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Eight centuries of the risk-free rate: bond market reversals from the Venetians to the 'VaR shock'

Paul Schmelzing

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Eight centuries of the risk-free rate: bond market reversals from the Venetians to the 'VaR shock'

Paul Schmelzing[(1)]

Abstract

This paper presents a new dataset for the annual risk-free rate in both nominal and real terms going back to the 13th century. On this basis, we establish for the first time a long-term comparative investigation of 'bond bull markets'. It is shown that the global risk-free rate in July 2016 reached its lowest nominal level ever recorded. The current bond bull market in US Treasuries which originated in 1981 is currently the third longest on record, and the second most intense.

The second part of this paper presents three case studies for the 20th century, to typify modern forms of bond market reversals. It is found that fundamental, inflation-led bond market reversals have inflicted the longest and most intense losses upon investors, as exemplified by the 1960s market in US Treasuries. However, central bank (mis-) communication has played a key role in the 1994 'Bond massacre'. The 2003 Japanese 'VaR shock' demonstrates how curve steepening dynamics can create positive externalities for the banking system in periods of monetary policy and financial uncertainty.

The paper finally argues that the inflation dynamics underlying the 1965–70 bond market sell-off in US Treasuries could hold particular relevance for the current market environment.

Key words: Bond markets, interest rate history, real rates, financial history.

JEL classification: G12, N10, N20.

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INTRODUCTION

In the midst of historically low interest rates in advanced economies following the Great Financial Crisis and renewed discussions about "secular stagnation" (Hansen, 1939; Summers, 2016), sovereign bond markets have reflected the depressed yield environment and enjoyed years of above-average (price) returns. The current "bull market" in bonds, however, originated prior to 2008 – mirroring the structural dynamics in global inflation rates, which inflected as Paul Volcker's "war on inflation" triggered by the Oil Shocks started bearing fruit (Rachel and Smith 2017; Goodfriend 1993): it has been recognized that 1981 marked the beginning of a "bull market" period of rising prices and falling yields (Homer and Sylla, 1991), as bond prices typically incorporate investors' assessment of future inflation and interest rates over the lifetime of the asset (in addition to liquidity, default risk, and term premia considerations, cf. Drake and Fabozzi, 2011). Yet, after 36 years of secularly falling risk-free rates, a significant proportion of sovereign debt recording negative yields, and short-term fallouts such as the 2013 "Taper Tantrum", more often the enthusiasm in policy and market circles has been giving way in recent years to concerns about an unprecedented "bond bubble" which could eventually inflict significant losses upon holders of government debt.[2]

Are such fears warranted? And if we accept the proposition that the bond market shows signs of a "bubble", how have such conditions normalized in the past? In contrast to the academic references on the history of equity bubbles, the history of bond market reversals remains relatively unexplored territory. This is partly due to a lack of consistent historical data necessary to undertake empirical work in bond markets.

Based on a new dataset for the global risk-free rate in nominal and real terms since the year 1311, this paper will argue that the current global bond market does indeed show strong signs of a historically unusual price expansion since 1981. In the first part, nine major secular bond bull markets since the 13th century are identified, and the current price expansion placed into its (very) long-term context. Furthermore, the new dataset indicates that in July 2016 the global risk-free rate reached its lowest point ever.

[2] Exemplary: "Paul Singer says bond market is 'broken'", Financial Times, August 18, 2016; "Is the Bond Market in a Bubble?", Wall Street Journal, October 10, 2016; For a policy perspective, see Claeys (2016), prepared for the European Parliament Committee on Economic and Monetary Affairs.

The second part of this paper proceeds empirically in its focus on notable "bull market reversals" in the 20th century, to investigate closer the more recent dynamics leading to sharp investor losses. We distinguish among (1) "monetary (mis-) communication reversals" in which central bank communication plays a central role, (2) non-fundamental, "curve steepening reversals", and (3) fundamental, inflation-led reversals. While important idiosyncrasies exist, an eventual end to the current bond bull market could involve similar fundamentally-driven dynamics as experienced in 1965-1970.

PART 1: BOND MARKET AND RATES DATA OVER THE LAST 700 YEARS

1.1 SOURCES AND CHOICE OF ASSETS

To establish the inception point for a long-term index of "risk-free" long-term sovereign bond yields, we follow a vast literature of financial history which has identified the Italian city states of Venice, Florence, Siena, and Genoa as the earliest issuers of marketable long-term sovereign debt in the early Renaissance.[3]

According to the accounts of Tracy (2003), Epstein (2000), and the classic study by Homer and Sylla (1991), the earliest "funded debt" of Italian city states can be traced back to a forced loan by Venice on its wealthy citizens in 1171-2.[4] No interest was paid on this loan for more than three decades, and the rates did not reflect market prices of risk.

We have to wait until 1262 for secondary markets in Venetian long-term debt to be established, by a decree of the Venetian Grand Council, the *ligatio pecuniae*, which also fixed annual coupons at 5%.[5] Relatively continuous market prices are from then onwards recorded in Luzzatto (1929). Following Venice, Genoa consolidated its various long-term loans into a single fund, the *Compere*, in 1340. Florence equally consolidated debts in the 1340s, henceforth known as the *Monte Comune*. The instruments of these city-republics could be pledged as collateral for bank loans, lent to third parties,

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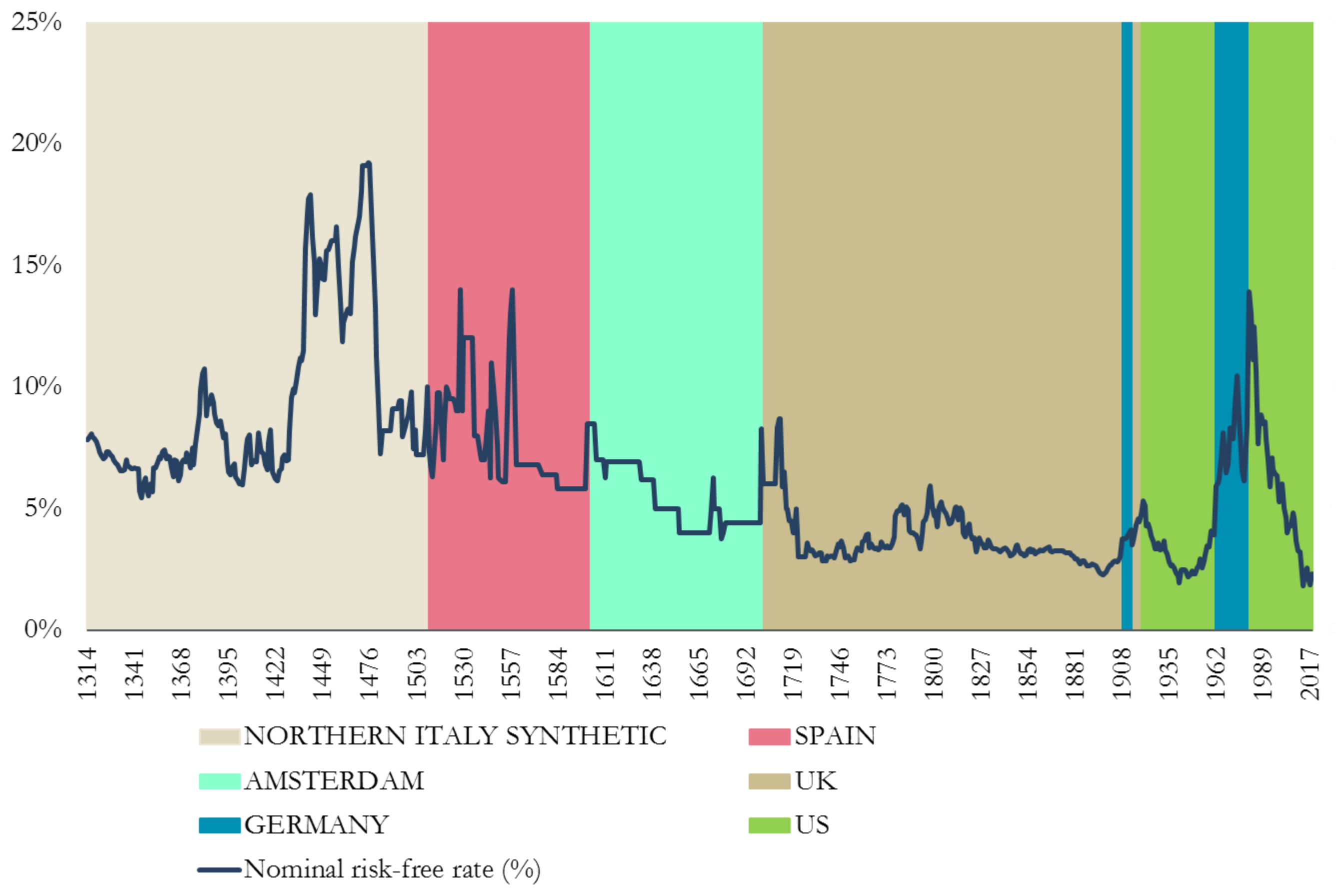
[3] Fratianni and Spinelli (2006), Michie (2006), Pezzolo (2005), Tracy (2003), Epstein (2000), Kindleberger (1984).
[4] Luzzatto (1929), p.7; Homer and Sylla (1991), p.92.
[5] Tracy (2003), p.21.

used in lieu of money to pay private obligations, and the “vivacious” turnover gave rise to the establishment of money market broker houses as early as 1408.[6] The participation of international investors – ranging from foreign rulers such as the Portuguese King, to religious orders such as the Knights Hospitallers in Jerusalem (typical “institutional investors” of the day), and private German merchants – has been extensively documented.[7] All of them were attracted by Italian debt “because they had no similar investment opportunity in their own capital cities and because they sought to put a safe distance between internecine struggles in their own courts and the hoards that could guarantee survival to themselves or their heirs in case of a change of political fortune”.[8] Italian urban debt thus constituted the proverbial risk-free asset of the day.[9] Venice was the largest by population, and can be regarded as the most advanced, most liquid – and by extension, therefore, the most advanced long-term debt market internationally.

[6] Mueller (1997), pp.453ff.
[7] Mueller (1997), chapter 14.
[8] Mueller (1997), p.545.
[9] For Florence, see also Molho (1971).

CHART 1: GLOBAL NOMINAL RISK FREE RATE AND ASSET COMPOSITION, 1311-2017.



Sources: See text.

The "bottleneck" in our rate data is set by the price data by Allen (2001), which commences in the Italian city states in the year 1311. This year, hence, marks the first to allow the calculation of real rates. Allen (2001) constructs his "Northern Italy" index with data from various Italian city-states, including Venice, Milan, and Florence. The data has been used in the academic literature in different contexts.[10]

To match the nature of Allen's price data most closely, for the years 1311 to 1508, we construct a synthetic "Northern Italy" nominal bond series, which incorporates 242 specific annual datapoints from Venetian *Monte Vecchio* and *Monte Nuovo* bonds (104 datapoints), Florentine *Comune* bond

[10] Among them Reinhart and Rogoff (2009), Turchin (2009), Clark (2008), Lindert and Williamson (2003).

yields (52 datapoints), and for Genoa *Compere* bonds and San Giorgi *Luoghi* rates (96 datapoints). For datapoints not explicitly documented, we rely on linear interpolations – however, there are only 18 annual instances for which none of the three city-Republics has a confirmed explicit bond yield datapoint. The main data sources used include Luzzatto (1929), Mueller (1997), and Pezzolo (2003) for Venice, Conti (1963) for Florence, and Day (1961) and Heers (1963) for Genoa. We weight the three city-states according to size of population and taxable wealth, giving a 55% share to Venice, 25% to Genoa, and 20% to Florence.[11]

There is broad consensus among economic historians that the late 15th century marks the beginning of the long secular decline in economic pre-eminence of the Italian city states, with the Portuguese discoveries in India in 1498, and the conquest of Egypt by the Ottoman Empire in 1517 often singled out.[12] We choose the year 1509 for the transition – the date of the decisive Venetian defeat in the famous Battle of Agnadello against the League of Cambrai. Niccolo Machiavelli – referring to the event in *The Prince* – claimed that Venice at this occasion had lost "in one day what took them eight hundred years exertion to conquer".[13]

At this point – spanning the reign of Charles V and Philip II as Emperors of the Habsburg dynasty – we enter the Spanish phase of financial dominance. During the 16th century, "no other power controlled...armed forces as powerful or financial resources as vast as Habsburg Spain".[14] Soon after Philip's death in 1598, however, decline set in with equal swiftness: "the Empire on which the sun never set had become a target on which the sun never set".[15]

Between 1599 and 1702, we rely on long-term bond yields from the Dutch Province of Holland, then home to the "financial capital of the world", Amsterdam.[16]

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[11] Mueller (1997, pp.479, 491) uses a basis for Venice population in 1379 of 70,000, of which 2,100 households had net taxable wealth, and 37,000 for Florence. He also suggests a population figure of 50% of Venice's level for Genoa – while Bairoch et al (1988, p.49) would suggest a higher population figure for Genoa, Kedar (1976, 43) in turn suggests a lower basis of taxable households on the basis of custompayers.
[12] Pezzolo (2013), p.255; Michie (2006, chapter 1); Stasavage (2011).
[13] Machiavelli (2003), p.77.
[14] Drelichman and Voth (2014), p.243. See also Ehrenberg (1896) on the Crown's relationship with the Fuggers.
[15] Parker (2000), p.283; for our Spanish bond yield data we rely on figures supported by the "European State Finance Database" (cf. Bonney, 2007), as well as Homer and Sylla (1991), and Drelichman and Voth (2014). Missing explicit datapoints are linearly interpolated. Both our averages and spreads conform closely to the 7.14% Juros average, and the 7.2% spread to Asientos suggested by Drelichman and Voth (2014, pp.177, 206).
[16] Hart, Jonker, and Zanden (1997), p.48. Data via Dormans (1991), Homer and Sylla (1991). Missing datapoints are linearly interpolated.

