	2	-2.178	-2.090	-2.569	-2.067	
	3	-2.345*	-2.156*	-2.740*	-2.119*	
	4	-2.327	-2.139	-2.727	-2.102	
Information criteria for 0 to M globally determined breaks	5	-2.298	-2.112	-2.709	-2.074	
	*Break dates:					
		1941m03	1941m03	1942m03	1941m07	
		1976m08	1976m09	1977m05	1976m11	
		1993m11	1993m12	1993m11	1994m01	

Section A.11 Pockets of data

Figure A.11.I Rolling estimates of β_r coefficient



This figure shows the point estimates of the coefficient of interest β_r for the in-sample predictive regression $\left(\frac{12}{j}\right) \sum_{j=1}^k (r_{t+j}^{eq} - r_{t+j}^{safe}) = \alpha_r + \beta_r dp_t + \varepsilon_{t+j}^r$, using the DP ratio adjusted for structural breaks and estimated recursively in a rolling window of 120 months. The top quadrants refer to the predicted equity excess return over bills at 12- and 36-month horizons; the bottom quadrants show the estimates for the premium over bonds at the same time horizons. Shaded areas connote months in which the point estimates are positive and the p-value is below the 5% significance level.

Section A.12 Out-of-sample R2 of predictive regressions

To test the ability of the DP ratio to predict excess returns in real time, i.e. out-of-sample, we estimate the regression $\left(\frac{12}{j}\right) \sum_{j=1}^k (r_{t+j}^{eq} - r_{t+j}^{safe}) = \alpha_r + \beta_r dp_t + \varepsilon_{t+j}^r$ recursively in an expanding window. Our regressor is the unadjusted log DP ratio, since we assume investors could not identify structural breaks in real time. After 20 years of “training” (January 1900-December 1919), we use the point-estimate of β_r to predict excess returns 12 to 60 months ahead (i.e. from December 1920 to December 1924); then we expand the window by one month (January 1900-January 1920) to produce forecasts until January 1925, and so on. We repeat the exercise until the end of the sample. We want to compare the prediction errors of the model with those of a “naïve” model in which the

recursively estimated historical mean of the risk premium at month t is used as the expected risk premium up to 60 months ahead. For each period from the first estimates (January 1920) up to month t , we compute the cumulative sums of squared errors from the out-of-sample predictive regression, SSE_j^t , and the “naïve” regression, SST_j^t :

$$SSE_j^t = \sum_{\tau=j}^t (r_\tau - \hat{r}_\tau)^2$$

$$SST_j^t = \sum_{\tau=j}^t (r_\tau - \bar{r}_\tau)^2$$

where j is the prediction horizon (from 12 to 60 months ahead), r_τ is the observed excess return at τ , $\hat{r}_\tau$ is the excess return predicted for τ by the coefficients $\alpha_\tau + \beta_\tau dp_\tau$ estimated in the sample until $\tau-j$, and $\bar{r}_\tau$ is the mean excess return until $\tau-j$. Their difference ($SST_j^t - SSE_j^t$) is then standardized by:

$$SST_j^T = \sum_{\tau=j}^T (r_\tau - \bar{r}_\tau)^2$$

which is the total sum of residuals from the “naïve” regressions estimated over the entire sample T . The lines in the figures below represent the out-of-sample R^2 at each month τ :

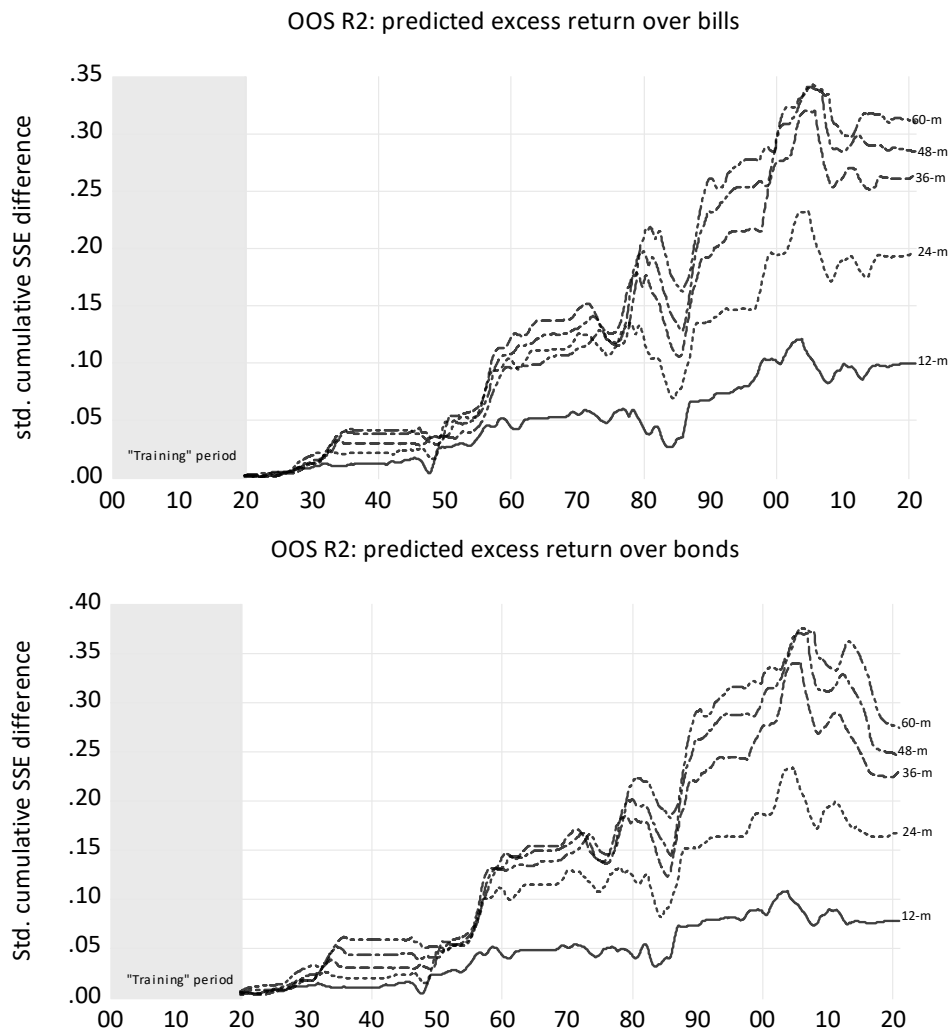
$$OOSR^2 = \frac{SST_j^t - SSE_j^t}{SST_j^T}$$

and measures the forecast gains of including the (log) DP ratio in the model relative to the “naïve” model. The overall out-of-sample R^2 is measured at the last month in the sample (December 2020) as

$$OOSR^2 = \frac{SST_j^T - SSE_j^T}{SST_j^T} = 1 - \frac{SSE_j^T}{SST_j^T}$$

The figures below plot the out-of-sample R^2 estimated at each month for excess returns from 12 to 60 month ahead. As indicated by the rising lines, the predictive regression systematically over-performs the benchmark model, confirming the out-of-sample forecasting power of the DP ratio.

Figure A.12.I Out-of-sample R^2



This figures compare the out-of-sample performance of the prediction model with respect to the naïve model. A rising (declining) line indicates when the fit of the predictive model increases (falls). We report results for forecast horizons from 12 to 60 months.

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