From 1703, we switch to British consol data, as recorded by the Thomas and Dimsdale (2017).[17] In our geographic shift, we follow standard accounts such as Neal (1990), which treat British public sector assets beginning with the inception of the Central Bank in 1694 as the "risk-free" instrument, concurrent with the transition of dominant financial market activity from Amsterdam to London.[18]

From 1919 until 1961, and from 1981 to the present, we use US Treasury 10-year constant maturity bonds, as recorded by the Federal Reserve Board (1943, 1976), and FRED (2017). The United States first overtake the United Kingdom in per capita GDP in 1901, but subsequently fall back again in 1904 and 1914. From 1919, however, the lead is continuous, and which coupled with the country's leading function in debt and capital markets constitutes the rationale for the transition point.[19]

Between 1908 and 1914, we rely on the German Imperial 3% benchmark bond, and between 1962 until 1980 we rely on German 10-year government bonds. In 1908, Germany overtook the United Kingdom in total GDP and entered a stronger growth trajectory than the United Kingdom, only interrupted by World War One. In 1961, after the revaluation of the Deutschmark, the rise of the Eurodollar market in London as an alternative financing pool, and consistently lower inflation rates, German rates started being considered as prime advanced economy assets (Cohen, 2015). We return to US assets with Paul Volcker's first success in his "war on inflation" in 1981.[20] Table 1 provides a full overview of all assets chosen.

[17] We rely on table A.19 in the database by Thomas and Dimsdale (2017), available via http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx, which calculates yields between 1703-55 based on Janssen et al. (2002), and afterwards based on Mitchell (1988).
[18] Neal (1990), p.51.
[19] We rely on Angus Maddison's dataset for per capita GDP data. See Maddison (2007), updated in Bolt and van Zanden (2014).
[20] Data sources: cf. Table 1 below.

TABLE 1: OVERVIEW OF NOMINAL BOND DATA AND INFLATION DATA CHOSEN SINCE 1314.

PERIOD	NOMINAL YIELD SOURCE	INFLATION DATA	ASSET USED
1314-1508	*Venice (55%):* Luzzatto (1929, pp. CXXVII-CXXIX), Mueller (1997, pp. 472ff.), Pezzolo (2003).	Allen (2001): Florence bread price, 1311-1323; Northern Italy CPI, 1324-1508.	Venice: *Monte Vecchio* long term yields (1311-1481), *Monte Nuovo* long-term yields (1482-1508).
	Genoa (25%): Day (1963, p.XXVI), Heers (1961, p.630) Kedar (1976, p.191), Sieveking (1906), pp.44-5.	Allen (2001).	*Compere* long term yields, San Giorgi Bank *Luoghi* yield (1408-).
	Florence (20%): Conti (1984, p.34).	Allen (2001).	*Monte Comune* long-term bonds.
1509-1598	Ucendo and Garcia in: ESFB (2007), Homer/Sylla (1991, p.115), Drelichman and Voth (2014, p.114).	Allen (2001): Valencia CPI, 1509-1598.	Spain: *Juros* long-term.
1599-1702	Homer/Sylla (1991, p.128), Dormans (1991, pp.26,52,71).	Allen (2001): Amsterdam CPI, 1599-1702.	Dutch Province of Holland long-term *Rentes* yields.
1703-1907	Thomas and Dimsdale (2017), Tab A31, Column P.	Thomas and Dimsdale (2017): “Preferred headline CPI”, Tab A47, Column AW.	British consol long-term yields.
1908-1913	NBER Macrohistory database, series m13028a, December yield.	Bundesbank (1968, p.19).	German Imperial 3% bonds.

1914-1918	Thomas and Dimsdale (2017), Tab A31, Column P.	Thomas and Dimsdale (2017): "Preferred headline CPI", Tab A47, Column AW.	British consol long-term yields.
1919-1961	Federal Reserve Board (1943, p.468), Federal Reserve Board (1976, p.720).	FRED (2017), series CPIAUCNS.	US Long-term bonds (11.5 year maturity, 1943-7), 10-Y UST bonds (1948-61).
1962-1980	FRED (2017), series IRLTLT01DEA156N.	Bundesbank (2017).	German 10-year bond yields.
1981-2017	FRED (2017), series DGS10.	FRED (2017), series CPIAUCSL.	US 10-year bond yields.

1.2 EXISTING LITERATURE ON BOND MARKET RATES

A vast literature on the financial evolution of the developed world does exist, with a special focus on the "Price Revolution" and the "Financial Revolution" typically associated with the early 1500s and the Italian *Cinquecento*.[21] Without exception, however, none of these contributions provide a long-term investigation of bond market performance in particular and apply the analytical frameworks now relevant for financial markets.

The prime historical compendium on Western bond markets remains Homer and Sylla's "History of Interest Rates" (1991), tracing back developments in advanced economies' debt markets to Mesopotamian times. It can be seen as a significant expansion of previous long-term studies in interest rate trends such as or Kaufman (1986), Macaulay (1938), Billeter (1898). Reliable higher frequency data only begins with their observations at the Italian city state level in the 12th and 13th centuries. For all its outstanding illuminations, however, the work is not focused on bond market

[21] See Ferguson (2001); Hamilton (1934).

crises, or sharp interest rate reversals. The authors' identification of the "first bear bond market" occurs as late as the final decade of the 19th century – specifically 1899-1920, followed by the "great bull bond market 1920-1946".[22] Similarly, the revised third edition by 1991 opines that "an end to the Cold War would increase the likelihood that peak yields of the greatest bear market in bonds were reached in 1981". [23] Unfortunately, these observations are nowhere systematically placed into a broader definition of "bear bond markets", nor do the authors use their impressive historical breadth to offer wider interpretations of "bear market" typology, its historical frequency, or its severity. A brief discussion of "suprasecular" interest rate movements occurs at the end of the bond, but the aggregating trendline involves a mere 16 datapoints (Ibid., pp.553-558).

There are other recent additions with a special focus on particular fixed income assets, specific regional trends, and time periods – but bar exception these studies lack the ambition to put the results systematically into long-term historical contexts, or link observations to the present day financial market discussion. A representative example includes Basile et al (2015), which uses corporate junk bond market data from 1910-1955 to add to the debate on the Great Depression banking crisis, the 1937 "liquidity trap", and general trends in the interwar cost of capital. There are also useful additions from the market community. Notable additions include Loeys (1994), writing at the height of the "Bond Massacre" in the same year. Loeys applies a simple "peak-to-trough" measure to the US 10-year Treasury market to identify six bear bond markets between 1970 and 1993.[24] The contribution is valuable for its insights on the interaction of bond prices with other asset classes, and its closer investigation of fundamental triggers of sustained yield appreciations. The author specifically isolates inflation trends – rather than monetary policy announcements – as best correlating with bond price cyclicality. Still, Loeys' methodology is aimed at a non-academic audience, and omits any historical investigations prior to 1970. King and Low (2014) have presented a dataset for a "world" real interest rate, by incorporating global GDP shares to construct a G7 average based on inflation-linked sovereign bonds. Unfortunately, the index only spans the years between 1985-2013, hence not even encompassing the entirety of the present bond bull market. Haldane (2015) has referred to a long-term

[22] Homer and Sylla (1991), p.335.
[23] Idib., p.336.
[24] I thank Jan Loeys for sharing his 1994 presentation material.

nominal rate chart previously on the Homer and Sylla (1991) basis, but with no intent to study bond markets, or reference to real rates. His asset selection, meanwhile, contrasts with the one presented here, given methodological differences including, but not limited to, the 16th century.[25] The closest approximation of long-term real rate performance probably remains Clark (2005), who in an unpublished account used rental yield data for England to suggest a long-term falling trend.

1.3 ESTABLISHING THE YIELD PEAK AND BOTTOM

Following market and valuation practices, we treat the 10-year maturity point as the "risk-free" rate, or the most liquid long-term maturity point in pre-modern times.[26]

In the summer of 2016, under the impression of continued global monetary accommodation of government assets, a relatively new negative interest rate policy pursued by the European Central Bank, and the Bank of Japan, and "safe haven" purchases following a heightened sense of political risk among market participants emanating from the British referendum to exit the European Union on June 23, US government debt recorded yields never previously reached. On July 5, 2016, US 10-year government debt closed at an unprecedented 1.37%, undercutting previous lows in July 2012 (when rates had closed at 1.43% on July 25, 2012).[27]

One has to go back to the 1940s to find previous secular bottoms in US bond yields. The official "US Monetary Statistics 1941-1970" list the lowest "long-term" US government bond yield in the week of August 2, 1941, at a level of 1.97%.[28] The low for US 3-5 year issues is recorded for the

[25] Haldane (2015, p.31) does not provide the asset chosen for the 17th century; and does not report the "risk-free" rate of the dominant market economy, but rather the lowest rate per se. His long-term rates between 1575-1735 peak below 10%; the data presented here records meaningfully higher nominal yields for the Italian city states.
[26] Damodaran (2008), p.9.
[27] Global Financial Data. The November 1945 yield levels were reached against the maintenance of Federal Reserve System wartime purchases of US government debt, amounting to USD 5.4bn for 1945, representing 9.7% of net federal debt increase. Cf. Meltzer (2003), pp. 597ff.; Federal Reserve Bank of St. Louis, FRED database. These nominal lows were thus reached before the 2.5% long-term yield cap on US bonds went into effect in November 1947, see Chaurushiya and Kuttner (2003), p.7.
[28] Cf. Federal Reserve Board (1976), p.728. "Long-term" for the period 1941-1960 is defined by the Federal Reserve Board as 15-year maturity.

week of September 6, 1941, at a level of 0.58%. For market yields in 3-month bills, it is the week of February 15th, 1941, at just 2 basis points.[29]

Homer and Sylla (1991) record a pre-war monthly-basis low of 1.85% for 1941, with a 12-year government securities basis. The underlying Federal Reserve Board data reveal the weekly-basis low as 1.83% in the week of November 1, 1941.[30]

David Durand and Willis Winn in their 1947 paper on bond market patterns provide duration-adjusted yields going back to the 1920s, and record the low for 10-year US Treasury paper at the end of the first quarter 1946, at 1.40%.[31]

Compared against several, well-known existing official sources, it can thus be established that the global risk-free asset – in our time the 10-year constant maturity bond – indeed reached its lowest nominal yield ever in July 2016.

The respective all-time peak in nominal yields is recorded in the late 15th century – in 1475 on the nominal basis, at 19.2%, and in 1480 on the real (7-Y MA) basis, at 21.1%. The period is marked by the "Great Bullion Famine", and deflationary tendencies related to spiralling current account deficits to the Levant, and the Ottoman takeover of Balkan silver mines (Day 1978), both trends depleting European bullion funds. While interest payment delays were equally common in many European cities at this stage, these are more likely a consequence of the international coin shortage, and principal repayments were never affected. Keynes (1924, pp.162f.) in the interwar period has referred to the dynamics as a historical precedent for forced deflationary monetary contraction under the bullion standard automatism.

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[29] Ibid., p.697.
[30] Cf. Homer and Sylla (1991), p.352; Federal Reserve Board (1943), p.474.
[31] Durand and Winn (1947), p.14. Partially tax-exempt US Treasury bonds recorded in their tables are not included, given the unattractiveness for commercial investors, and their consequent inability to serve as broader "risk-free" instruments (Cf.: Ibid., p.16). Homer and Sylla (1991) equally focus exclusively on taxable bonds (p.352).

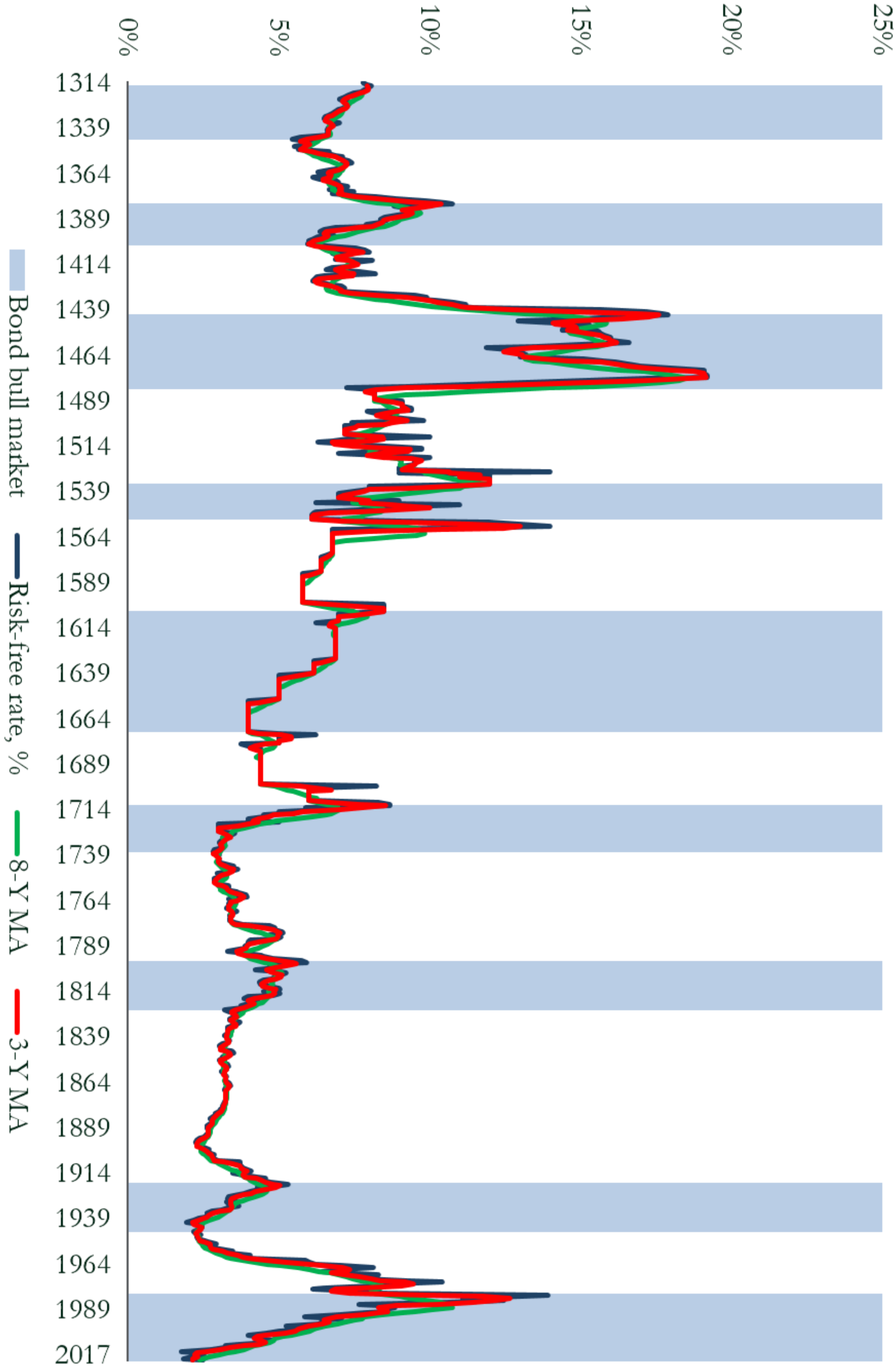
1.4 LONG-RUN TRENDS IN REAL RATES, NOMINAL RATES, AND INFLATION

Having established a suitable dataset of publicly-issued assets representative of the respective risk-free issuer of the time, we can proceed towards a comparative investigation of bond bull market lengths, and their intensities. Based on our annual frequency records, the first key step consists in arriving at a satisfactory definition of “bond bull markets” thus far found wanting in Homer and Sylla (1991), or Loeys (1994). It is put forward here to define a “secular bond bull market” as exhibiting the following characteristics: a compression of the risk-free rate between a local (global) maxima and a local (global) minima in headline yields of at least 5bps per year on average, over a period of at least 10 years. Furthermore, a “secular bond bull market” ends only if in addition the 3-year moving average yield crosses the 8-year moving average yield. The latter condition is applied to distinguish short-term trend reversals from the more fundamental inflection points that are of ultimate interest. Such boundaries will never fully be able to elude charges of arbitrariness. The practical effect here – as demonstrated in the case studies in the appendix – serves to extract from two instances of multi-decade yield compressions their most relevant, and most intense “bull market phases”, and the methodology in that context should stand scrutiny on practical terms.[32]

Based on this definition, we can proceed to identify a total of nine nominal “secular bull markets” in risk-free government bonds since the year 1311, highlighted in Chart 2.

[32] “Intensity” is here defined as average yield compression per annum over the cycle length.

CHART 2: THE NOMINAL RISK-FREE RATE AND (NOMINAL) BOND BULL MARKETS.



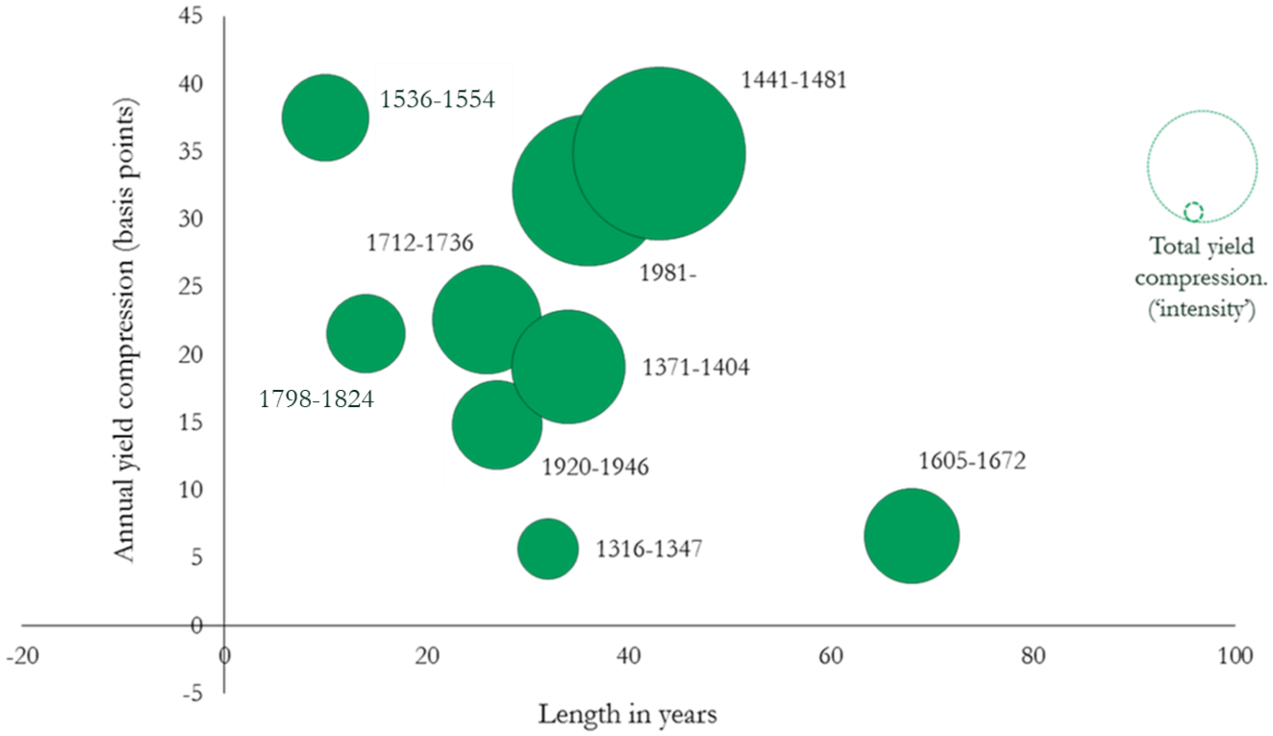
Our sample of secular bond bull markets is characterized by the following properties: secular bond bull markets have lasted between 10 and 68 years over the last eight centuries; on average, during these episodes the risk-free rate has compressed by a range of 5.7 – 37.5 basis points annually, with the global average during secular bond bull markets thus at an annual compression of 21.7 basis points. The cumulative yield compression from peak-to-trough ranges between 182 and 1500 basis points. Chart 3 exhibits the nine bull market cycles across length, and intensity features.

Which trends are observable over time? From the outset, it is evident that secular bond bull markets' variability was higher in the early phases of our sample (the Italian, Renaissance period for the risk-free rate) – with both the least intense, and most intense secular bond bull market being recorded relatively early (in the 14th and 15th centuries respectively). Between the late 15th and late 20th century, the intensity of bond bull markets broadly trended lower, alongside the downward trend in overall nominal rates.

The present bond bull market originating in 1981 – despite closing 36 basis points higher at the end of December 2016 over the previous December – still has the potential to surpass the 1441-1482 bull market in intensity (though at the present trajectory this would require another eleven years at continued rate compression trends). It is, however, already the second most intense bull bond market, with a significant margin to the 1371 cycle, and could still become the second longest bond bull market, potentially overtaking – once again – its 1441 predecessor by the year 2019.[33]

[33] At the time of writing – March 2017 – all conditions remain in place for 2017 to sustain the current secular bull market trend. Based on current rising nominal yield trends, in real rate terms the present bond bull market would come to a secular end in early 2020.

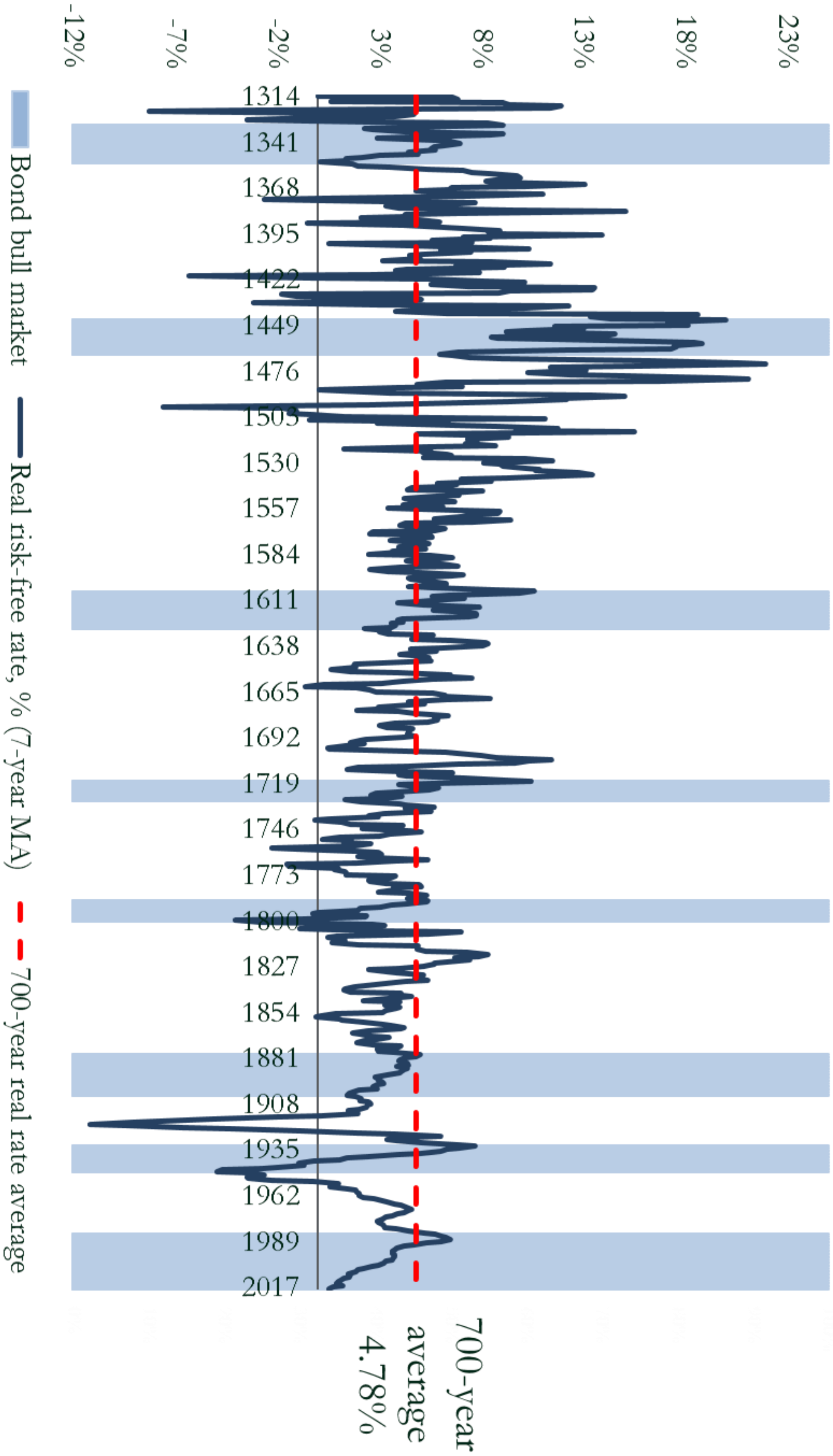
CHART 3: THE NINE SECULAR BOND BULL MARKETS: LENGTH, AVERAGE ANNUAL YIELD COMPRESSION, TOTAL YIELD COMPRESSION ('INTENSITY').



We now turn to real rates. Chart 4 shows our nominal rate dataset, adjusted by ex-post annual inflation rates since 1311. The data charted represents a 7-year moving average of individual annual real rates, given significant price volatility in the 14th and 15th centuries. We therefore smooth out volatility here, and equally incorporate more closely an approximation of forward-looking inflation expectations, as a function of past realized inflation.[34] There are only marginal differences if the moving average is adjusted up- or downwards.[35] We choose the respective inflation rates most closely linked to each particular issuer of the risk-free asset, as recorded for major European cities since the late Middle Ages by Allen (2001). The CPI basket includes the key food items, energy prices, linen, soap, and candles, and is based on institutional, urban price data.[36]

[34] On the weak performance of model-based inflation expectations versus "naïve approaches", see Atkeson and Ohanian (2001), and Fisher, Liu, and Zhou (2002).
[35] For the simple annual ex post real rate chart, see Appendix, Chart 1.
[36] For a discussion of the underlying methodology, see Allen (2001).

CHART 4: THE REAL RISK-FREE RATE SINCE 1311, AND (REAL) BOND BULL MARKETS.



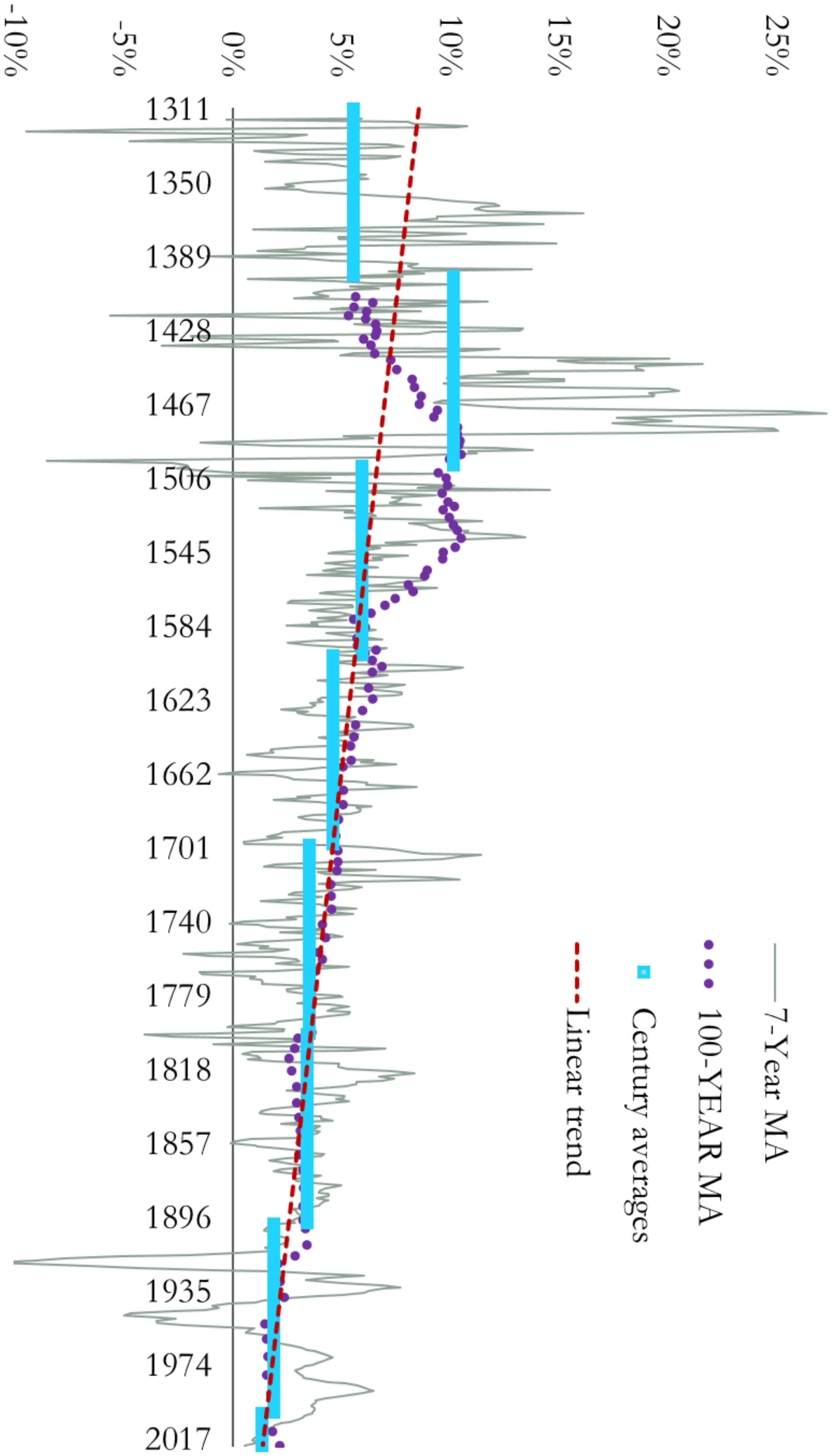
For the period until 1700, we rely on Allen's (2001) year-on-year CPI data for Northern Italy (1311-1508), Valencia (1509-1600), and Amsterdam (1601-1700), and afterwards on the CPI data reported by the Thomas and Dimsdale (2017) for the period of 1700-1919, as well as German (1908-13, 1962-80) and US y-o-y CPI (1919-62, 1981-present) for the remaining years.[37] The dataset reveals a number of interesting general features over its 700-year span: the average real rate since 1311 stands at 4.78%; the average real rate in the last 200 years stands at 2.58%. On both measures, therefore, current real rates (at 0.65% as of autumn 2017) are historically depressed. In fact, the year-end 2016 real rate (0.81% moving average) falls just short of the 95th-percentile threshold for the lowest real rates across the dataset.[38]

The lowest real rate ever is recorded in 1948, at -5.3%, following World War Two – under the impression of official debt purchases, yield caps, and parallel exalted wartime inflation rates (cf. footnote [27] above). Our sample of real rate bond bull markets (alternatively: "ex post real rate depression" periods) shows the following properties: in nine periods, the compression of the real rate fulfils the conditions for a "bull market", ranging from a total compression of 1724 basis points between 1325-1353, to 582 basis points since 1984. The average annual yield compression during these periods has been 47.5 basis points; the most intense real rate bond bull market was experienced between 1933 and 1948, at an annual average 81.6 basis points compression. The average length of bond bull markets stands at 25.8 years, with our present real rate bond bull market, at 34 years, already being the second longest ever recorded.

[37] For the UK inflation rate, see Thomas and Dimsdale (2017), "A Millennium of macroeconomic data", Tab A.47; German inflation data as per Bundesbank (1968) and Bundesbank (2017), and US year-on-year all-item CPI as per FRED data. Allen's (2001) wage and price data is available at http://www.iisg.nl/hpw/allen.rar. For the years 1311-1325 we use Allen's recorded wheat prices for Florence, switching to his broad Northern Italy CPI basket from 1326

[38] In 38 years since 1311, we record lower real rates than at year-end 2016, equivalent to 5.4% of observations.

CHART 5: RISK-FREE REAL RATE: CENTURY-, LINEAR-, AND 100-YEAR MOVING AVERAGES.[39]

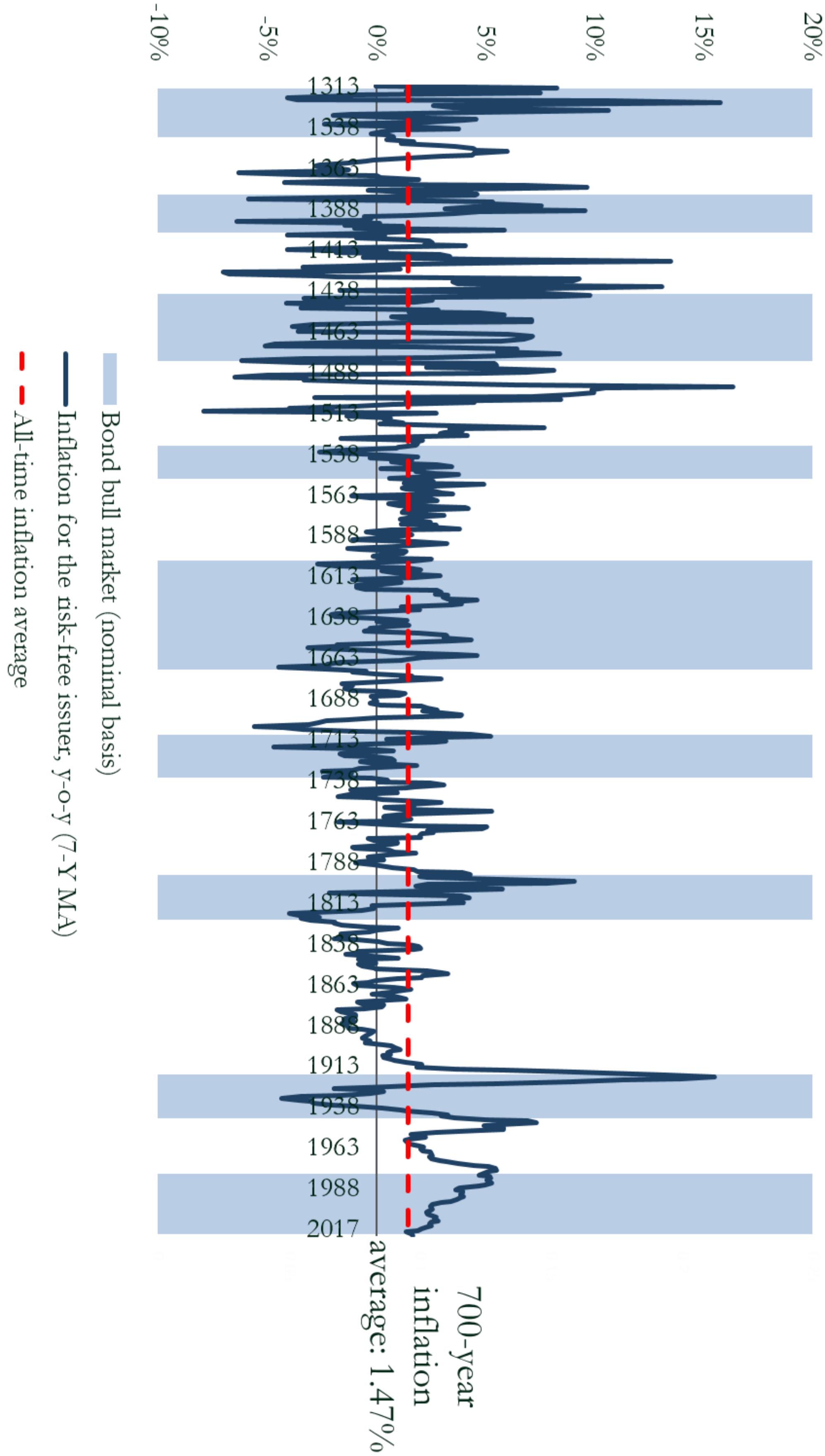


[39] I thank John Lewis for designing chart 5.

Chart 5 illustrates that long-term risk-free real rates have exhibited a downward trend for a prolonged time, an observation confirmed by a variety of possible aggregation measures. After significant volatility between the early 1300s and the late *Quattrocento* – a period which by itself already exhibited a slight downward trend – real rates fell on a consistent basis both on a "simple linear trend" measure, measured by "century-averages", or by a 100-year moving average. "Century average" real-rates fell every century from 9.43% in the 1400s, to 3.43% in the 1800s, 1.84% in the 1900s, and 1.24% in the 2000s (2000-2017). The 100-year moving average similarly peaks in the year 1607 at 9.67%, and records a low of 1.57% in 1979. Since then, it has gained approximately 30 basis points, closing at 1.86% in 2016. On a purely linear trend line, real rates on average fall by 4.1 basis points per annum since the all-time peaks in the 1450s. This slope has only marginally flattened on a 200-year horizon, with the average real rate decline since 1820 at 3.9 basis points per annum. These findings should qualify oft-advanced theses on the distinctiveness of the post-1980 "secular stagnation" trend fall in global real rates (Cf. Rachel and Smith, 2017; Bean et al., 2015): the episode of rising real rates in the mid-20th century, rather than the subsequent "reversal to historical trend fall" in many ways stands out as the outlier in the (very) long-term context. Declining real benchmark rates have in fact deep historical origins.

We can further decompose the real rate, and – having isolated the nominal rate in Chart 2 – consider underlying inflation rates separately for the respective risk-free issuer over time (Chart 6). The average annual inflation rate since the year 1311 stands at 1.47%.

CHART 6: ANNUAL INFLATION FOR THE RISK-FREE ASSET SINCE 1311.



The annual inflation rate over the last 200 years stands at 1.66%. Indeed, over the entire timespan, annual inflation rates timidly accelerate, rising on average 0.3 basis points per annum. Accounting for more than 75% of the aggregate decline in the real rate trend since 1311, the compression in nominal rates clearly represents the dominant driver since the late *Quattrocento*, falling on average just over 1 basis point per annum.

PART 2: BOND MARKET REVERSALS IN THE 20TH CENTURY

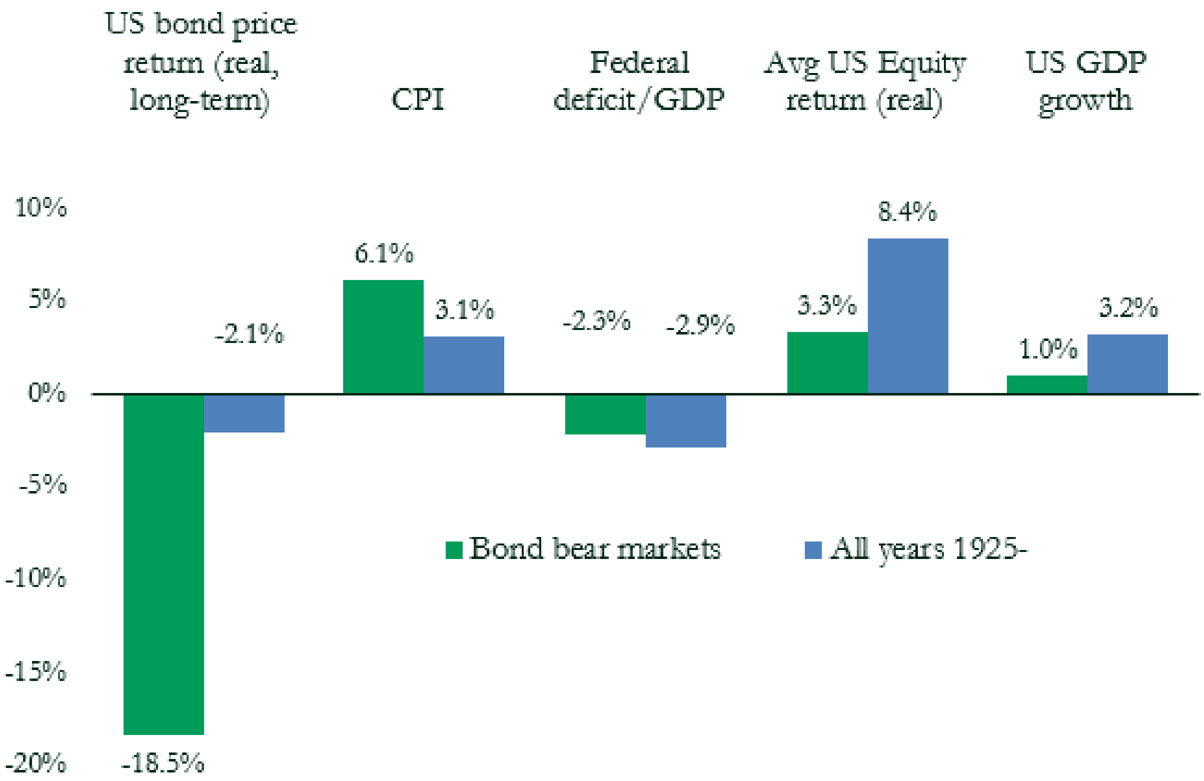
2.1 AGGREGATE FEATURES

To consider the flipside of "bond bull markets", I focus on the 20th century, and present case studies as a way of teasing out drivers of inflection points. This may help understand better the conditions that have contributed to bursts in bubbles in the past.

It is instructive first to consider the general features associated with "bond bear market years" for the current issuer of the global risk-free asset, the United States (Chart 7). A bond bear market year in the following discussion is defined as a decline in real price terms for the 10-year US Treasury bond of at least 15% over the span of one year. We thus exclude coupon payments – which are static, irrespective of market or fundamental conditions – from the definition, as the price dynamics present us with a "raw" assessment of investor risk perception of the bond market. Bond return data come from Barclays' *Equity Gilt Study* 2017. For the macroeconomic data, on Federal Reserve Bank of St Louis data (FRED), and the Congressional Budget Office (CBO) for budget data; we rely on Damodaran (2016) for equity returns.[40]

[40] CBO historical budget data published at: https://www.cbo.gov/about/products/budget-economic-data#2 ; Damodaran (2017). Underlying dataset available at author's website at: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html; U.S. Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers: All Items [CPIAUCSL], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CPIAUCSL, June 16, 2017.

CHART 7: GENERAL MACROECONOMIC PERFORMANCE IN “BOND BEAR MARKET YEARS”, SINCE 1925.



Sources: Barclays (2017), CBO (2017), Damodaran (2016), FRED (2017).

The results are summarized in Chart 7.[41] We observe, first, that “bond bear market years” are associated with a consumer price inflation rate almost double the long-term annual average; controlling for inflation, however, equally reveals that “bond bear market years” are not simply “high inflation years” - which may trigger recession or monetary tightening fears: even in real terms, “bond bear market years” stand out on their own, returning more than 18% in real price losses to investors. However, “bond bear market years” are associated with a general underperformance both in broad GDP and other asset markets, particularly equity markets. Perhaps most surprisingly, we find that bond bear market years are actually associated with lower-than-average federal fiscal deficits: in other words, higher bond issuance (higher bond supply) has not been a prime driver of bond sell-offs since 1925.

[41] Barclays (2017), Barclays US Bond index, pp.87f. Barclays defines “long term” US bonds as a blend of 10-year and 30-year instruments with an average maturity of 11.2 years.

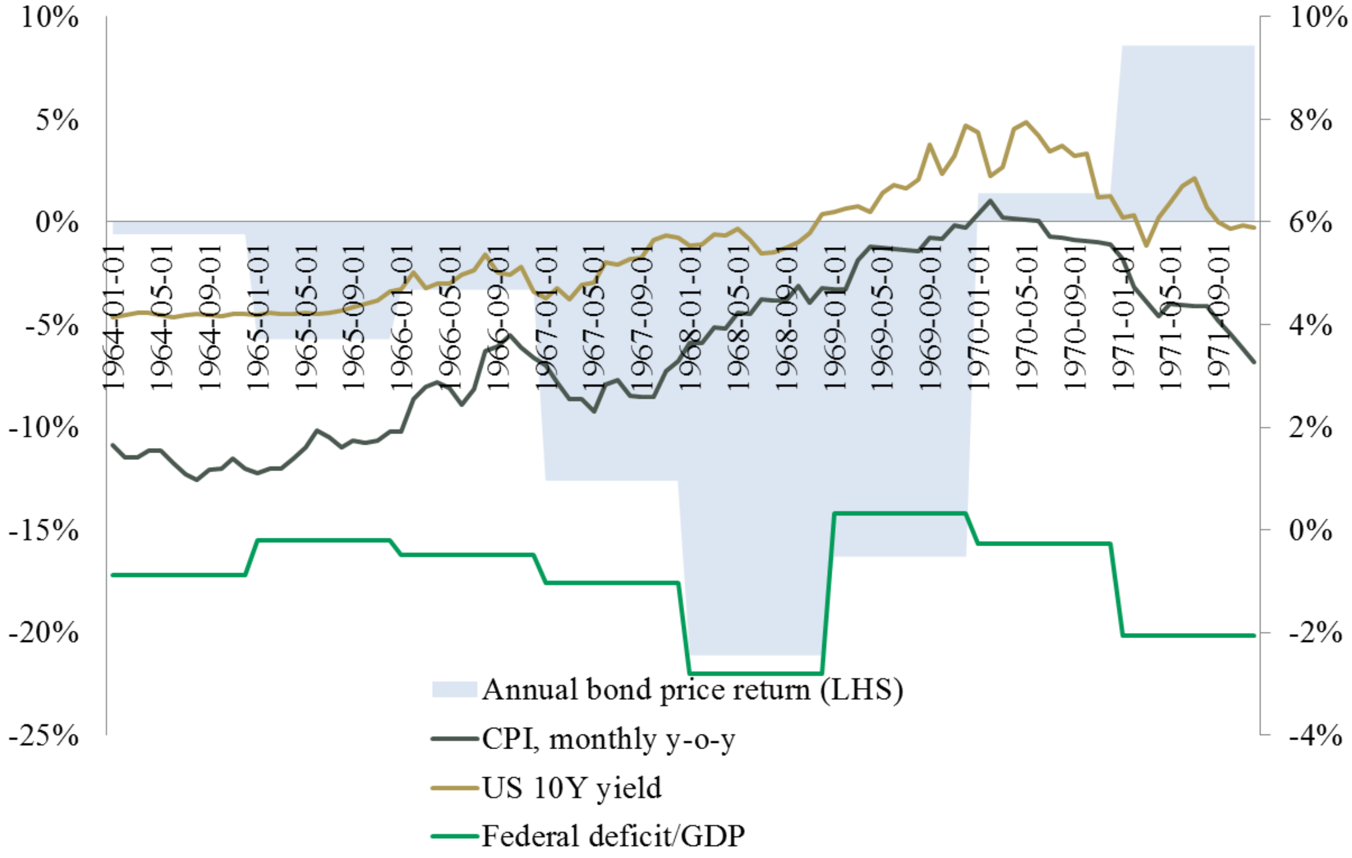
We proceed with three case studies to offer a closer look at the dynamics explaining three notable bond market reversals. These case studies are illuminating for their demonstration of the different drivers of such steep sell-offs, and can respectively be labelled the “fundamental reversal”, the “central bank (mis)-communication reversal”, and the “curve steepening reversal”.

2.2 THE 1965-70 “FUNDAMENTAL REVERSAL”

The first example marks the deepest multi-year period of negative bond market returns for investors in the 20th century – who lost 36% in real price terms between 1965-1970. In what can be adequately termed the “fundamental reversal”, I qualify the claim that on the aggregate level, sharp bond losses are not *per se* explained by inflation triggers. From a year-on-year rate of change of just 1.09% in January 1965, the consumer price inflation index in this period picked up sharply, to a peak of 6.42% in February 1970, thus almost rising six-fold in a matter of as many years. Equally important was the previous protractedness of low inflation: not since October 1958 had the year-on-year CPI surpassed even 2%. The increase was not driven by volatile food or energy, but by core items: today’s more prominent “core PCE” measure showed an identical trend, last recording levels above 2% during the expansion cycle in May 1960 – before rising sharply from 1.30% in early 1965, to above 4.70% in late 1969.[42]

[42] “Core PCE” denotes “Personal Consumption Expenditures”, excluding food and energy price changes. Data from Federal Reserve Bank of St. Louis database (FRED), cf. above.

CHART 8: THE 1965-1970 “FUNDAMENTAL BOND MARKET REVERSAL”.



We can see from the data that losses accelerated together with increases in inflation as measured by year-on-year CPI (Chart 8). The worst year for holders of long-term US Treasury securities is marked by the year 1968, when real price losses totalled 21.1%. 1968 equally marks the year with the fastest rise of consumer price inflation during the period, rising a total of 140 basis points throughout the year, to 4.2%. The following year marked another 120 basis point rise in consumer inflation, coupled with the second largest price losses in the period under investigation, a total of -16.3%. Peak annual consumer price inflation and peak 10-yer yields both fall in the first half of 1970, after which bonds very slowly began recouping their losses.

The chart also suggests an association between bond performance and fiscal indicators. Higher deficits, spurred by higher war-related defense spending, and Lyndon Johnson’s 1964 tax reform, coincided with investor losses – as the federal deficit widened from 0.2% in 1965 to 2.7% in 1968. It is notable however, that for investors, the turnaround in price dynamics by the early 1970s appeared more important than the – once more worsening – fiscal performance: despite an expansionary swing of the federal deficit by 60 basis points of GDP between 1969-70, the bond bear market came to an end that year.[43]

Meanwhile, the Federal Reserve reacted to, rather than initiated, dynamics in the bond market: already by the spring of 1965, money growth and US Treasury bond yields showed strong signs of appreciation, prompting "concern" at the Board. But only in December 1965, in a contested vote, and against the administration's preferences, did Chairman Martin find support to resume rate hikes, in what became subsequently known as the "stop-and-go" sequence of increases.[44]

What drove inflation? It is key to single out the labour market as a factor for accelerating broad price rises; the civilian unemployment rate (U3) reached a 15-year low in 1968, at just 3.6%, and fell another tenth of one percent in 1969, as bond losses mounted. At the same time, previous authors have pointed out the rising bargaining power of the currently employed proved strong: in consequence, average hourly earnings soared from 3.8% year-on-year in 1966, to 6.3% just three years later.

The decade of the 1960s appear to hold particular relevance to our current bond and interest rate environment, which exhibits a similar longevity of unprecedented low rates of inflation, policy rates, and inflation expectations, before showing sharp signs of acceleration emanating from labor market pressures. As previous authors have pointed out, observers in 1965 were certainly trapped in a "lower-for-longer inflation rate consensus belief" (Mertens, 2016). Academics and policymakers have recently realized the close parallels existing to the present day, and drawn inferences for the currently expected inflation path.[45] Though key idiosyncrasies exist – including the absence of official inflation targeting by central banks in previous cycles – such parallels also extend to Phillips Curve dynamics (Blanchard, 2016), and thus could prove most meaningful for forward conditions in bond markets.

[43] See Fessenden (2016) for details on the timing of Lyndon Johnson's tax reforms, and the Federal Reserve Board's response.
[44] Ibid; Chairman William McChesney Martin all but acknowledged the reactive nature of the Federal Reserve in a speech several days after the decision, in which he rationalized the hike as a response to the threat of an "inflationary boom" in the economy. Cf Martin (1965).
[45] Cf. a notable speech by former Richmond Fed President Jeffrey Lacker in March 2017, Lacker (2017); Fessenden (2016) provides an academic viewpoint.

2.3 THE 1994 "BOND MASSACRE"

Our second case study concerns the turmoil in US bond assets over the course of 1994 – dubbed by popular accounts the "Bond Massacre of 1994".[46] From peak to trough, US bond futures lost no less than 20.9% over the span of 274 trading days, or an annualized 19.3%.[47] The only academic investigation thus far remains Borio and McCauley's (1995) account – in which the authors dismiss both fundamental, as well as monetary policy variables as explanations for the sell-off. In real price terms, the losses (-16.5%) for investors rank below those of 1968, as prices started recovering towards the end of 1994.

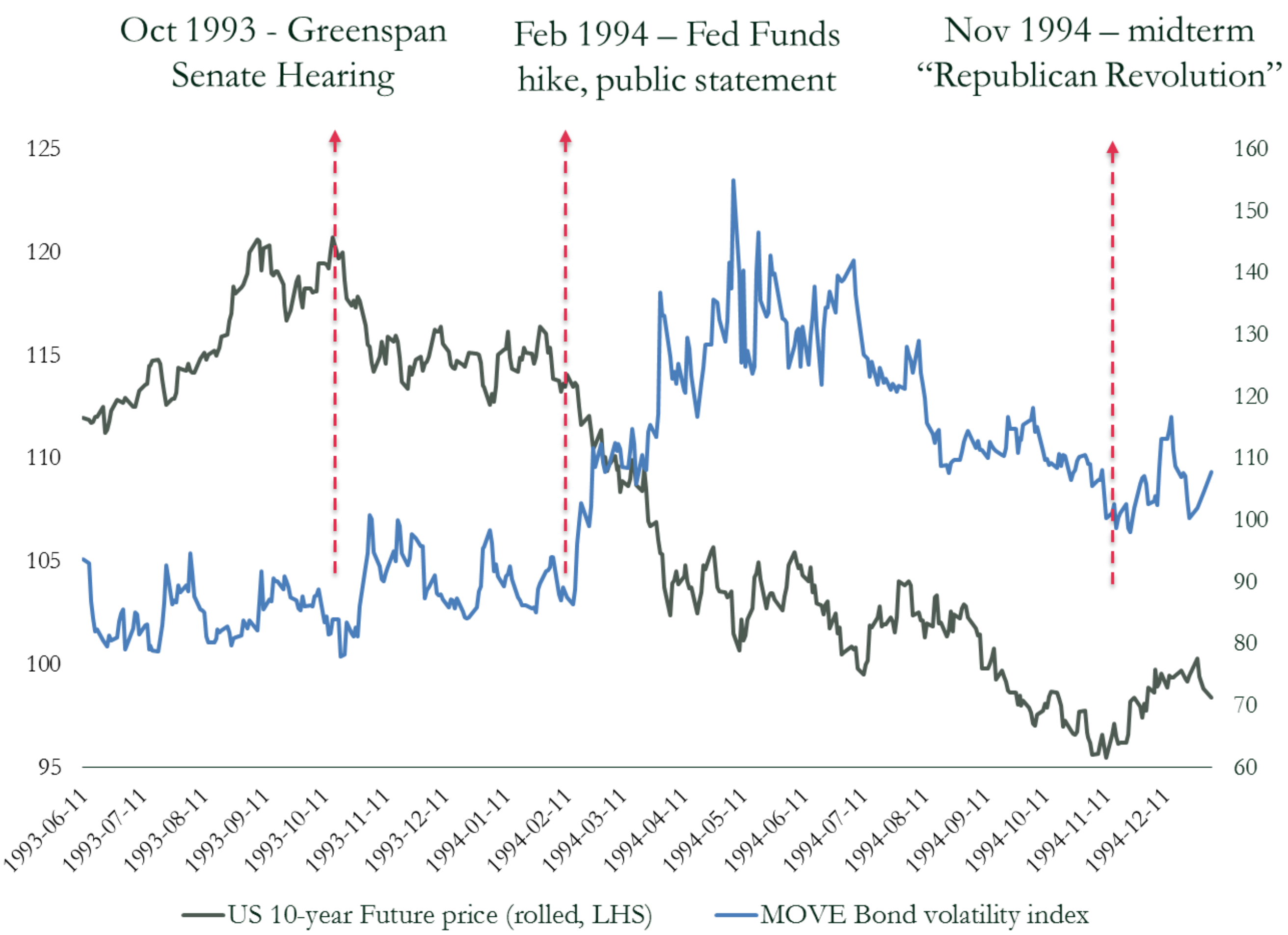
What distinguishes the episode? In contrast to Borio and McCauley (1995), journalistic accounts put much relevance on the February 1994 fed funds hike – the first since May 1989.[48] Against the background of relatively stable inflationary forces, the February 1994 hike has been described as a "well-timed preemptive increase" which "laid the foundation for the boom that followed" (Goodfriend, 2002). Monthly year-on-year headline consumer price inflation averaged 3.0% throughout 1992-3, and fell below that level from July 1993 until well into 1994. However, forward looking inflation expectations remained range-bound in late 1993 (Chart 10), and did not signal the need to "pre-empt" an upcoming surge in prices: the 12-month median expected rate of consumer price inflation trended downward from mid-1993 (at 3.3% in July, but 2.8% in November 1993, to which it also fell back in January and February 1994, after a brief 20 basis point rise in December 1993, Cf. Chart 10 below).[49]

In the FOMC minutes for the February 1994 meeting, participants were rather upbeat about the state of the US economy: a "strong advance in economic activity during the closing months of 1993" was coupled with "sharply" increased industrial production, "continued buoyancy in consumer

[46] Fortune Magazine, "The Great Bond Market Massacre", October 17, 1994, pp.77-92.
[47] We use rolled US bond future price data provided by Chicago Mercantile Exchange Futures, and for annualized performance assume 252 trading days per annum.
[48] Fortune Magazine, Ibid.
[49] University of Michigan, Survey of consumers: inflation expectations. Retrieved from FRED, Federal Reserve Bank of St. Louis, accessed June 19, 2017.

demand", and "sizable gains in business investment".[50] Only in May 1994, however, the official Fed funds rate hiking cycle was initiated, with a 25 basis point rise.

CHART 9: THE 1994 "BOND MARKET MASSACRE".



Sources: Bloomberg, Global Financial Data.

However, it is important to note that realized bond market volatility (as measured by Bank of America's "MOVE index", a proxy for implied US bond market volatility) for the 10-year maturity inflected in October 1993 – a quarter earlier than the policy tightening by the Federal Reserve (Cf. Chart 9). Underlying 10-year market yields inflected on October 15, 1993, when they reached a bottom of 5.19%. The FOMC outlook for September 1993 did not indicate a hiking inclination yet: the growth pace was "moderate"; fixed investment seemed to be "slowing"; members noted an

[50] FOMC February 4, 1994 meeting minutes available at: https://www.federalreserve.gov/fomc/MINUTES/1994/19940204min.htm.

"environment of low inflation" and "cautious attitudes" prevailing among consumers, in the housing sector, and in construction. Non-farm payroll gains signalled an expansionary, but not overheating environment. Against that background, the decision has been characterized as a "pre-emptive hike", as only the second such instance since World War Two (Goodfriend, 2013). But, in addition, it seems that concerns about extended asset valuations did play a role in the FOMC's considerations. As early as March 1993, Lawrence Lindsey advocated to "put a little cold water" on asset valuations by raising policy rates by 25 basis points.[51]

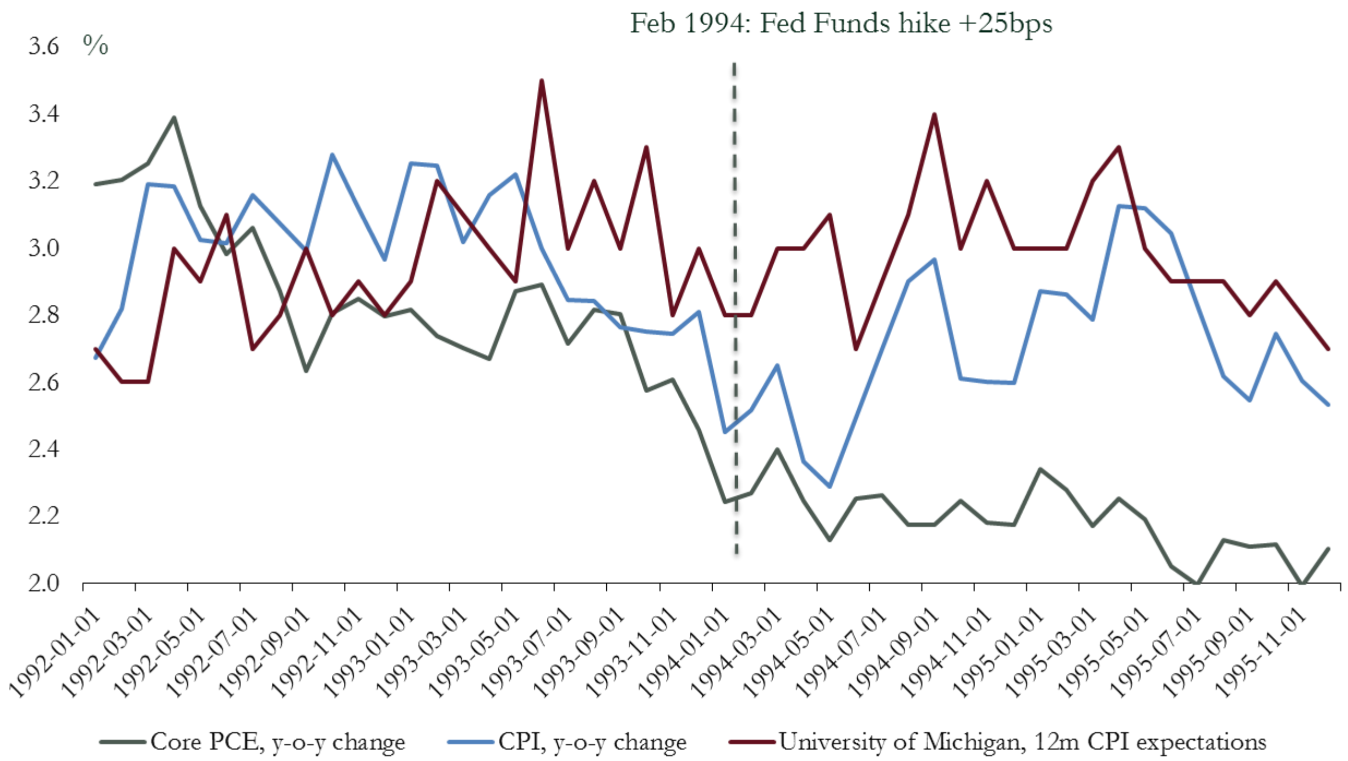
Interestingly, however, while the October yield and volatility inflection does not correspond well with changes in fundamentals, it exactly overlaps with a key hearing of Alan Greenspan at the US Senate Banking Committee, who came under heavy pressure from Democrats to increase transparency. The hearing provided few news in policy terms; however – to the bafflement of the audience – it revealed that policy transcripts of every FOMC meetings had been taped, a fact denied previously. Internally, however, Alan Greenspan was highly worried about the decision to publish decisions outright, fearing that an "immediate release could threaten to roil markets unnecessarily, and concern about market reaction could reduce flexibility in decisionmaking" (Blinder and Reis, 2005). But with both Democrats and raking Republicans raising pressure, the Fed found itself on the defensive. As an outcome of the hearing, the Federal Reserve agreed to publish policy statements and transcripts of its meeting to the public following its sittings from February 1994, a communication change seen in retrospect as a "milestone", and a "genuine surprise" to the public at the time (Haldane, 2017; Hansen et al., 2014; Lindsey 2003; Goodfriend, 2002).

US 10-year Treasury yields peaked on November 7, 1994, at 8.05%. Once more, the relationship with fundamentals at the end of the sell-off looks weak: year-on-year consumer inflation in 1994 peaked in September, at 2.94%, with the release – on October 14, 1994 – thus preceding the price bottom for US Treasuries by more than three weeks.[52] Such levels had furthermore been surpassed multiple times in the current cycle (including for almost all of 1992-3). Consumers' inflation

[51] Mallaby (2016), Chapter 20, Footnote 34.
[52] Cf.: "Inflation Fears Eased by Latest Economic Data - Consumer Prices, Retail Sales Show Moderate Growth; Industrial Output Steady", *Wall Street Journal*, October 17, 1994, p.A2; the flash estimate at the initial release was published as 2.8% year-on-year.

expectations rallied somewhat between June 1994 and September 1994, gaining 70 basis points, to reach 3.4%. But expectations had been declining for two months before the peak in yields, and higher inflation expectation levels were reached in 1993 without the associated bond market volatility.

CHART 10: US CPI, PCE and INFLATION EXPECTATIONS, 1992-1995.



Source: Federal Reserve Bank of St. Louis (FRED) Data, accessed June 24, 2017.

Rather, November 7, 1994 – the eve of the bear market reversal – marks the fortnight of the 1994 Midterm elections (today known as the “Republican Revolution”), when the oppositional “Grand Old Party” in a sweeping victory, and on a particularly conservative policy platform, overturned leadership of the house for the first time since 1946. Greenspan – a 1987 Republican nominee – could interpret the outcome as a rejection of Democratic attempts, as articulated ever more vocally since the 1993 Senate hearings, to curb existing status of monetary policy independence.

A plausible causal explanation of the turnaround, therefore, is the surprise by fixed income investors about the prospect of a radically more transparent central bank communication strategy, coupled with some concerns about its independence after a sweeping Democratic victory in the midterm elections, and a hawkish policy decision in February not necessitated by fundamentals. While this view contrasts with Borio and Macaulay (1995), monetary policymakers may thus be well-advised to consider the episode a downside scenario highlighting the consequences of poor policy communication. Given very similar communication mishaps surrounding the recent 2013 "Taper Tantrum" bond turbulence, these episodes suggest that still more attention needs to be paid to the historical bond market reaction functions by official rate setters.[53]

2.4 THE 2003 "VAR SHOCK" OR: THE "CURVE STEEPENING REVERSAL"

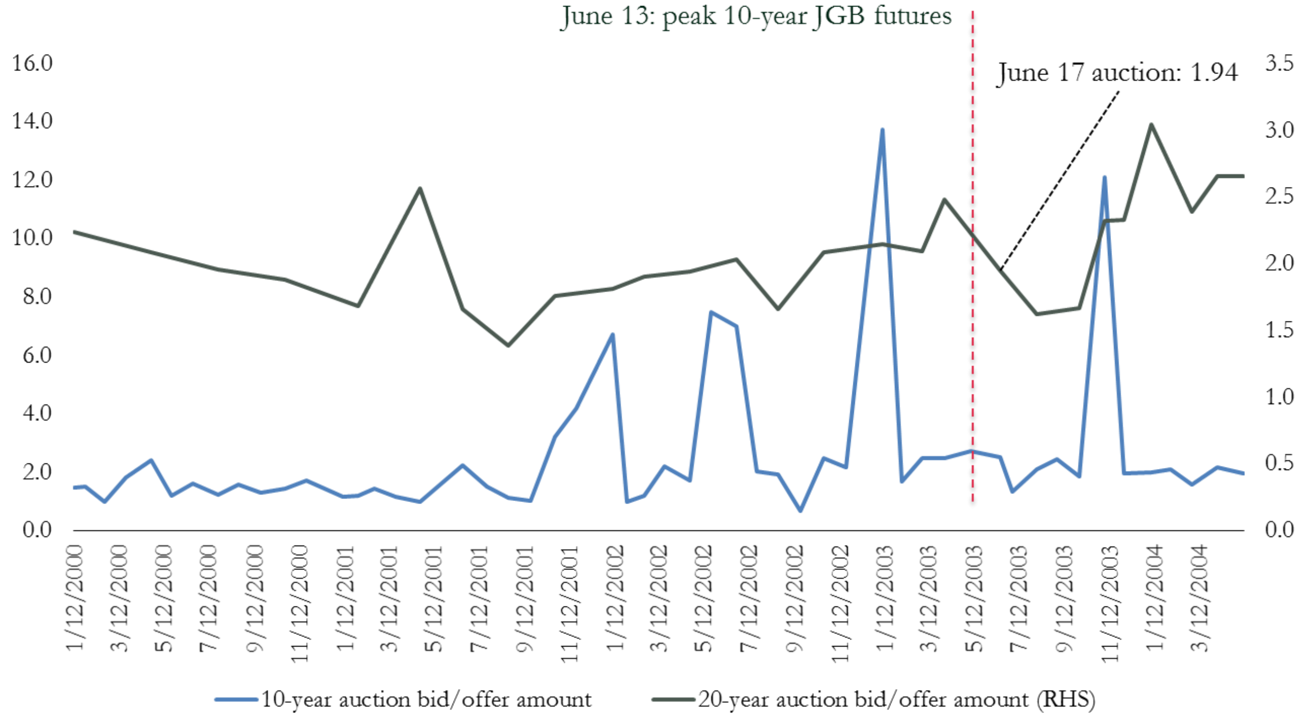
The concluding case study concerns the mid-2003 global bond market volatility – the biggest shock to bond markets on various measures since the 1994 turbulence (Packer and Wooldridge, 2003). We focus specifically on the "Value-at-Risk (VaR) Shock" in the Japanese Government Bond (JGB) market.[54] Both monetary policymakers and researchers (Sato, 2016; Tokuoka and Lam, 2011) have continued to issue warnings in recent years over a potential return of similar shocks, emanating from a high domestic concentration in sovereign debt markets.[55] Based on future contracts, Japanese bond investors lost 7.1% peak-to-trough over the span of 58 trading days, or an annualized 30.8%, thus outstripping the 1994 losses in US bond markets.

However, while the limited existing literature recognizes that in 2003 "in contrast to 1994, the most recent upturn in yields was not accompanied by a shift towards a more restrictive policy stance", as "the central banks of all the major economies continued an accommodative monetary policy" (Packer and Wooldridge, 2003), alternative explanations thus far are unconvincing. Packer and Wooldridge (2003) attribute some importance to a "failed" 20-year JGB auction on June 17, 2003, in

[53] See a brief synopsis of the "Taper Tantrum" in Neely (2014).
[54] For a "contemporary" official commentary, see Nakayama et al. (2004).
[55] Sato (2016) noted that from the vantage point of the Bank of Japan, he detected a "vulnerability similar to that seen in the VaR (Value at Risk) shock in 2003" given investors' appetite for very long term government bonds despite highly depressed curve steepness in mid-2016.

their rationale for a trigger. However, official data suggest that, with a competitive bid/offer ratio of 1.95, the auction does not stand out as particularly poor: in fact, the average bid/offer ratio since the beginning of 2001 in the 20-year tenor stands at 1.93.[56] In addition, the turnaround in JGB yields occurred five days prior to the auction (Cf. Chart 11).

CHART 11: JGB AUCTION RESULTS, 20-YEAR, AND 10-YEAR MATUTITIES, 2000-2004.[57]



To offer alternative explanations, it is crucial first to map out the broader macroeconomic trends in the Japanese economy prior to June 2003. The Bank of Japan as the first advanced economy central bank decided to pursue a large-scale "quantitative easing" program in March 2001, after experimenting unsuccessfully with a zero interest rate policy since 1999 to combat the strong deflationary forces in the economy (Baba et al., 2005).

Japanese government bond (JGB) yields compressed sharply as a result of these policies, from 1.42% on the 10-year maturities to a new historic all-time low of just 44 basis points on June 12,

[56] Japan Ministry of Finance, "Historical Data of Auction Results", available http://www.mof.go.jp/english/jgbs/auction/past_auction_results/index.html, accessed June 22, 2017.
[57] Source: Japan Ministry of Finance, "Historical Auction Results Data", accessed June 22, 2017.

2003. At the same time, the Japanese yield curve flattened significantly, with the 20-year maturity point in JGBs yielding just 76 basis points above 2-year maturities – compared to an average of 180 basis points in 2000-2; the spread between 2-year and the 30-year point compressed to 96 basis points, from an average of 208 basis points in 2000-2 (Chart 12).

In turn, the curve flattening put significant pressure on the domestic banking industry, whose maturity transformation business is generally dependent on the profiting from the spread between short-term liabilities (deposits) and long-term assets (loans). The industry's equity benchmark, the TOPIX bank index, lost no less than 64% between the announcement of the quantitative easing program in March 2001, and April 2003.[58] A number of institutions did not survive the profit squeeze, with Resona Group, the country's fifth-largest lender, being the most high-profile victim in June 2003 (Cf. Chart 12).

The flattening of the sovereign curve, the clouds over the banking sector, and the uncertainty over the Bank of Japan's leadership – which saw the inauguration of a new governor in Toshihiko Fukui in March 2003, and had previously pledged a review of its debt purchase program once a "stably zero percent or an increase year-on-year" in CPI was recorded – led to increased bond market volatility, as exhibited by the "Value-at-Risk" measures widely-used by the banking houses to manage duration exposure. A rise in JGB volatility would increase the potential "maximum daily losses" in banks' bond portfolio, and thus such risk models would prompt the sale of bonds (Malz, 2011).[59] Bank equity returns, meanwhile, are in our sample generally impacted negatively by yield curve flattening: between the third quarter 1993, and November 1994, for instance, the S&P 500 Financials Sector Index underperformed its composite parent by 14.2%.[60] But the Japanese case was exacerbated by its traditionally heavy home bias in sovereign debt ownership: by 2003, more than 95% of sovereign debt was domestically owned, in what counted as one of the highest shares among advanced economies (MoF, 2004; Lam and Tokuoda, 2011; Arbatli et al., 2016).

[58] Data source: Global Financial Data. The index closed at an all-time low of 123.9 on April 28, 2003.
[59] For a description of the practices from the practitioner's side, see Mizuho (2004), pp.46-7; a theoretical discussion in Malz (2011), chapter 3.
[60] Global Financial Data. Week of November 19, 1994, versus week of October 2, 1993.

The VaR Shock can be separated into two distinct phases. First, from the all-time low on June 13, Japanese yields rose sharply, gaining 72 basis points over just 18 trading days, to close at 1.16% on July 8th, 2003. The second phase began after a normalization period, on August 11, 2003, when yields rapidly gained 74 basis points, to close at 1.62% - a level last recorded in January 2001, months before the "QE" announcement.[61]

Fundamentals did play a meaningful, but not sufficient, role in Japan's case: following the QE decision in March 2001, Japanese CPI remained sluggish at first, and indeed fell to a new year-on-year all-time low by February 2002, at -1.63% y-o-y. From then onwards, however, the situation improved, and inflation steadily gained momentum until – by March 2003 – it reached just -0.09%. Given the BoJ's prior conditionality to leave QE in place until inflation reached "stably zero", concerns emerged about a potential tapering. However, while such fears contributed, the two most recent inflation data points prior to the sell-off once more showed a more pronounced return to deflationary territory: in May, year-on-year inflation declined to -0.2%, and worsened further In May 2003, the BoJ increased its target range for JGB purchases to "around 27 to 30 trillion yen", citing the Resona bailout and SARS as reasons for continued market uncertainty. The market, however, took the decision as a hawkish turn, expecting a bigger expansion of targets.[62]

From some contemporary risk reporting, the strict reliance on VaR signals by the major Japanese banks can be gauged. Mizuho documented its adherence to the internal models vis-à-vis investors in its annual reports at the time. From its data, it is evident that the June sell-off in JGBs was preceded by a rise in Mizuho's VaR to record levels above JPY 250BN, after which they dropped sharply in parallel to the rise in bond yields; by early September, Mizuho's VaR had dropped to just JPY 78.9BN.[63] Underlying high-frequency reported VaR reveals that the major banks tried to opportunistically gain from the bond turbulence. Mizuho, after scaling back daily VaR to levels below JPY 100BN in early September, almost doubled its risk tolerance once again in the banking

[61] Global Financial Data records January 10, 2001 as the last comparable closing quote, at 1.65% for the 10-year maturity.
[62] "BoJ move won't cut mustard", The Daily Yomimuri, May 21, 2003, p.8.
[63] Mizuho Financial Group, Annual Investor Report Fiscal Year 2004, pp.46-7.

department until the end of the month, while in the more short-term oriented trading book, it increased VaR by more than a third during the "second wave" of the shock, until early September.[64]

What most markedly distinguishes the 2003 episode from its 1994 predecessor – which exhibited an undisturbed flattening of US bond yield curves[65] – are the clear positive externalities which stabilized JGB demand, and emanated from the steepening of the Japanese yield curve: corporate balance sheet data from the "Big Three" Japanese mega banks show that such institutions eventually increased their exposure to JGB assets until end of September 2003 – despite recording significant unrealized book losses on their JGB portfolios. Between March 30, 2003, and September 30, 2003, Mizuho, Sumitomo, and MUFG witnessed a decline of no less than JPY 742BN in JGB book values. Yet, the three banks increased total JGB assets by more than 16% in just 6 months (Chart 13). More granular data also confirms that the banks particularly increased exposure to short-term government debt as they recalibrated VaR levels between August and late September – a behaviour consistent with expectations of a "bull steepening" scenario and a continued dovish stance by the Bank of Japan. By August, bond inventories had declined markedly in value terms over March, to then recover for until the next reporting period.[66]

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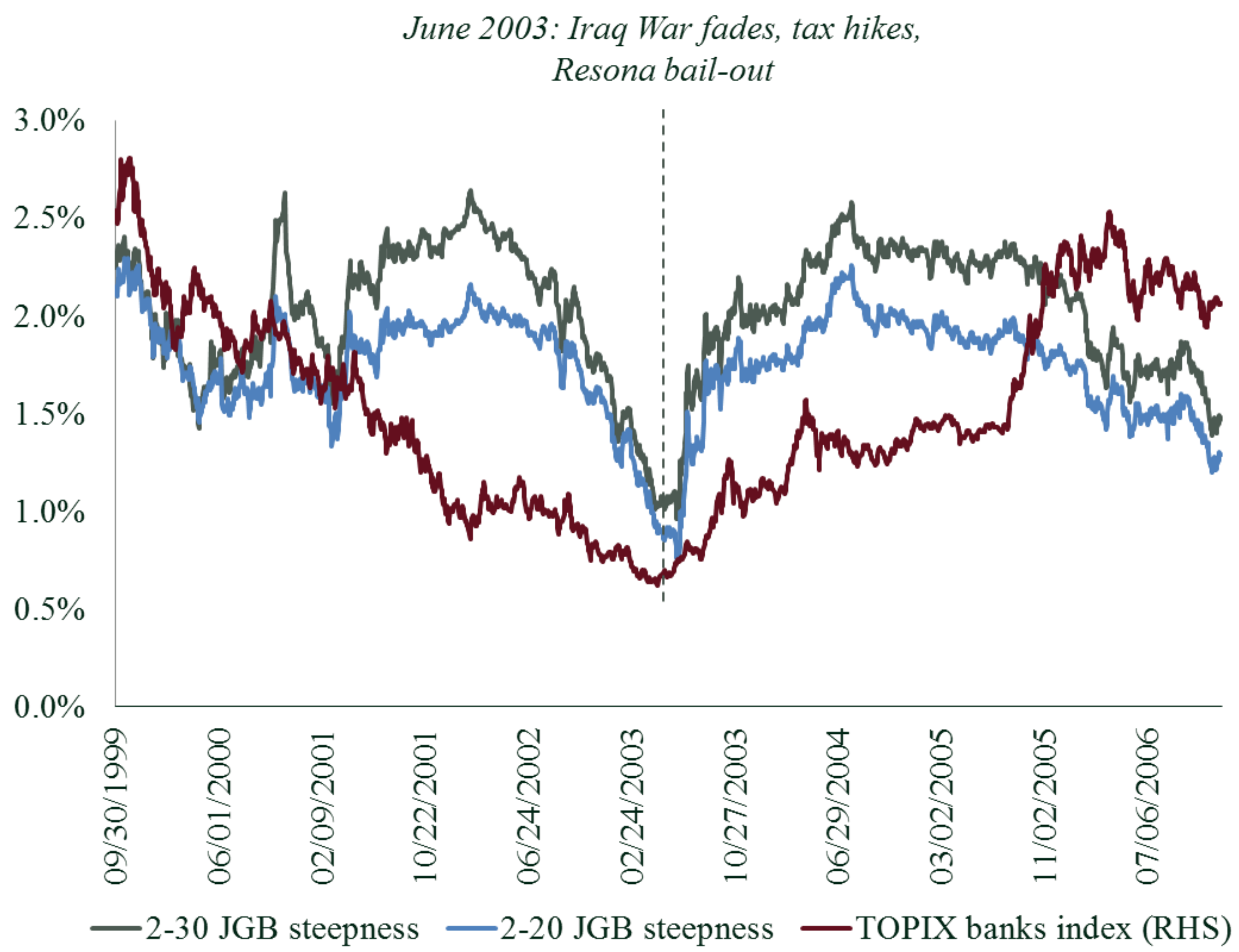
[64] Mizuho (2004), Charts on p.47.
[65] Peak 2-10 US curve steepness in the period concerned was reached on January 24, 1994, at 1.65%, and fell to a low of no less than 9 basis points on December 27, 1994. Cf. FRED data.
[66] In Mizuho's case by 99% over the 6 month horizon, to JGB 7.1TN, for maturities up to 12 months; in MUFJ's case, short-term JGB exposure rose 53% between March and September, to JPY 5.5TN.

CHART 12: THE 2003 “VAR-SHOCK” IN THE JAPANESE GOVERNMENT BOND (JGB) MARKET: CURVE STEEPNESS, TOPIX BANK EQUITY INDEX.



Source: Global Financial Data.

The reversal of the general sell-off across maturities, specifically the sharp rally in short-term JGBs, overlaps directly with a particularly dovish policy speech by governor Fukui on September 3, 2003, in which he stressed the need for “stronger case for the Bank to continue implementing an easy monetary policy” given domestic deflationary tendencies in light of “continued severe conditions for employment and income”. In key aspects, this speech already foreshadowed the subsequently dovish clarification of the “stably positive” price condition outlined by the Bank as a prerequisite for an end to QE.[67] From a peak of 29 basis points on September 3, 2003, 2-year JGB yields fell to no less than

[67] Bank of Japan, “Summary of a Speech by Toshihiko Fukui, Governor of the Bank of Japan, at a Meeting with Business People in Nagoya”, September 3, 2003.

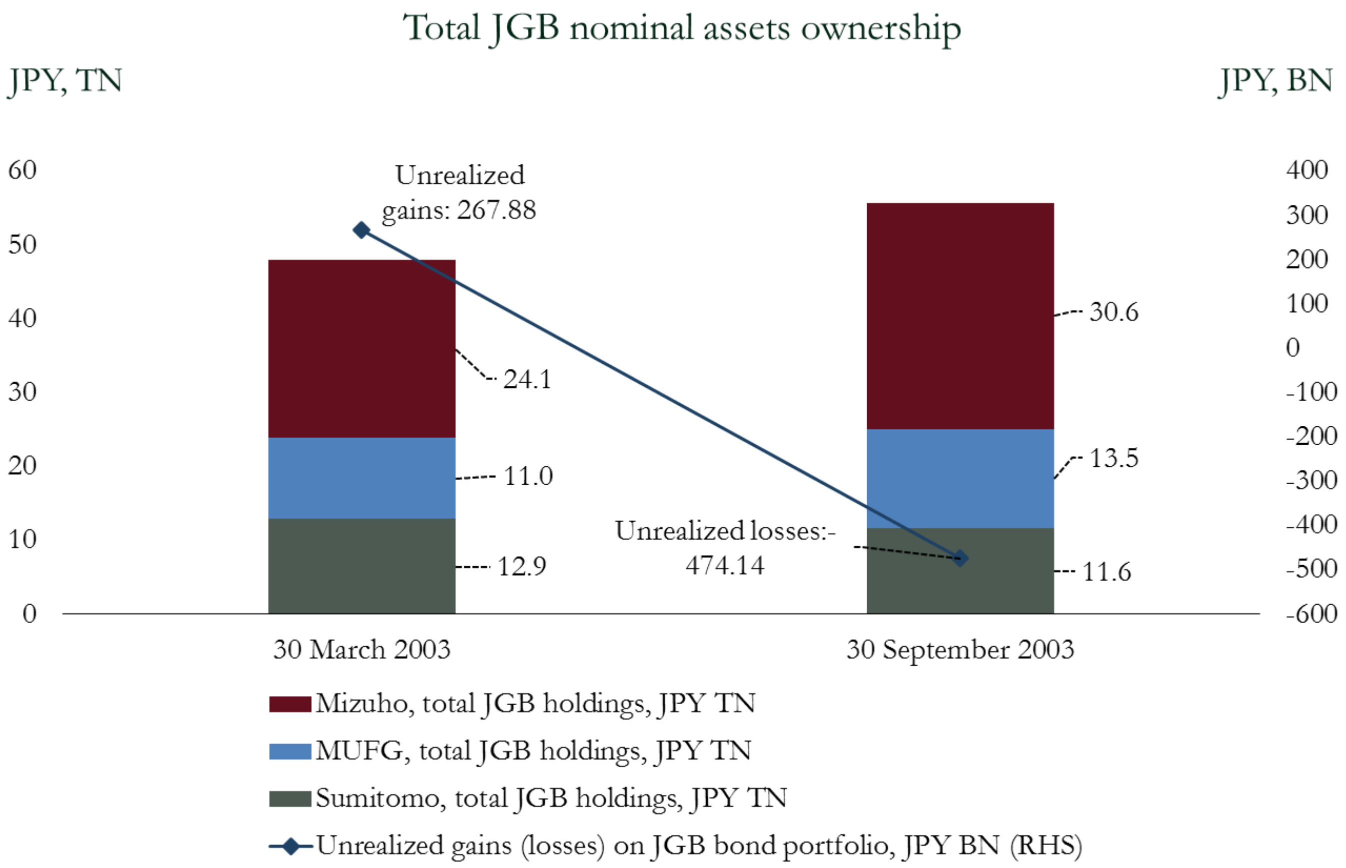
11 basis points until the actual policy announcement on October 10, 2003. At this latter date, the Bank of Japan noted "persistent structural problems, such as debt overhang and excess labor" in the economy warranting another increase in the QE monthly range, to JPY 27-32BN. However, the BoJ managed to keep long-term rates comparatively stable: 30-year JGBs only fell 9 basis points following Fukui's September 3 speech. On September 26 the governor stressed that the "excessively pessimistic scenarios from the spring" had not materialized against the prospect of more stable global growth prospects and strong domestic leading indicators.[68]

Crucially, on October 3, the board clarified its necessary QE exit conditions: first, consumer price inflation ex-food now had to be "stably a zero percent or an increase year-on-year", on a trend persisting "over a few months"; secondly, "prospective core CPI" would need to be in positive territory as well over the forecasting period in the view of "many" policy board members. Moreover, these conditions were explicitly not deemed necessarily sufficient, and further board discretion despite a realization of the necessary conditions emphasized.[69]

The same banks which previously sunk bond prices with their heavy selling between June and mid-August, now turned into stabilizing factors, and for the remainder of the quarter once more embraced trading risks in the wake of steepening yield curves. In that sense, neither hard data nor the BoJ did directly trigger the sell-off in JGBs, which is far more consistent in its timing with financial instability after the Resona bailout, and doubts over the banks' business model given the excessive curve flattening. But if not in intent, in effect the monetary authorities staved off worse turmoil by finding language that steepened bond curves; banks, meanwhile, did clearly not use VaR models slavishly; as the prospects for curve steepening improved, the major banks were once again quick to increase risk tolerance and increase (short-term) JGB exposure.

[68] "The Japanese Economy and Asia", Speech by Toshihiko Fukui, Governor of the Bank of Japan, at the Asian Affairs Research Council in Tokyo, on September 26, 2003.
[69] Bank of Japan, "Enhancement of Monetary Policy Transparency", October 10, 2003. See also: Ito (2006).

CHART 13: 'BIG THREE' JAPAN BANKS' JGB HOLDINGS AND UNREALIZED GAINS/LOSSES ON JGB BOND PORTFOLIOS, MARCH 2003 VERSUS SEPTEMBER 2003.[70]



CONCLUSION

This paper has started by providing long-term historical context to the current bond market environment, and established the comparative length and intensity of the "bull market" in the risk-free rate originating in the early 1980s. In a second step, a selection of "reversal dynamics" in the 20th century have been investigated, to distinguish different drivers of bond losses for investors. At a cumulative 36%, the inflation-driven bond market reversal of the 1960s left investors with the steepest, and most long-lasting losses. It is such a scenario which investors, therefore, should seek to

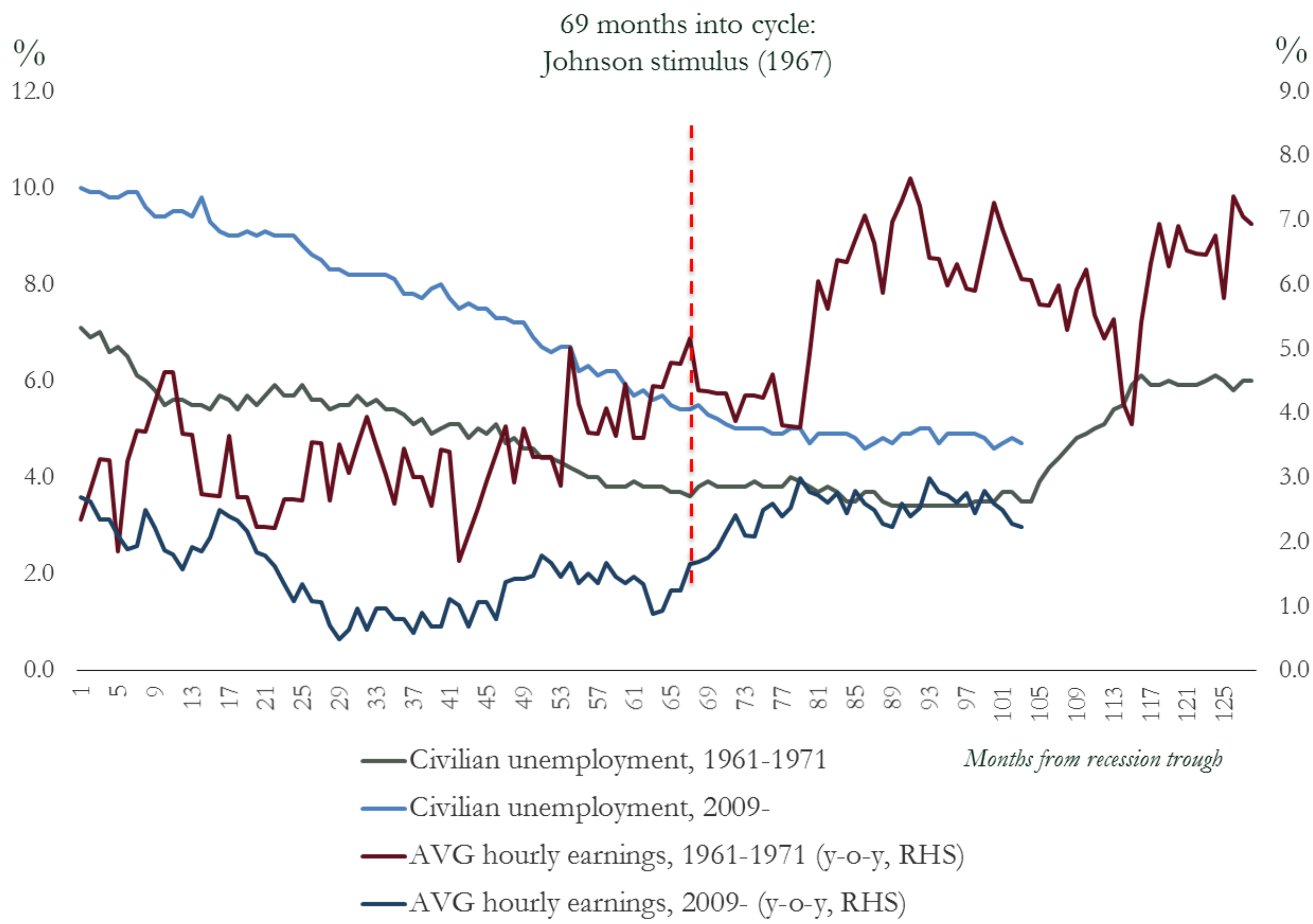
[70] Source: corporate interim FY 2004 and final FY 2003 reporting.

understand best, amid some current signs that similar wage and inflation dynamics are potentially emerging in the United States (Cf. Chart 14; and Lacker, 2017).

Meanwhile, in comparative terms, the Japanese shock proved shorter, but – adjusted for its length – more intense than the 1994 bond massacre. Based on our case studies, we can conclude that monetary policy (mis-)communication has often triggered the most rapid and steepest convolutions in bond market reversals – but that such price adjustments have given way to equally quick recoveries, if unsubstantiated by a parallel reversal in fundamentals.

The key difference according for the much longer instability in the US bond market in 1994 clearly can be attributed to official Federal Reserve communication, and the lack of a "steepening bias" in Alan Greenspan's bond market jawboning. Underestimating the uncertainty created by his data-independent policy line on "pre-emptive hiking", by the rather rapid move to a new "milestone" (Goodfriend, 2002) in transparency in February 1994 with the policy statement releases, and also by Democrats' unchecked push to restrain central bank independence via its appointment procedures, the Federal Reserve and the Clinton administration in 1994 denied bondholders the relief provided by Toshihiko Fukui at the Bank of Japan. The lessons for the Federal Reserve – if lower bond market volatility does constitute a policy desideratum, which is not necessarily answered here in the affirmative – would be to pay greater attention to changes in official language and transparency, as well as the uncertainty generated by political interference.

CHART 14: US LABOR MARKET DYNAMICS, 1961-1971, AND 2009-PRESENT.



Source: Federal Reserve Bank of St. Louis Data (FRED).

Ultimately, these "communication factors" may constitute aggravating factors, but not prime movers of the eventual reversal of the present secular bond bull market. Rather, it could be a "fundamental reversal" analogous to the dynamics in the 1960s that may culminate in an inflection point for the current bull bond market. In lieu of the parallels also stressed by Lacker (2017), it is notable that the combination of US labor market strength, and even a mild fiscal stimulus in 1967 by President Lyndon Johnson proved sufficient to sharply accelerate the inflation path – even given the fact that the business cycle was, at 69 months after the last NBER recession, already at mature stages, and the Federal Reserve Board under William McChesney Martin had initiated its hiking cycle by July 1963 (Bordo and Humpage, 2016). Chart 14 illustrates that recent US labor market dynamics thus far have evolved along comparable lines to the 1960s – and that despite rather weak recent wage inflation, a meaningful acceleration of these and broader price trends against the backdrop of a higher fiscal deficit tolerance would at least be consistent with existing historical precedents.

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APPENDIX

CHART 1: THE REAL RISK-FREE RATE SINCE 1311, NO MOVING AVERAGE.